*Codes :*

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 4 | 3 | 1 | 2 | (*b*) | 3 | 4 | 2 | 1 |
| (*c*) | 4 | 3 | 2 | 1 | (*d*) | 3 | 4 | 1 | 2 |

**Ans.** (*d*)

**Q.31.** Consider the following statements :
For precision machining of non-ferrous alloys, diamond is preferred because it has
1. low coefficient of thermal expansion
2. high wear resistance
3. high compression strength
4. low fracture toughness

Which of these statements are correct ?
(*a*) 1 and 2 (*b*) 1 and 4 (*c*) 2 and 3 (*d*) 3 and 4

**Ans.** (*a*)

**Q.32.** In turning operation, the feed could be doubled to increase the metal removal rate. To keep the same level of surface finish, the nose radius of the tool should be
(*a*) halved (*b*) kept unchanged (*c*) doubled (*d*) made four times

**Ans.** (*b*)

**Q.33.** The radical force in single-point tool during turning operation varies between
(*a*) 0.2 to 0.4 times the main cutting force
(*b*) 0.4 to 0.6 times the main cutting force
(*c*) 0.6 to 0.8 times the main cutting force
(*d*) 0.5 to 0.6 times the main cutting force

**Ans.** (*a*)

**Q.34.** Match List-I (Drill bits) with List-II (Applications) and select the correct answer using the codes given below the Lists :

| *List-I* | *List-II* |
|---|---|
| A. Core drill | 1. To enlarge a hole to a certain depth so as to accommodate the bolt head of a screw |
| B. Reamer | 2. To drill and enlarge an already existing hole in a casting |
| C. Counterbore drill | 3. To drill a hole before making internal thread |
| D. Tap drill | 4. To improve the surface finish and dimensional accuracy of the already drilled hole |

*Codes :*

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 3 | 2 | 4 | (*b*) | 2 | 3 | 1 | 4 |
| (*c*) | 2 | 4 | 1 | 3 | (*d*) | 3 | 2 | 4 | 1 |

**Ans.** (*c*)

**Q.35.** Consider the following reasons :
1. Grinding wheel is soft
2. RPM of grinding wheel is too low
3. Cut is very fine
4. An improper cutting fluid is used

A grinding wheel may become loaded due to reasons stated at
(*a*) 1 and 4 (*b*) 1 and 3 (*c*) 2 and 4 (*d*) 2 and 3

**Ans.** (*b*)

**Q.36.** Which one of the following processes results in the best accuracy of the hole made ?
(*a*) Drilling (*b*) Reaming (*c*) Broaching (*d*) Boring

**Ans.** (*b*)

**Q.37.** A straight teeth slab milling cutter of 100 *mm* diameter and 10 teeth rotating at 200 r.p.m. is used to remove a layer of 3 *mm* thickness from a steel bar. If the table feed is 400 *mm/minute*, the feed per tooth in this operation will be
(*a*) 0.2 mm (*b*) 0.4 mm (*c*) 0.5 mm (*d*) 0.6 mm

**Ans.** (*a*) Table feed = feed/teeth × No. of teeth × rpm

$$\frac{400}{10\times200} = \text{feed per teeth} = 0.2 \text{ mm.}$$

**Q.38.** Consider the following processes for the manufacture of gears :

1. Casting
2. Powder metallurgy
3. Machining from bar stock
4. Closed die forging

The correct sequence in increasing order of bending strength of gear teeth is

(*a*) 1, 2, 3, 4 (*b*) 1, 2, 4, 3 (*c*) 2, 1, 4, 3 (*d*) 2, 1, 3, 4

**Ans.** (*d*)

**Q.39.** Match List-I with List-II and select the correct answer using the codes given below the Lists :

| *List-I* | *List-II* |
|---|---|
| A. Die sinking | 1. Abrasive jet machining |
| B. Deburring | 2. Laser beam machining |
| C. Fine hole drilling (thin materials) | 3. EDM |
| D. Cutting/sharpening hard materials | 4. Ultrasonic machining |
| | 5. Electrochemical grinding |

*Codes :*

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 3 | 5 | 4 | 1 | (*b*) | 2 | 4 | 1 | 3 |
| (*c*) | 3 | 1 | 2 | 5 | (*d*) | 4 | 5 | 1 | 3 |

**Ans.** (*a*)

**Q.40.** Match List-I with List-II and select the correct answer using the codes given below the Lists :

| *List-I* | *List-II* |
|---|---|
| A. Drawing | 1. Soap solution |
| B. Rolling | 2. Camber |
| C. Wire drawing | 3. Pilots |
| D. Sheet metal operations using progressive dies | 4. Crater |
| | 5. Ironing |

*Codes :*

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 2 | 5 | 1 | 4 | (*b*) | 4 | 1 | 5 | 3 |
| (*c*) | 5 | 2 | 3 | 4 | (*d*) | 5 | 2 | 1 | 3 |

**Ans.** (*d*)

**Q.41.** In solidification of metal during casting, compensation for solid contraction is

(*a*) provided by the oversize pattern (*b*) achieved by properly placed risers
(*c*) obtained by promoting directional solidification
(*d*) made by providing chills

**Ans.** (*a*)

**Q.42.** The correct sequence of the given materials in ascending order of their weldability is

(*a*) MS, copper, cast iron, aluminium (*b*) cast iron, MS, aluminium copper
(*c*) copper, cast iron, MS, aluminium (*d*) aluminium, copper, cast iron, MS

**Ans.** (*a*)

**Q.43.** Consider the following statements :

Earing in a drawn cup can be due to non-uniform

1. speed of the press
2. clearance between tools
3. material properties
4. blank holding

Which of these statements are correct ?

(*a*) 1, 2 and 3 (*b*) 2, 3 and 4 (*c*) 1, 3 and 4 (*d*) 1, 2 and 4

**Ans.** (*d*)

**Q.44.** Consider the following operations involved in forging a hexagonal bolt from a round bar stock, whose diameter is equal to the bolt diameter :
1. Flattening 2. Upsetting 3. Swaging 4. Cambering
The correct sequence of these operations is
(*a*) 1, 2, 3, 4 (*b*) 2, 3, 4, 1 (*c*) 2, 1, 3, 4 (*d*) 3, 2, 1, 4
**Ans.** (*a*)

**Q.45.** Which one of the following is the correct temperature range for hot extrusion of aluminium ?
(*a*) 300–340°C (*b*) 350–400°C (*c*) 430–480°C (*d*) 550–650°C
**Ans.** (*b*)

**Q.46.** Consider the following statements regarding reaming process :
1. Reaming generally produces a hole larger than its own diameter
2. Generally rake angles are hot provided on reamers.
3. Even numbers of teeth are preferred in reamer design.
Which of these statements are correct ?
(*a*) 1 and 2 (*b*) 2 and 3 (*c*) 1 and 3 (*d*) 1, 2 and 3
**Ans.** (*b*)

**Q.47.** A 60-teeth gear when hobbed on a differential hobber with a two-start hob, the index change gear ratio is governed by which one of the following kinematic balance equations ?
(*a*) 1 revolution of gear blank = 1/60 of hob revolutions
(*b*) 1 revolution of gear blank = 2/60 of hob revolutions
(*c*) 1 revolution of hob = 2/60 of blank revolutions
(*d*) 1 revolution of hob = 1/60 of blank revolutions
**Ans.** (*c*)

**Q.48.** Consider the following components :
1. A dedicated computer 2. Bulk memory 3. Telecommunication lines
Which of these components are required for a DNC system ?
(*a*) 2 and 3 (*b*) 1 and 2 (*c*) 1, 2 and 3 (*d*) 1 and 3
**Ans.** (*c*)

**Q.49.** Transfer machines can be defined as
(*a*) material processing machines (*b*) material handling machines
(*c*) material processing and material handling machines
(*d*) component feeders for automatic assembly
**Ans.** (*b*)

**Q.50.** Consider the following statements regarding numerically controlled machine tools :
1. They reduce non-productive time. 2. They reduce fixturing.
3. They reduce maintenance cost.
Which of these statements are correct ?
(*a*) 1, 2 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1 and 3
**Ans.** (*b*)

**Q.51.** Diamond pin location is used in a fixture because
(*a*) it does not wear out
(*b*) it takes care of any variation in centre distance between two holes
(*c*) it is easy to clamp the part on diamond pins (*d*) it is easy to manufacture
**Ans.** (*b*)

**Q.52.** The correct sequence of the given processes in manufacturing by powder metallurgy is
(*a*) blending, compacting, sintering and sizing (*b*) blending, compacting, sizing and sintering
(*c*) compacting, sizing, blending and sintering (*d*) compacting, blending, sizing and sintering
**Ans.** (*a*)

**Q.53.** The standard time of an operation has been calculated as 10 min. The worker was rated at 80%. If the relaxation and other allowances were 25%, then the observed time would be
(*a*) 12.5 min (*b*) 10 *min* (*c*) 8 *min* (*d*) 6.5 *min*

**Ans.** (*b*) Observed time = Std. time $\times \frac{\text{Allowances}}{\text{Rating of worker}} = \frac{10 \times 1.25}{.8} = 10$ min.

**Q.54.** MTM is a work measurement technique by
(*a*) stopwatch study (*b*) work sampling study
(*c*) pre-determined motion time systems (*d*) past data comparison

**Ans.** (*c*) MTM (Methods-time measurement) is based on use of standard time for work elements that have been predetermiined from long periods of observation and analysis.

**Q.55.** Given that
$E$ = Earning in time $T_a$, $T_a$ = Actual time of work
$T_s$ = Standard time set to complete the task, $R$ = Rate per unit time
if $E = R \cdot T_a + \frac{R}{2}(T_s - T_a)$, then the graph between bonus earned and time saved is a
(*a*) straight line (*b*) convex curve (*c*) concave curve (*d*) parabola

**Ans.** (*a*)

**Q.56.** A process of discovering and identifying the pertinent information relating to the nature of a specific job is called
(*a*) job identification (*b*) job description (*c*) job analysis (*d*) job classification

**Ans.** (*b*)

**Q.57.** The type of layout suitable for use of the concept, principles and approaches of 'group technology' is
(*a*) product layout (*b*) job-shop layout (*c*) fixed position layout (*d*) cellular layout

**Ans.** (*a*)

**Q.58.** A manufacturer's master product schedule of a product is given below :

| *Period Planned* : | Week-1 | Week-2 | Week-3 |
|---|---|---|---|
| *Planned Production*: | 50 | 100 | 100 |
| | Week-4 | Week-5 | Week-6 |
| | 100 | 150 | 50 |

Each product requires a purchased component A in its sub-assembly. Before the start of week-1, there are 400 components of type A in stock. The lead time to procure this component is 2 weeks and the order quantity is 400. Number of components A per product is only one. The manufacturer should place the order for
(*a*) 400 components in week-1 (*b*) 400 components in week-3
(*c*) 200 components in week-1 and 200 components in week-3
(*d*) 400 components in week-5

**Ans.** (*b*)

**Q.59.** Consider the following costs :
1. Cost of inspection and return of goods 2. Cost of obsolescence
3. Cost of scrap 4. Cost of insurance
5. Cost of negotiation with suppliers

Which of these costs are related to inventory carrying cost ?
(*a*) 1, 2 and 3 (*b*) 1, 3 and 4 (*c*) 2, 3 and 4 (*d*) 2, 4 and 5

**Ans.** (*d*)

**Q.60.** An operations consultant for an automatic car wash wishes to plan for enough capacity to handle 60 cars per hour. Each car will have a wash time of 2 minutes, but there is to be a 20 per cent allowance

for setup time, delays and payment transactions. The installation capacity of car wash stalls should be
(*a*) 3 (*b*) 4 (*c*) 5 (*d*) 6

**Ans.** (*a*)

**Q.61.** A company intends to use exponential smoothing technique for making a forecast for one of its products. The previous year's forecast has been 78 units and the actual demand for the corresponding period turned out to be 73 units. If the value of the smoothening constant $\alpha$ is 0.2, the forecast for the next period will be
(*a*) 73 units (*b*) 75 units (*c*) 77 units (*d*) 78 units

**Ans.** (*c*) New forecast = Old forecast + $\alpha$ (actual – old forecast) = 78 + 0.2 (73 – 78) = 77

**Q.62.** Which one of the following statements is correct in relation to production, planning and control ?
(*a*) Expediting initiates the execution of production plans, whereas dispatching maintains them and sees them through to their successful completion
(*b*) Dispatching initiates the execution of production plans, whereas expediting maintains them and sees them through to their successful completion
(*c*) Both dispatching and expediting initiate the execution of production plans
(*d*) Both dispatching and expediting maintain the production plans and see them through to their successful completion

**Ans.** (*b*)

**Q.63.** In a transportation problem North-West corner rule would yield
(*a*) an optimum solution (*b*) an initial feasible solution
(*c*) a Vogel's approximate solution (*d*) a minimum cost solution

**Ans.** (*b*)

**Q.64.** In the solution of a linear programming problem by Simplex method, if during an iteration, all ratios of right-hand side $b_i$ to the coefficients of entering variable $a$ are found to be negative, it implies that the problem has
(*a*) infinite number of solutions (*b*) infeasible solution
(*c*) degeneracy (*d*) unbound solution

**Ans.** (*b*)

**Q.65.** Consider the following statements regarding the characteristics of the standard form of a linear programming problem :
1. All the constraints are expressed in the form of equations.
2. The right-hand side of each constraint equation is non-negative.
3. All the decision variables are non-negative.

Which of these statements are correct ?
(*a*) 1, 2 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1 and 3

**Ans.** (*a*)

**Q.66.** The average time between two arrivals of customers at a counter in a readymade garment store is 4 min. The average time of the counter clerk to serve the customer is 3 min. The arrivals are distributed as per Poisson distribution and the services are as per the exponential distribution. The probability that a customer arriving at the counter will have to wait, is
(*a*) zero (*b*) 0.25 (*c*) 0.50 (*d*) 0.75

**Ans.** (*d*) Utilisation parameter $= \frac{\lambda}{\mu} = \frac{15}{20} = \frac{3}{4}$, Probability that system is idle = $1 - \frac{\lambda}{\mu} = 0.25$

Probability that a customer has to wait = 0.75.

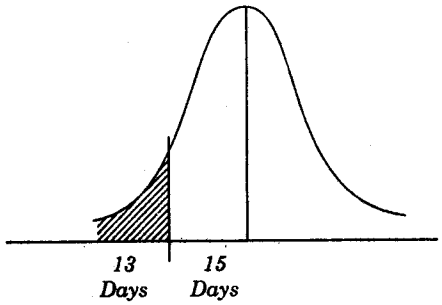
**Q.67.** Time estimates of an activity in a PERT network are :
Optimistic time $t_0$ = 9 days; pessimistic time $t_p$ = 21 days and most likely time $t_e$ = 15 days. The

approximates probability of completion of this activity in 13 days is

(*a*) 16% (*b*) 34% (*c*) 50% (*d*) 84%

**Ans.** (*a*) Expected time $= \frac{t_0 + 4t_e + t_p}{6} = \frac{9 + 4\times15 + 21}{6} = 15$ days

$$\sigma = \frac{t_p - t_0}{6} = \frac{21-9}{6} = 2$$




Probability of completing in 13 days is shaded area = 50% – Area for $1\sigma$ = 50 – 34 = 16%.

**Q.68.** Which one of the following statements is not corrected in respect of dBase III plus ?

(*a*) CREATE command is used for creating a new database file.

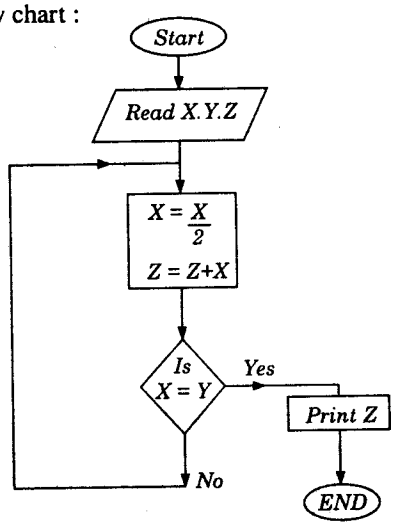
(*b*) The structure of the database file to be created, can be decided by the user.

(*c*) The structure of an existing database file, can be altered by 'CHANGE STRUCTURE' command.

(*d*) The package does not have facility for drawing graphs, curves, etc.

**Ans.** (*c*)

**Q.69.** Consider the following flow chart :




If the values of inputs are $X = 20$, $Y = 6$ and $Z = 0$, then the value of output Z will be

(*a*) 35 (*b*) 25 (*c*) 15 (*d*) 5

**Ans.** (*c*)

**Q.70.** A dealer sells a radio set at Rs. 900 and makes 80% profit on his investment. If he can sell it at Rs. 200 more, his profit as percentage of investment will be

(*a*) 160 (*b*) 180 (*c*) 100 (*d*) 120

**Ans.** (*d*)

***Directions :***

*The following 15 (fifteen) items consist of two statements, one labelled the 'Assertion A' and the other labelled the 'Reason R'. You are to examine these two statements carefully and decide if the Assertion A and the Reason R are individually true and if so, whether the Reason is a correct explanation of the Assertion. Select your answers to these items using the codes given below and mark your answer sheet accordingly.*

***Codes :***

(*a*) Both A and R are true and R is the correct explanation of A.
(*b*) Both A and R are true but R is not a correct explanation of A.
(*c*) A is true but R is false.
(*d*) A is false but R is true.

**Q.71.** *Assertion* (*A*) : It is possible to have more than one break-even point in break even charts.
*Reason* (*R*) : All variable costs are directly variable with production.
**Ans.** (*d*)

**Q.72.** *Assertion* (*A*) : In case of control charts for variables, if some points fall outside the control limits, it is concluded that the process is not under control.
*Reason* (*R*) : It was experimentally proved by Shewhart that averages of four or more consecutive readings from a universe (population) or from a process, when plotted, will form a normal distribution curve.
**Ans.** (*a*)

**Q.73.** *Assertion* (*A*) : In atomization process of manufacture of metal powder, the molten metal is forced through a small orifice and broken up by a stream of compressed air.
*Reason* (*R*) : The metallic powder obtained by atomization process is quite resistant to oxidation.
**Ans.** (*b*)

**Q.74.** *Assertion* (*A*) : Spherical washers are used to locate the job in the fixtures.
*Reason* (*R*) : 3-2-1 principle should be adopted to locate the job.
**Ans.** (*d*)

**Q.75.** *Assertion* (*A*) : In a two high rolling mill there is a limit to the possible reduction in thickness in one pass.
*Reason* (*R*) : The reduction possible in the second pass is less than that in the first pass.
**Ans.** (*b*)

**Q.76.** *Assertion* (*A*) : In sheet metal blanking operation, clearance must be given to the die.
*Reason* (*R*) : The blank should be of required dimensions.
**Ans.** (*d*)

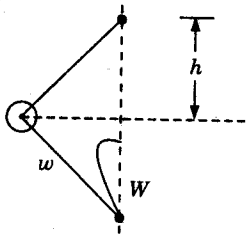
**Q.77.** *Assertion* (*A*) : A long column of square cross section has greater buckling stability than a similar column of circular cross-section of same length, same material and same area of cross-section with same end conditions.
*Reason* (*R*) : A circular cross-section has a smaller second moment of area than a square cross-section of same area.
**Ans.** (*a*)

**Q.78.** *Assertion* (*A*) : In a composite shaft having two concentric shafts of different materials, the torque shared by each shaft is directly proportional to its polar moment of inertia.
*Reason* (*R*) : In a composite shaft having concentric shafts of different materials, the angle of twist for each shaft depends upon its polar moment of inertia.
**Ans.** (*c*)

**Q.79.** *Assertion* (*A*) : Specimens for impact testing are never notched.
*Reason* (*R*) : A notch introduces triaxial tensile stresses which cause brittle fracture.
**Ans.** (*d*)

**Q.80.** *Assertion* (*A*) : Carbon forms interstitial solid solution when added to iron.
*Reason* (*R*) : The atomic radius of carbon atom is much smaller than that of iron.
**Ans.** (*a*)

**Q.81.** Consider the given figure :




*Assertion* (*A*) : In order to have the same equilibrium speed for the given values of $w$, $W$ and $h$, the masses of balls used in the Proell governor are less than those of balls used in the Porter governor.
*Reason* (*R*) : The ball is fixed to an extension link in Proell governor.
**Ans.** (*a*)

**Q.82.** *Assertion* (*A*) : In locomotive engines, the reciprocating masses are only partially balanced.
*Reason* (*R*) : Full balancing might lead to lifting the locomotive engine off the rails.
**Ans.** (*a*)

**Q.83.** *Assertion* (*A*) : Shafts supporting helical gears must have only deep groove ball-bearings.
*Reason* (*R*) : Helical gears produce axial thrusts.
**Ans.** (*a*)

**Q.84.** *Assertion* (*A*) : In pulley design of flat belt drive, the cross-sections of arms are made elliptical with major axis lying in the plane of rotation.
*Reason* (*R*) : Arms of a pulley in belt drive are subjected to torsional shear stresses and are designed for torsion.
**Ans.** (*c*)

**Q.85.** *Assertion* (*A*) : In lifts, wire ropes are preferred over solid steel rods of same diameter.
*Reason* (*R*) : Wire ropes are more flexible than steel rods and also provide plenty of time for remedial action before failure.
**Ans.** (*a*)

**Q.86.** The diameter of tommy bar for a screw jack is designed for
(*a*) bending moment due to effort applied
(*b*) torque on the tommy bar due to effort applied
(*c*) a percentage of axial loads
(*d*) some axial loads coupled with transverse loads
**Ans.** (*a*)

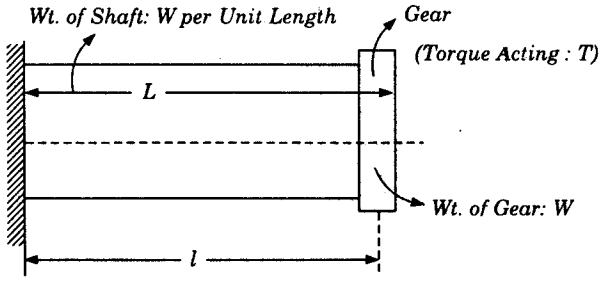
**Q.87.** Centrifugal tension in belts is
(*a*) useful because it maintains some tension even when no power is transmitted
(*b*) not harmful because it does not take part in power transmission
(*c*) harmful because it increases belt tension and reduces the power transmitted
(*d*) a hypothetical phenomenon and does not actually exist in belts
**Ans.** (*c*)

**Q.88.** In a single reduction, a large velocity ratio is required. The best transmission is
(*a*) spur gear drive (*b*) helical gear drive (*c*) bevel gear drive (*d*) worm gear drive
**Ans.** (*a*)

**Q.89.** Which one of the following belts should not be used above 40°C ?
(*a*) Balata belt (*b*) Rubber belt (*c*) Fabric belt (*d*) Synthetic belt

**Ans.** (*b*)

**Q.90.** For obtaining the maximum shear stress induced in the shaft shown in the given figure, the torque should be equal to




(*a*) $T$ (*b*) $Wl + T$

(*c*) $\left[(Wl)^2 + \left(\frac{wL}{2}\right)^2\right]^{\frac{1}{2}}$ (*d*) $\left[\left\{Wl + \frac{wL^2}{2}\right\}^2 + T^2\right]^{\frac{1}{2}}$

**Ans.** (*d*)

**Q.91.** A certain minimum number of teeth is to be kept for a gear wheel
(*a*) so that the gear is of a good size (*b*) for better durability
(*c*) to avoid interference and undercutting (*d*) for better strength

**Ans.** (*c*)

**Q.92.** In a single row deep groove ball-bearing, cages are needed to
(*a*) separate the two races
(*b*) separate the balls from the inner race
(*c*) separate the outer race from the balls
(*d*) ensure that the balls do not cluster at one point and maintain proper relative angular positions.

**Ans.** (*d*)

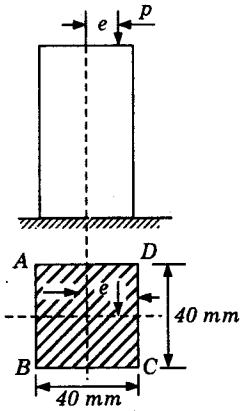
**Q.93.** Which one of the following types of bearings is employed in shafts of gearboxes of automobiles ?
(*a*) Hydrodynamic journal bearings
(*b*) Multi-lobed journal bearings
(*c*) Antifriction bearings
(*d*) Hybrid journal bearings

**Ans.** (*c*)

**Q.94.** A hole is to be punched in a 15 mm thick plate having an ultimate shear strength of 3N-mm$^{-2}$. If the allowable crushing stress in the punch is 6 N-mm$^{-2}$, the diameter of the smallest hole which can be punched is equal to
(*a*) 15 mm (*b*) 30 mm
(*c*) 60 mm (*d*) 120 mm

**Ans.** (*b*) Min. dia. $= 4t\frac{f_s}{f_c} = 4 \times 20 \times \frac{3}{6} = 30$

**Q.95.** A column of square section 40 mm × 40 mm, fixed to the ground carries an eccentric load $P$ of 1600 $N$ as shown in the figure.




If the stress developed along the edge $CD$ is $-1.2$ N/mm$^2$, the stress along the edge $AB$ will be

(*a*) $-1.2$ N/mm$^2$ (*b*) $+1$ N/mm$^2$ (*c*) $+0.8$ N/mm$^2$ (*d*) $-0.8$ N/mm$^2$

**Ans.** (*d*) Compressive stress at $CD = 1.2$ N/mm$^2 = \frac{P}{A}\left(1+\frac{6e}{b}\right)=\frac{1600}{1600}\left(1+\frac{6e}{20}\right)$, or $\frac{6e}{20}=0.2$

$\therefore$ Stress at $AB = \frac{1600}{1600}(1-0.2)=0.8$ N/mm$^2$ (compressive) $= -0.8$ N/mm$^2$.

**Q.96.** Cast iron is used for machine beds because of its high

(*a*) tensile strength (*b*) endurance strength

(*c*) damping capacity (*d*) compressive strength

**Ans.** (*d*)

**Q.97.** If a compression coil spring is cut into two equal parts and the parts are then used in parallel, the ratio of the spring rate to its initial value will be

(*a*) 1 (*b*) 2

(*c*) 4 (*d*) indeterminable for want of sufficient data

**Ans.** (*c*) When a spring is cut into two, no. of coils gets halved.

$\therefore$ Stiffness of each half gets doubled.

When these are connected in parallel, stiffness $= 2S + 2S = 4S$.

**Q.98.** Match List-I with List-II and select the correct answer using the codes given below the Lists :

| *List-I* | *List-II* |
|---|---|
| A. 4 links, 4 turning pairs | 1. Complete constraint |
| B. 3 links, 3 turning pairs | 2. Successful constraint |
| C. 5 links, 5 turning pairs | 3. Rigid frame |
| D. Footstep bearing | 4. Incomplete constraint |

*Codes :*

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 3 | 1 | 4 | 2 |
| (*c*) | 3 | 1 | 2 | 4 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 1 | 3 | 2 | 4 |
| (*d*) | 1 | 3 | 4 | 2 |

**Ans.** (*d*) 4 links and 4 turning pairs satisfies the equation $L=\frac{2}{3}(J+2)$

$\therefore$ It is case of complete constraint.

3 links and 3 turning pairs form rigid frame. Foot step bearing results in successful constraint and 5 links and 5 turning pairs provides incomplete constraint.

**Q.99.** The relative acceleration of two points which are at variable distance apart on a moving link can be determined by using the

(*a*) three centres in line theorem (*b*) instantaneous centre of rotation method

(*c*) Coriolis component of acceleration method (*d*) Klein's construction

**Ans.** (*b*) The relative acceleration of two variable points on a moving link can be determined by using the instantaneous centre of rotation method.

**Q.100.** Consider a four-bar mechanism shown in the given figure.

The driving link *DA* is rotating uniformly at a speed of 100 r.p.m. clockwise.

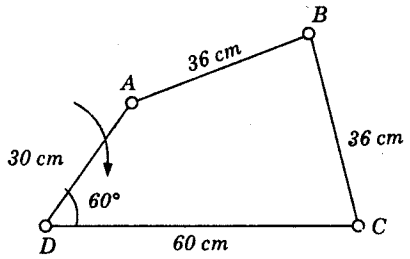
The velocity of *A* will be

(*a*) 300 cm/s

(*b*) 314 cm/s

(*c*) 325 cm/s

(*d*) 400 cm/s




**Ans.** (*b*) Velocity of $A = \omega r = \frac{2\pi \times 100}{60} \times 30 = 314$ cm/s

**Q.101.** Which one of the following pairs is correctly matched ?

(*a*) Governors ... Interference (*b*) Gears .... Hunting

(*c*) Klein's construction .... Acceleration of piston (*d*) Cam .... Pinion

**Ans.** (*c*)

**Q.102.** The primary disturbing force due to inertia of reciprocating parts of mass *m* at radius *r* moving with an angular velocity ω is given by

(*a*) $m\omega^2 r \sin\theta$ (*b*) $m\omega^2 r \cos\theta$ (*c*) $m\omega^2 r \sin\left(\frac{2\theta}{n}\right)$ (*d*) $m\omega^2 r \cos\left(\frac{2\theta}{n}\right)$

**Ans.** (*b*)

**Q.103.** A link *AB* is subjected to a force *F* (→) at a point *P* perpendicular to the link at a distance *a* from the CG as shown in the figure.

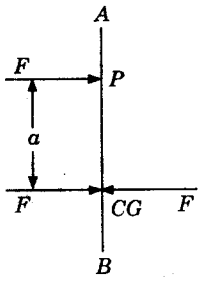
This will result in

(*a*) an inertia force *F* (→) through the *CG* and no inertia torque

(*b*) an inertia force *F*·*a* (↻) and no inertia force

(*c*) both inertia force *F* (→) through the *CG* and inertia torque *F*·*a* (↻)

(*d*) both inertia force *F* (←) through the *CG* and inertia torque *F*·*a* (↺)




**Ans.** (*c*) Apply two equal and opposite forces *F* at *CG*. Thus inertia force *F* (→) acts at *CG* and inertia torque *F*·*a* (↻)

**Q.104.** Consider the following statements :

A pinion of $14\frac{1^\circ}{2}$ pressure angle and 48 involute teeth has a pitch circle diameter of 28.8 cm. It has

1. module of 6 mm
2. circular pitch of 18 mm
3. addendum of 6 mm
4. diametral pitch of $\frac{11}{113}$

Which of these statements are correct ?

(*a*) 2 and 3 (*b*) 1 and 3 (*c*) 1 and 4 (*d*) 2 and 4

**Ans.** (*b*) Module $= \frac{d}{T} = \frac{288}{48} = 6mm$ (Thus 1 is correct)

$$\text{Circular pitch} = \frac{\pi d}{T} = \pi \times 6 = 18.84\, mm \qquad \text{(Thus 2 is not correct)}$$

$$\text{addendum} = 1 \text{ module} = 6\ mm \qquad \text{(Thus 3 is correct)}$$

$$\text{diametral pitch} = \frac{T}{d} = \frac{1}{6} \qquad \text{(Thus 4 is not correct).}$$

**Q.105.** For a given lift of the follower in a given angular motion of the cam, the acceleration/retardation of the follower will be the least when the profile of the cam during the rise portion is
(*a*) such that the follower motion is simple harmonic
(*b*) such that the follower motion has a constant velocity from start to end
(*c*) a straight line, it being a tangent cam
(*d*) such that the follower velocity increases linearly for half the rise portion and then decreases linearly for the remaining half of the rise portion.

**Ans.** (*b*)

**Q.106.** Consider the following statements regarding the choice of conjugate teeth for the profile of mating gears :
1. They will transmit the desired motion. 2. They are difficult to manufacture.
3. Standardisation is not possible. 4. The cost of production is low.
Which of these statements are correct ?
(*a*) 1, 2 and 3 (*b*) 1, 2 and 4 (*c*) 2, 3 and 4 (*d*) 1, 3 and 4

**Ans.** (*a*) Cost of production of conjugate teeth, being difficult to manufacture is high.

**Q.107.** The motion transmitted between the teeth of two spur gears in mesh is generally
(*a*) sliding (*b*) rolling
(*c*) rotary (*d*) party sliding and partly rolling

**Ans.** (*a*)

**Q.108.** In a single slider four-bar linkage, when the slider is fixed, it forms a mechanism of
(*a*) hand pump (*b*) reciprocating engine
(*c*) quick return (*d*) oscillating cylinder

**Ans.** (*a*)

**Q.109.** Consider the following parameters :
1. Limit of peripheral speed 2. Limit of centrifugal stress
3. Coefficient of fluctuation of speed 4. Weight of the rim
Which of these parameters are used in the calculation of the diameter of fly wheel rim ?
(*a*) 1, 3 and 4 (*b*) 2, 3 and 4 (*c*) 1, 2 and 3 (*d*) 1, 2 and 4

**Ans.** (*a*) Limit of centrifugal stress is not considered.

**Q.110.** Consider the following speed governors :
1. Porter governor 2. Hartnell governor 3. Watt governor 4. Proell governor
The correct sequence of development of these governors is
(*a*) 1, 3, 2, 4 (*b*) 3, 1, 4, 2 (*c*) 3, 1, 2, 4 (*d*) 1, 3, 4, 2

**Ans.** (*b*) Watt, Porter, Proell, Hartnell.

**Q.111.** If a two-mass system is dynamically equivalent to a rigid body, then the system will not satisfy the condition that the
(*a*) sum of the two masses must be equal to that of the rigid body
(*b*) polar moment of inertia of the system should be equal to that of the rigid body
(*c*) centre of gravity (c.g.) of the system should coincide with that of the rigid body
(*d*) total moment of inertia about the axis through c.g. must be equal to that of the rigid body

**Ans.** (*d*) First three conditions are essential.

**Q.112.** A rigid shaft when laid on horizontal parallel ways will not roll if the
(*a*) centre of gravity falls on parallels (*b*) centre of gravity lies on the shaft axis
(*c*) horizontal moments are large (*d*) vertical moments are large
**Ans.** (*b*)

**Q.113.** If the ratio of the length of connecting rod to the crank radius increases, then
(*a*) primary unbalanced forces will increase (*b*) primary unbalanced forces will decrease
(*c*) secondary unbalanced forces will increase (*d*) secondary unbalanced forces will decrease
**Ans.** (*d*) Secondary force only involves ratio of length of connecting rod and crank radius and is equal to

$$m\omega^2 r\frac{\cos 2\theta}{n}$$

. If $n$ increases, value of secondary force will decrease.

**Q.114.** If a spring-mass-dashpot system is subjected to excitation by a constant harmonic force, then at resonance, its amplitude of vibration will be
(*a*) infinity (*b*) inversely proportional to damping
(*c*) directly proportional to damping (*d*) decreasing exponentially with time
**Ans.** (*a*)

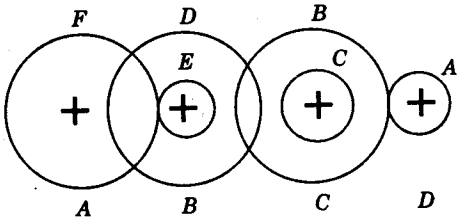
**Q.115.** In a forced vibration with viscous damping, maximum amplitude occurs when forced frequency is
(*a*) equal to natural frequency (*b*) slightly less than natural frequency
(*c*) slightly greater than natural frequency (*d*) zero
**Ans.** (*a*)

**Q.116.** The value of the natural frequency obtained by Rayleigh's method
(*a*) is always greater than the actual fundamental frequency
(*b*) is always less than the actual fundamental frequency
(*c*) depends upon the initial deflection curve chose and may be greater than or less than the actual fundamental frequency
(*d*) is independent of the initial deflection curve chosen
**Ans.** (*d*)

**Q.117.** In a multi-rotor system of torsional vibration maximum number of nodes that can occur is
(*a*) two (*b*) equal to the number of rotor plus one
(*c*) equal to the number of rotors (*d*) equal to the number of rotors minus one
**Ans.** (*d*)

**Q.118.** A rotating shaft carries a flywheel which overhangs on the bearing as a cantilever. If this flywheel weight is reduced to half of its original weight, the whirling speed will
(*a*) be double (*b*) increase by $\sqrt{2}$ times
(*c*) decrease by $\sqrt{2}$ times (*d*) be half
**Ans.** (*b*) Whirling speed $\propto \sqrt{\frac{1}{I}}$

**Q.119.** Consider the gear train shown in the given figure and table of gears and their number of teeth.



| *Gear* | : | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|
| *No. of teeth* | : | 20 | 50 | 25 | 75 | 26 | 65 |

Gears *BC* and *DE* are moulded on parallel shaft rotating together.
If the speed of *A* is 975 r.p.m., the speed of F will be
(*a*) 39 r.p.m. (*b*) 52 r.p.m. (*c*) 75 r.p.m. (*d*) 80 r.p.m.

**Ans.** (*b*) Speed ratio $\frac{N_F}{N_A} = \frac{T_A \times T_C \times T_E}{T_B \times T_D \times T_F} = \frac{20 \times 25 \times 26}{50 \times 75 \times 65} = \frac{4}{75}$

$$\therefore \quad N_F = 975 \times \frac{4}{75} = 52 \text{ rpm}$$

**Q.120.** Consider the following statements in respect of introduction of feedback in a control system :
1. It enhances its gain. 2. It attenuates the unwanted noise.
3. It helps in improving the accuracy of the system.
Which of these statements are correct ?
(*a*) 2 and 3 (*b*) 1, 2 and 3 (*c*) 1 and 3 (*d*) 1 and 2

**Ans.** (*c*)

# I.E.S. (Objective)
# MECHANICAL ENGINEERING–2000
# PAPER - I

**Q. 1.** An aeroplane travels at 400 km/hr at sea level where the temperature is 15°C. The velocity of the aeroplane at the same Mach number at an altitude where a temperature of – 25°C is prevailing, would be

(*a*) 126.78 km/hr (*b*) 130.6 km/hr (*c*) 371.2 km/hr (*d*) 400.10 km/hr

**Ans.** (*d*)

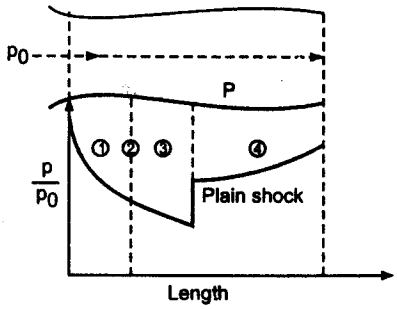
**Q. 2.** The plot for the pressure ratio along the length of the convergent-divergent nozzle is shown in the given figure. The sequence of the flow conditions labelled 1, 2, 3, and 4 in the figure is respectively

(*a*) supersonic, sonic, subsonic and supersonic

(*b*) sonic, supersonic, subsonic and supersonic

(*c*) subsonic, supersonic, sonic and subsonic

(*d*) subsonic, sonic, supersonic and subsonic




**Ans.** (*d*)

**Q. 3.** If the full-scale turbine is required to work under a head of 30 m and to run at 428 r. p. m., then a quarter-scale turbine model tested under a head of 10 m must run at

(*a*) 143 r. p. m. (*b*) 341 r. p. m. (*c*) 428 r. p. m. (*d*) 988 r. p. m.

**Ans.** (*d*)

**Q. 4.** The dimensionless group formed by wavelength $\lambda$, density of fluid $\rho$, acceleration due to gravity $g$ and surface tension $\sigma$, is

(*a*) $\frac{\sigma}{\lambda^2 g\rho}$ (*b*) $\frac{\sigma}{\lambda g^2 \rho}$ (*c*) $\frac{\sigma g}{\lambda^2 \rho}$ (*d*) $\frac{\rho}{\lambda^2 g\sigma}$

**Ans.** (*a*)

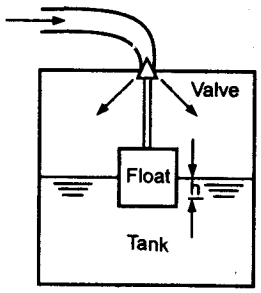
**Q. 5.** Which one of the following sets of standard flows is superimposed to represent the flow around a rotating cylinder ?

(*a*) Doublet, vortex and uniform flow (*b*) Source, vortex and uniform flow

(*c*) Sink, vortex and uniform flow (*d*) Vortex and uniform flow

**Ans.** (*a*)

**Q. 6.**



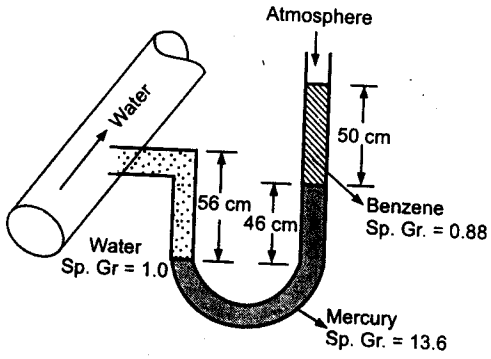

A float of cubical shape has sides of 10 cm. The float valve just touches the valve seat to have a flow area of 0.5 $cm^2$ as shown in the given figure. If the pressure of water in the pipeline is 1 bar, the rise of water level h in the tank to just stop the water flow will be

(*a*) 7.5 cm (*b*) 5.0 cm (*c*) 2.5 cm (*d*) 0.5 cm

**Ans.** (*b*)

**Q. 7.** A U-tube manometer is connected to a pipeline conveying water as shown in the given figure. The pressure head of water in the pipeline is

(*a*) 7.12 m (*b*) 6.56 m
(*c*) 6.0 m (*d*) 5.12




**Ans.** (*c*)

**Q. 8.** The eye of a tornado has a radius of 40 m. If the maximum wind velocity is 50 m/s, the velocity at a distance of 80 m radius is

(*a*) 100 m/s (*b*) 2500 m/s
(*c*) 31.25 m/s (*d*) 25 m/s

**Ans.** (*d*)

**Q. 9.** If a vessel containing liquid moves downward with constant acceleration g, then

(*a*) the pressure throughout the liquid mass is atmospheric
(*b*) the pressure in the liquid mass is greater than the hydrostatic pressure
(*c*) there will be vacuum in the liquid
(*d*) the pressure throughout the liquid mass is greater than atmospheric

**Ans.** (*a*)

**Q. 10.** Improved streamlining produces 25% reduction in the drag coefficient of a torpedo. When it is travelling fully submerged and assuming the driving power to remain the same, the increase in speed will be

(*a*) 10% (*b*) 20% (*c*) 25% (*d*) 30%

**Ans.** (*a*)

**Q. 11.** If a bullet is fired in standard air at 15°C at the Mach angle of 30°, the velocity of the bullet would be

(*a*) 513.5 m/s (*b*) 585.5 m/s (*c*) 645.5 m/s (*d*) 680.5 m/s

**Ans.** (*d*)

**Q. 12.** A stream function is given by $(x^2 - y^2)$. The potential function of the flow will be

(*a*) $2xy + f(x)$ (*b*) $2xy$ + constant (*c*) $2(x^2 - y^2)$ (*d*) $2xy + f(y)$

**Ans.** (*b*)

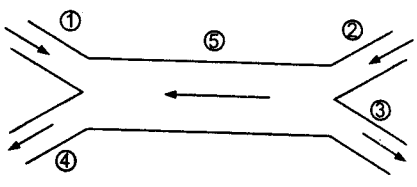
**Q. 13.** The height of a cylindrical container is twice that of its diameter. The ratio of the horizontal forces on the wall of the cylinder when it is completely filled to that when it is half filled with the same liquid, is

(*a*) 2 (*b*) 3 (*c*) 3.5 (*d*) 4

**Ans.** (*a*)

**Q. 14.** The velocities and corresponding flow areas of the branches labelled 1, 2, 3, 4 and 5 for a pipe system shown in the given figure are given in the following table :

| *Pipe Label 1* | *Velocity* | *Area* |
|---|---|---|
| 1 | 5 cm / s | 4 sq cm |
| 2 | 6 cm / s | 5 sq cm |
| 3 | $V_3$ cm / s | 2 sq cm |
| 4 | 4 cm / s | 10 sq cm |
| 5 | $V_5$ cm / s | 8 sq cm |



The velocity $V_5$ would be

(*a*) 2.5 cm/s (*b*) 5 cm/s (*c*) 7.5 cm/s (*d*) 10 cm/s

**Ans.** (*b*)

**Q. 15.** A pipe is connected in series to another pipe whose diameter is twice and length is 32 times that of the first pipe. The ratio of frictional head losses for the first pipe to those for the second pipe is (both the pipes have the same frictional constant)

(*a*) 8 (*b*) 4 (*c*) 2 (*d*) 1

**Ans.** (*d*)

**Q 16.** Which one of the following statements is correct ?

(*a*) Hydraulic grade line and energy grade line are the same in fluid flow problems

(*b*) Energy grade line lies above the hydraulic grade line and is always parallel to it

(*c*) Energy grade line lies above the hydraulic grade line and they are separated from each other by a vertical distance equal to the velocity head

(*d*) The hydraulic grade line slopes upwards meeting the energy grade line only at the exit of flow

**Ans.** (*c*)

**Q. 17.** If laminar flow takes place in two pipes, having relative roughnesses of 0.002 and 0.003, at a Reynolds number of 1815, then

(*a*) the pipe of relative roughness of 0.003 has a higher friction factor

(*b*) the pipe of relative roughness of 0.003 has a lower friction factor

(*c*) both pipes have the same friction factor

(*d*) no comparison is possible due to inadequate data

**Ans.** (*a*)

**Q. 18.** A pipeline connecting two reservoirs has its diameter reduced by 20% due to deposition of chemicals. For a given head difference in the reservoirs with unaltered friction factor, this would cause a reduction in discharge of

(*a*) 42.8% (*b*) 20% (*c*) 17.8% (*d*) 10.6%

**Ans.** (*a*)

**Q. 19.** A tank containing water has two orifices of the same size at depths of 40 cm and 90 cm below the free surface of water. The ratio of discharges through these orifices is

(*a*) 1 : 1 (*b*) 2 : 3 (*c*) 4 : 9 (*d*) 16 : 81

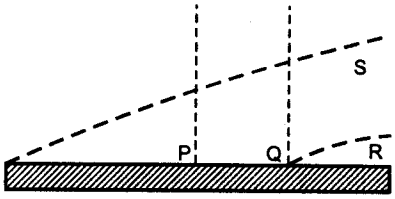
**Ans.** (*b*)

**Q. 20.** A Pitot static tube is used to measure the velocity of water using a differential gauge which contains a manometric fluid of relative density 1.4. The deflection of the gauge fluid when water flows at a velocity of 1.2 m/s will be (the coefficient of the tube may be assumed to be 1)

(*a*) 183.5 mm (*b*) 52.4 mm (*c*) 5.24 mm (*d*) 73.4 mm

**Ans.** (*b*)

**Q. 21.** The development of boundary layer zones labelled P, Q, R and S over a flat plate is shown in the given figure



Based on this figure, match List (Boundary layer zones) with List II (Types of boundary layer) and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. P | 1. Transitional |
| B. Q | 2. Laminar viscous sub-layer |
| C. R | 3. Laminar |
| D. S | 4. Turbulent |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 3 | 1 | 2 | 4 | (*b*) | 3 | 2 | 1 | 4 |
| (*c*) | 4 | 2 | 1 | 3 | (*d*) | 4 | 1 | 2 | 3 |

**Ans.** (*a*)

**Q. 22.** A pipe of 20 cm diameter and 30 km length transports oil from a tanker to the shore with a velocity of 0.318 m/s. The flow is laminar. If $\mu = 0.1$ N-m/s$^2$, the power required for the flow would be

(*a*) 9.25 kW (*b*) 8.36 kW (*c*) 7.63 kW (*d*) 10.13 kW

**Ans.** (*a*)

**Q. 23.** In a turbulent boundary layer over the entire length of a plate, the boundary layer thickness increases with its distance X from the leading edge as

(*a*) $X^{1/2}$ (*b*) $X^{1/5}$ (*c*) $X^{2/5}$ (*d*) $X^{4/5}$

**Ans.** (*d*)

**Q. 24.** Separation of fluid flow is caused by

(*a*) reduction of pressure in the direction of flow (*b*) reduction of the boundary layer thickness
(*c*) presence of adverse pressure gradient (*d*) presence of favourable pressure gradient

**Ans.** (*c*)

**Q. 25.** When pressure drag over a body is large as compared to the friction drag, then the shape of the body is that of

(*a*) an aerofoil (*b*) a streamlined body (*c*) a two-dimensional body (*d*) a bluff body

**Ans.** (*d*)

**Q. 26.** A circular cylinder of 400 mm diameter is rotated about its axis in a stream of water having a uniform velocity of 4 m/s. When both the stagnation points coincide, the lift force experienced by the cylinder is

(*a*) 160 kN/m (*b*) 10.05 kN/m (*c*) 80 kN/m (*d*) 40.2 kN/m

**Ans.** (*b*)

**Q. 27.** An automobile moving at a velocity of 40km/hr is experiencing a wind resistance of 2kN. If the automobile is moving at a velocity of 50km/hr, the power required to overcome the wind resistance is

(*a*) 43.4kW (*b*) 3.125 kW (*c*) 2.5 kW (*d*) 27.776 kW

**Ans.** (*a*)

**Q. 28.** When a cylinder is placed in an ideal fluid and the flow is uniform, the pressure coefficient $C_p$ is equal to

(*a*) $1 - \sin^2\theta$ (*b*) $1 - 2\sin^2\theta$ (*c*) $1 - 4\sin^2\theta$ (*d*) $1 - 8\sin^2\theta$

**Ans.** (*a*)

**Q. 29.** If the upstream Mach number of a normal shock occurring in air ($k = 1.4$) is 1.68, then the Mach number after the shock is

(*a*) 0.84 (*b*) 0.646 (*c*) 0.336 (*d*) 0.564

**Ans.** (*b*)

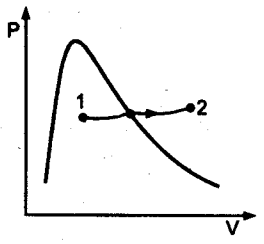
**Q. 30.** Which one of the following sets of thermodynamic laws/relations is directly involved in determining the final properties during an adiabatic mixing process ?
(*a*) The first and second laws of thermodynamics
(*b*) The second law of thermodynamics and steady flow relations
(*c*) Perfect gas relationship and steady flow relations
(*d*) The first law of thermodynamics and perfect gas relationship
**Ans.** (*d*)

**Q. 31.** The air with enthalpy of 100kJ/kg is compressed by an air compressor to a pressure and temperature at which its enthalpy becomes 200kJ/kg. The loss of heat is 40kJ/kg from the compressor as the air passes through it. Neglecting kinetic and potential energies, the power required for an air mass flow of 0.5kg/s is
(*a*) 30kW (*b*) 50kW (*c*) 70kW (*d*) 90kW
**Ans.** (*a*)

**Q. 32.** Consider the following statements :
1. The first law of thermodynamics is a law of conservation of energy.
2. Perpetual motion machine of the first kind converts energy into equivalent work.
3. A closed system does not exchange work or energy with its surroundings.
4. The second law of thermodynamics stipulates the law of conservation of energy and entropy.
Which of the statements are correct ?
(*a*) 1 and 3 (*b*) 2 and 4 (*c*) 2, 3 and 4 (*d*) 1, 2 and 3
**Ans.** (*d*)

**Q. 33.** A heat engine receives 1000kW of heat at a constant temperature of 285°C and rejects 492 kW of heat at 5°C. Consider the following thermodynamic cycles in this regard :
1. Carnot cycle 2. Reversible cycle 3. Irreversible cycle
Which of these cycles could possible be executed by the engine ?
(*a*) 1 alone (*b*) 3 alone
(*c*) 1 and 2 (*d*) None of 1, 2 and 3
**Ans.** (*a*)

**Q. 34.** The process 1-2 for steam shown in the given figure is
(*a*) isobaric (*b*) isentropic (*c*) isenthalpic (*d*) isothermal
**Ans.** (*c*)




**Q. 35.** In which one of the following working substances, does the relation $\frac{T_2}{T_1}=\left(\frac{p_2}{p_1}\right)^{0.286}$ hold good if the process takes place with zero heat transfer ?
(*a*) Wet steam (*b*) Superheated steam
(*c*) Petrol vapour and air mixture (*d*) Air
**Ans.** (*b*)

**Q. 36.** Consider the following statements :
When dry saturated steam is throttled from a higher pressure to a lower pressure, the
1. pressure decreases and the volume increases
2. temperature decreases and the steam becomes superheated
3. temperature and the dryness fraction increase
4. entropy increases without any change in enthalpy
Which of these statements are correct ?
(*a*) 1 and 4 (*b*) 1, 2 and 4 (*c*) 1 and 3 (*d*) 2 and 4
**Ans.** (*a*)

**Q. 37.** 10kg of water is heated from 300 K to 350 K in an insulated tank due to churning action by a stirrer. The ambient temperature is 300 K. In this context, match List I and List II and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Enthalpy change | 1. 12.2 kJ/kg |
| B. Entropy change/kg | 2. 1968 kJ |
| C. Availability/kg | 3. 2090 kJ |
| D. Loss of availability | 4. 656 J/kg-k |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 3 | 1 | 4 | 2 | (*b*) | 2 | 4 | 1 | 3 |
| (*c*) | 3 | 4 | 1 | 2 | (*d*) | 2 | 1 | 4 | 3 |

**Ans.** (*c*)

**Q. 38.** In which one of the following situations the entropy change will be negative

(*a*) Air expands isothermally from 6 bars to 3 bars
(*b*) Air is compressed to half the volume at constant pressure
(*c*) Heat is supplied to air at constant volume till the pressure becomes three folds
(*d*) Air expands isentropically from 6 bars to 3 bars

**Ans.** (*a*)

**Q. 39.** Consider the following thermodynamic relations :

1. $Tds = du + pdv$ 2. $Tds = du - pdv$
3. $Tds = dh + vdp$ 4. $Tds = dh - vdp$

Which of these thermodynamic relations are correct ?

(*a*) 1 and 3 (*b*) 1 and 4 (*c*) 2 and 3 (*d*) 2 and 4

**Ans.** (*b*)

**Q. 40.** The heat added to a closed system during a reversible process is given by $Q = \alpha T + \beta T^2$, where $\alpha$ and $\beta$ are constants. The entropy change of the system as its temperature changes from $T_1$ to $T_2$ is equal to

(*a*) $\alpha + \beta (T_2 - T_1)$

(*b*) $\left[ \alpha (T_2 - T_1) + \frac{\beta}{2} (T_2^2 - T_1^2) \right] / T_1$

(*c*) $\left[ \frac{\alpha}{2} (T_2^2 - T_1^2) + \frac{\beta}{3} (T_2^3 - T_1^3) \right] / T_1^2$

(*d*) $\alpha \ln \left( \frac{T_2}{T_1} \right) + 2\beta (T_2 - T_1)$

**Ans.** (*c*)

**Q. 41.** The internal energy of a gas obeying van der Waals equation $\left( p + \frac{a}{v^2} \right)(v - b) = RT$ depends on its

(*a*) temperature
(*b*) temperature and pressure
(*c*) temperature and specific volume
(*d*) pressure and specific volume

**Ans.** (*b*)

**Q. 42.** Consider the following statements :

A real gas obeys perfect gas law at very

1. high temperatures 2. high pressures 3. low pressures

Which of these statements is/are correct ?

(*a*) 1 alone (*b*) 1 and 3 (*c*) 2 alone (*d*) 3 alone

**Ans.** (*d*)

**Q. 43.** The Clapeyron equation with usual notations is given by

$(a)\left(\frac{dT}{dP}\right)_{sat}=\frac{h_{fg}}{Tv_{fg}}$ $(b)\left(\frac{dP}{dT}\right)_{sat}=\frac{h_{fg}}{Tv_{fg}}$ $(c)\left(\frac{dT}{dP}\right)_{sat}=\frac{Th_{fg}}{v_{fg}}$ $(d)\left(\frac{dP}{dT}\right)_{sat}=\frac{Th_{fg}}{v_{fg}}$

**Ans.** (*b*)

**Q. 44.** The capacity of an air compressor is specified as 10 $m^3$/min. It means that the compressor is capable of

(*a*) supplying 3 $m^3$ of compressed air per minute

(*b*) compressing 3 $m^3$ of free air per minute

(*c*) supplying 3 $m^3$ of compressed air at NTP

(*d*) compressing 3 $m^3$ of standard air per minute

**Ans.** (*a*)

**Q. 45.** A two-stage compressor takes in air at 1.1 bars and discharges at 20 bars. For maximum efficiency, the intermediate pressure is

(*a*) 10.55 bars (*b*) 7.33 bars (*c*) 5.5. bars (*d*) 4.7 bars

**Ans.** (*d*)

**Q. 46.** For the same maximum pressure and heat input, the most efficient cycle is

(*a*) Otto cycle (*b*) Diesel cycle

(*c*) Brayton cycle (*d*) Dual combustion cycle

**Ans.** (*a*)

**Q. 47.** Consider the following statements :

1. Octane rating of gasoline is based on iso-octane and isoheptane fuels which are paraffins.
2. Tetraethyl lead is added to gasoline to increase octane number.
3. Ethylene dibromide is added as scavenging agent to remove lead deposits on spark plugs.
4. Surface ignition need not necessarily cause knocking.

Which of these statements are correct ?

(*a*) 1, 2, 3 and 4 (*b*) 2, 3 and 4 (*c*) 1 and 4 (*d*) 1, 2 and 3

**Ans.** (*b*)

**Q. 48.** Consider the following statements :

1. Recycling exhaust gases with intake increases emission of oxides of nitrogen from the engine.
2. When the carburettor throttle is suddenly opened, the fuel air mixture leans out temporarily causing engine stall.
3. The effect of increase in altitude on carburettor is to enrich the entire part-throttle operation.
4. Use of multiple venturi system makes it possible to obtain a high velocity air stream when the fuel is introduced at the main venturi throat.

Which of these statements are correct ?

(*a*) 1 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 2 and 4

**Ans.** (*c*)

**Q. 49.** Match List I (Air-fuel ratio by mass) with List II (Engine operation mode) and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. 10 : 1 | 1. CI engine part load |
| B. 16 : 1 | 2. SI engine part load |
| C. 35 : 1 | 3. SI engine idling |
| D. 12.5 : 1 | 4. CI full load |
| | 5. SI full load |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 3 | 2 | 1 | 5 |
| (*c*) | 3 | 1 | 2 | 4 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 4 | 2 | 1 | 5 |
| (*d*) | 4 | 1 | 2 | 3 |

**Ans.** (*a*)

**Q. 50.** Consider the following statements :

In down draft carburettor, a hot spot is formed at the bottom wall which is common for intake and exhaust manifolds. This helps to

1. improve evaporation of liquid fuel
2. provide higher thermal efficiency
3. reduce fuel consumption
4. lower the exhaust gas temperature

Which of these statements are correct ?

(*a*) 1, 2 and 4 (*b*) 1, 2 and 3 (*c*) 1, 3 and 4 (*d*) 2, 3 and 4

**Ans.** (*a*)

**Q. 51.** In a petrol engine car, which one of the following performance characteristics is affected by the front-end volatility of the gasoline used ?

(*a*) Hot starting and vapour lock
(*b*) Engine warm-up and spark plug fouling
(*c*) Spark plug fouling and hot starting
(*d*) Vapour lock, engine warm-up and spark plug fouling

**Ans.** (*d*)

**Q. 52.** In turbo prop, the expansion of gases takes place approximately

(*a*) 100% in the turbine
(*b*) 80% in the turbine and 20% in the nozzle
(*c*) 50% in the turbine and 50% in the nozzle
(*d*) 100% in the nozzle

**Ans.** (*a*)

**Q. 53.** The most commonly used moderator in nuclear power plants is

(*a*) heavy water (*b*) concrete and bricks (*c*) steel (*d*) graphite

**Ans.** (*d*)

**Q. 54.** Shielding in a nuclear reactor is generally done to protect against

(*a*) excess electrons
(*b*) X-rays
(*c*) α-and-β rays
(*d*) neutron and gamma rays

**Ans.** (*d*)

***Direction : The following (12) items consist of two statements, one labelled the 'Assertion (A)' and the other labelled the 'Reason (R)'. You are to examine these two statements and decide if the Assertion (A) and the Reason (R) are individually true and if so, whether the Reason is a correct explanation of the Assertion. Select your answers to these items using the codes given below and mark your Answer Sheet accordingly.***

***Codes :***

(*a*) Both A and R are true and R is the correct explanation of A
(*b*) Both A and R are true but R is *NOT* the correct explanation of A
(*c*) A is true but R is false
(*d*) A is false but R is true

**Q. 55.** *Assertion (A) :* If a cube is placed in a liquid with two of its surfaces parallel to the free surface of the liquid, then the pressures on the two surfaces which are parallel to the free surface, are the same.

*Reason (R) :* Pascal's law states that when a fluid is at rest, the pressure at any plane is the same in all directions.

**Ans.** (*d*)

**Q. 56.** *Assertion (A) :* Catalytic converters for reduction of oxides of nitrogen in engine exhaust cannot be used with leaded fuels.
*Reason (R) :* Catalyst will be removed due to chemical corrosion by lead salts.
**Ans.** (*a*)

**Q. 57.** *Assertion (A) :* The CI engine is basically more suitable for supercharging than the SI engine.
*Reason (R) :* In the CI engine supercharging tends to prevent diesel knocking.
**Ans.** (*b*)

**Q. 58.** *Assertion (A) :* With the help of a Bomb calorimeter, the lower calorific value of a solid or liquid fuel can be determined, as the water vapour formed is carried away by the exhaust gases.
*Reason (R) :* The lower calorific value of a fuel is the net value of heat available found by subtracting the latent head of the water formed and carried away by exhaust gas from the higher calorific value.
**Ans.** (*a*)

**Q. 59.** *Assertion (A) :* The thermal efficiency of Brayton cycle would not necessarily increase with reheat.
*Reason (R) :* Constant pressure lines on the T-s diagram slightly diverge with increase in entropy.
**Ans.** (*b*)

**Q. 60.** *Assertion (A) :* A thermodynamic system may be considered as a quantity of working substance with which interactions of heat and work are studied.
*Reason (R) :* Energy in the form of work and heat are mutually convertible.
**Ans.** (*b*)

**Q. 61.** *Assertion (A) :* All analyses of heat transfer in turbulent flow must eventually rely on experimental data.
*Reason (R) :* The eddy properties vary across the boundary layer and no adequate theory is available to predict their behaviour.
**Ans.** (*a*)

**Q. 62.** *Assertion (A) :* The leakage heat transfer from the outside surface of a steel pipe carrying hot gases is reduced to a greater extent on providing refractory brick lining on the inside of the pipe as compared to that with brick lining on the outside.
*Reason (R) :* The refractory brick lining on the inside of the pipe offers a higher thermal resistance.
**Ans.** (*a*)

**Q. 63.** *Assertion (A) :* Thermal conductance of heat pipe is several hundred times that of the best available metal conductor under identical conditions.
*Reason (R) :* The value of latent heat is far greater than that of specific heat.
**Ans.** (*a*)

**Q. 64.** *Assertion (A) :* The efficiency of a pump is generally less than that of a turbine.
*Reason (R) :* Although the losses in the two types of machines are of the same kind, the losses in pumps are more due to eddies and turbulence.
**Ans.** (*a*)

**Q. 65.** *Assertion (A) :* Modern turbines have velocity compounding at the initial stages and pressure compounding in subsequent stages.
*Reason (R) :* Excessive tip leakage occurs in the high pressure region of reaction blading.
**Ans.** (*d*)

**Q. 66.** *Assertion (A) :* The air-fuel ratio employed in a gas turbine is around 60 : 1
*Reason (R) :* A lean mixture of 60 : 1 in a gas turbine is mainly used for complete combustion.
**Ans.** (*c*)

**Q. 67.** Which one of the following pairs of features and compressors type is NOT correctly matched ?

(*a*) Intake and delivery ports compression is attained by back flow and internal compression cylindrical rotor set to eccentric casing : Vane compressor

(*b*) Intermittent discharge requires receiver, produces high pressure, slow speed and lubrication problems : Reciprocating compressor

(*c*) Continuous flow, radial flow, handles large volume, much higher speed and fitted into design of aero-engine : Centrifugal compressor

(*d*) Successive pressure drops through contracting passages, blades are formed from a number of circular arcs, axial flow : Axial flow compressor

**Ans.** (*c*)

**Q. 68.** Consider the following statements :

1. Forced circulation is always used in high pressure power boilers.
2. Soot blowers are used for cleaning tube surfaces at regular intervals.
3. Electrostatic precipitator is used to remove fly ash from flue gases.

Which of these statements are correct ?

(*a*) 1, 2 and 3 (*b*) 2 and 3 (*c*) 1 and 3 (*d*) 1 and 2

**Ans.** (*b*)

**Q. 69.** Once-through boilers operate at

(*a*) subcritical pressure (*b*) supercritical pressure

(*c*) subcritical as well as supercritical pressures (*d*) critical pressure only

**Ans.** (*c*)

**Q. 70.** Match List I (Components) with List II (Functions) and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Steam trap | 1. Controls steam flow rate |
| B. Fusible plug | 2. Controls rate of water flow to boiler |
| C. Blow-off cock | 3. Puts off furnace fire when water level reaches unsafe limit |
| D. Feed check valve | 4. Removes mud and dirt collected at the bottom of boiler |
| | 5. Drains off water collected by partial condensation of steam in pipes |

*Codes :*

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 5 | 1 | 4 | 2 |
| (*b*) | 1 | 3 | 5 | 4 |
| (*c*) | 5 | 3 | 4 | 2 |
| (*d*) | 1 | 2 | 5 | 4 |

**Ans.** (*c*)

**Q. 71.** Partial admission steam turbine refers to the situation where the

(*a*) steam is admitted partially into the blades through nozzles

(*b*) nozzles occupy the complete circumference leading into the blade annulus

(*c*) nozzles do not occupy the complete circumference leading into the annulus

(*d*) steam is admitted partially into the blades directly

**Ans.** (*a*)

**Q. 72.** Consider the following statements regarding a 100% reaction turbine :

1. Change in absolute velocity of steam across the moving blades is zero.
2. Change in absolute velocity of steam across the moving blades is negative.
3. Enthalpy drop in fixed blades is zero.

Which of these statements is/are correct ?

(*a*) 1 alone (*b*) 2 alone (*c*) 2 and 3 (*d*) 1 and 3

**Ans.** (*c*)

**Q. 73.** Which one of the following pairs is NOT correctly matched ?

| | | | |
|---|---|---|---|
| (*a*) | Internal efficiency of steam turbine | : | Product of stage efficiency and reheat factor |
| (*b*) | Stage efficiency of a turbine | : | Ratio of adiabatic heat drop to the isentropic heat drop per stage |
| (*c*) | Dryness fraction of steam within a stage | : | Decreases due to reheating |
| (*d*) | Steam condensation during expansion through the turbine | : | Enhances blade erosion |

**Ans.** (*c*)

**Q. 74.** Consider the following statements :

For supersaturated flow through a steam nozzle, the

1. enthalpy drop reduces further 2. exit temperature increases
3. flow rate increases

Which of these statements are correct ?

(*a*) 1, 2 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1 and 3

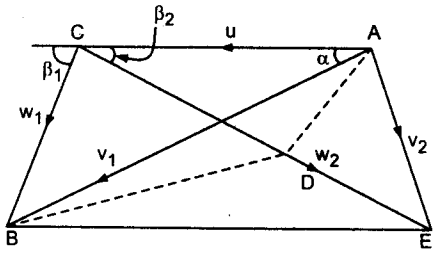
**Ans.** (*d*)

**Q. 75.** Velocity triangle for a reaction turbine stage is shown in the given figure. ($AB = v_1$ = absolute velocity at rotor blade inlet ; $CB = w_1$ = relative velocity at rotor blade inlet ; $CE = w_2$ = relative velocity at rotor blade exit and $CD = CB$)

The ratio of reaction force to impulse force is

(*a*) *CE/CB* (*b*) *CD/CE*

(*c*) *DE/BD* (*d*) *AE/AB*




**Ans.** (*c*)

**Q. 76.** Consider the following statements :

1. Throttle governing improves quality of steam in the last few stages.
2. Internal efficiency of steam is not seriously effected by throttle governing.
3. Throttle governing is better than nozzle governing.

Which of these statements are correct ?

(*a*) 1, 2 and 3 (*b*) 1 and 3 (*c*) 2 and 3 (*d*) 1 and 2

**Ans.** (*d*)

**Q. 77.** Which one of the following statements is correct ?

(*a*) Reheat factor is zero if efficiency of the turbine is close to unity.

(*b*) Lower the efficiency, higher will be the reheat factor.

(*c*) Reheat factor is independent of steam conditions at turbine inlet.

(*d*) Availability of reheat is higher at low pressure end.

**Q. 78.** In a steam power plant, the ratio of the isentropic heat drop in the prime mover to the amount of heat supplied per unit mass of steam is known as

(*a*) stage efficiency (*b*) degree of reaction (*c*) Rankine efficiency (*d*) relative efficiency

**Ans.** (*c*)

**Q. 79.** The critical pressure ratio for maximum discharge through a nozzle is given by

(*a*) $\left(\frac{n+1}{2}\right)^{\frac{n}{n-1}}$ (*b*) $\left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$ (*c*) $\left(\frac{n+1}{2}\right)^{\frac{n-1}{n}}$ (*d*) $\left(\frac{2}{n+1}\right)^{\frac{n-1}{n}}$

**Ans.** (*b*)

**Q. 80.** Consider the following statements :
The volumetric efficiency of a reciprocating compressor can be enhanced by
1. heating the intake air 2. decreasing the clearance volume 3. cooling the intake air
Which of these statements is/are correct ?
(*a*) 1 alone (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 3 alone
**Ans.** (*c*)

**Q. 81.** Reciprocating compressors are provided with
(*a*) simple disc/plate valve (*b*) poppet valve
(*c*) spring-loaded disc valve (*d*) solenoid valve
**Ans.** (*a*)

**Q. 82.** Consider the following statements :
In centrifugal compressors, there is a tendency of increasing surge when
1. the number of diffuser vanes is less than the number of impeller vanes
2. the number of diffuser vanes is greater than the number of impeller vanes
3. the number of diffuser vanes is equal to the number of impeller vanes
4. mass flow is greatly in excess of that corresponding to the design mass flow
Which of these statements is/are correct ?
(*a*) 1 and 4 (*b*) 2 alone (*c*) 3 and 4 (*d*) 2 and 4
**Ans.** (*d*)

**Q. 83.** In an axial flow compressor design, velocity diagrams are constructed from the experimental data of aerofoil cascades. Which one of the following statements in this regard is correct ?
(*a*) Incidence angle of the approaching air is measured from the trailing edge of the blade
(*b*) $\delta$ is the deviation angle between the angle of incidence and tangent to the camber line.
(*c*) The deflection $\varepsilon$ of the gas stream while passing through the cascade is given by $\varepsilon = \alpha_1 - \alpha_2$
(*d*) $\varepsilon$ is the sum of the angle of incidence and camber less any deviation angle, *i.e.*, $\varepsilon = i + \theta - \delta$
**Ans.** (*a*)

**Q. 84.** The efficiency of a simple gas turbine can be improved by using a regenerator, because the
(*a*) work of compression is reduced (*b*) heat required to be supplied is reduced
(*c*) work output of the turbine is increased (*d*) heat rejected is increased
**Ans.** (*b*)

**Q. 85.** Which one of the following pairs of formulae represents the specific speeds of turbine and pump respectively ? (Notations have their usual meanings)
(*a*) $\frac{NQ^{1/2}}{H^{3/4}}$ and $\frac{NP^{1/2}}{H^{5/4}}$ (*b*) $\frac{NQ^{1/2}}{H^{3/4}}$ and $\frac{NP^{1/2}}{H^{3/4}}$ (*c*) $\frac{NP^{1/2}}{H^{3/4}}$ and $\frac{NQ^{1/2}}{H^{5/4}}$ (*d*) $\frac{NP^{1/2}}{H^{5/4}}$ and $\frac{NQ^{1/2}}{H^{3/4}}$
**Ans.** (*d*)

**Q. 86.** Consider the following turbines/wheels :
1. Francis turbine 2. Pelton wheel with two or more jets
3. Pelton wheel with a single jet 4. Kaplan turbine
The correct sequence of these turbines/wheels in increasing order of their specific speeds is
(*a*) 2, 3, 1, 4 (*b*) 3, 2, 1, 4 (*c*) 2, 3, 4, 1 (*d*) 3, 2, 4, 1
**Ans.** (*b*)

**Q. 87.** The gross head available to a hydraulic power plant is 100 m. The utilised head in the runner of the hydraulic turbine is 72 m. If the hydraulic efficiency of the turbine is 90%, the pipe friction head is estimated to be
(*a*) 20 m (*b*) 18 m (*c*) 16.2 m (*d*) 1.8 m
**Ans.** (*a*)

**Q. 88.** Match List I (Outlet vane angle $\beta_2$) with List II (Curves labelled 1, 2 and 3 in the given figure) for a pump and select the correct answer using the codes given below the Lists :

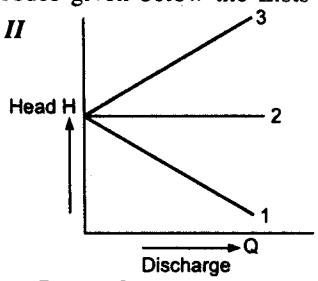
***List I***

A. $\beta_2 < 90°$

B. $\beta_2 = 90°$

C. $\beta_2 > 90°$

***List II***




***Codes :***

| | A | B | C | | A | B | C |
|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 2 | 3 | (*b*) | 1 | 3 | 2 |
| (*c*) | 2 | 1 | 3 | (*d*) | 3 | 2 | 1 |

**Ans.** (*a*)

**Q. 89.** Consider the following statements regarding the volute casing of a centrifugal pump :

1. Loss of head due to change in velocity is eliminated.
2. Efficiency of the pump is increased.
3. Water from the periphery of the impeller is collected and transmitted to the delivery pipe at constant velocity.

Which of these statements are correct ?

(*a*) 1, 2 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1 and 3

**Ans.** (*a*)

**Q. 90.** The cavitation number of any fluid machinery is defined as $\sigma = \frac{p - p'}{\rho V^2/2}$ ($p$ is absolute pressure, $\rho$ is density and $V$ is free stream velocity

The symbol $p'$ denotes

(*a*) static pressure of fluid (*b*) dynamic pressure of fluid

(*c*) vapour pressure of fluid (*d*) shear stress of fluid

**Ans.** (*c*)

**Q. 91.** Consider the following statements :

A water turbine governor

1. helps in starting and shutting down the turbo unit
2. controls the speed of turbine set to match it with the hydroelectric system
3. sets the amount of load which a turbine unit has to carry

Which of these statements are correct ?

(*a*) 1, 2 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1 and 3

**Ans.** (*c*)

**Q. 92.** Consider the following statements regarding a torque converter :

1. Its maximum efficiency is less than that of the fluid coupling.
2. It has two runners and a set of stationary vanes interposed between them.
3. It has two runners.
4. The ratio of secondary to primary torque is zero for the zero value of angular velocity of secondary.

Which of these statements are correct ?

(*a*) 1 and 2 (*b*) 3 and 4 (*c*) 1 and 4 (*d*) 2 and 4

**Ans.** (*c*)

**Q. 93.** Consider the following statements :

The reheat cycle helps to reduce

1. fuel consumption
2. steam flow
3. the condenser size

Which of these statements are correct ?

(*a*) 1 and 2 (*b*) 1 and 3 (*c*) 2 and 3 (*d*) 1, 2 and 3

**Ans.** (*a*)

**Q. 94.** The outer surface of a long cylinder is maintained at constant temperature. The cylinder does not have any heat source

The temperature in the cylinder will

(*a*) increase linearly with radius (*b*) decrease linearly with radius

(*c*) be independent of radius (*d*) vary logarithmically with radius

**Ans.** (*c*)

**Q. 95.** A composite plane wall is made up of two different materials of the same thickness and having thermal conductivities of $k_1$ and $k_2$ respectively. The equivalent thermal conductivity of the slab is

(*a*) $k_1 + k_2$ (*b*) $k_1 k_2$ (*c*) $\frac{k_1 + k_2}{k_1 k_2}$ (*d*) $\frac{2k_1 k_2}{k_1 + k_2}$

**Ans.** (*c*)

**Q. 96.** A copper wire of radius 0.5 mm is insulated with a sheathing of thickness 1 mm having a thermal conductivity of 0.5 $W/m - K$. The outside surface convective heat transfer coefficient is 10 $W/m^2 - K$. If the thickness of insulation sheathing is raised by 10 mm, then the electrical current-carrying capacity of the wire will

(*a*) increase (*b*) decrease

(*c*) remain the same (*d*) vary depending upon the electrical conductivity of the wire

**Ans.** (*c*)

**Q. 97.** For the fully developed laminar flow and heat transfer in a uniformly heated long circular tube, if the flow velocity is doubled and the tube diameter is halved, the heat transfer coefficient will be

(*a*) double of the original value (*b*) half of the original value

(*c*) same as before (*d*) four times of the original value

**Ans.** (*b*)

**Q. 98.** Heat transfer by radiation between two grey bodies of emissivity $\varepsilon$ is proportional to (notations have their usual meanings)

(*a*) $\frac{(E_b - J)}{(1 - \varepsilon)}$ (*b*) $\frac{(E_b - J)}{(1 - \varepsilon)/\varepsilon}$

(*c*) $\frac{(E_b - J)}{(1 - \varepsilon)^2}$ (*d*) $\frac{(E_b - J)}{(1 - \varepsilon^2)}$

**Ans.** (*b*)

**Q. 99.** Solar radiation of 1200 $W/m^2$ falls perpendicularly on a grey opaque surface of emissivity 0.5. If the surface temperature is 50° C and surface emissive power 600 $W/m^2$, the radiosity of that surface will be

(*a*) 600 $W/m^2$ (*b*) 1000 $W/m^2$

(*c*) 1200 $W/m^2$ (*d*) 1800 $W/m^2$

**Ans.** (*c*)

**Q. 100.** The overall heat transfer coefficient U for a plane composite wall of n layers is given by (the thickness of the $i$th layer is $t_i$, thermal conductivity of the $i$th layer is $k_i$, convective heat transfer coefficient is $h$)

(a) $\dfrac{1}{\dfrac{1}{h_1}+\sum_{i=1}^{n}\dfrac{t_i}{k_i}+\dfrac{1}{h_n}}$ (b) $h_1+\sum_{i=1}^{n}\dfrac{t_i}{k_i}+h_n$ (c) $\dfrac{1}{h_1+\sum_{i=1}^{n}\dfrac{t_i}{k_i}+h_n}$ (d) $\dfrac{1}{h_1}+\sum_{i=1}^{n}\dfrac{t_i}{k_i}+\dfrac{1}{h_n}$

**Ans.** (a)

**Q. 101.** The equation of effectiveness $\varepsilon = 1 - e^{-NTU}$ of a heat exchanger is valid (NTU is number of transfer units) in the case of

(a) boiler and condenser for parallel flow (b) boiler and condenser for counterflow
(c) boiler and condenser for both parallel flow and counterflow
(d) gas turbine for both parallel flow and counterflow

**Ans.** (d)

**Q. 102.** Match List I with List II and select the correct answer using the codes given below the Lists (notations have their usual meanings) :

| *List I* | *List II* |
|---|---|
| A. Fin | 1. $\dfrac{UA}{C_{min}}$ |
| B. Heat exchanger | 2. $\dfrac{x}{2\sqrt{\alpha\tau}}$ |
| C. Transient conduction | 3. $\sqrt{\dfrac{hp}{kA}}$ |
| D. Heisler chart | 4. $hl/k$ |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 3 | 1 | 2 | 4 |
| (c) | 3 | 4 | 2 | 1 |

| | A | B | C | D |
|---|---|---|---|---|
| (b) | 2 | 1 | 3 | 4 |
| (d) | 2 | 4 | 3 | 1 |

**Ans.** (a)

**Q. 103.** The Nusselt number is related to Reynolds number in laminar and turbulent flows respectively as

(a) $Re^{-1/2}$ and $Re^{0.8}$ (b) $Re^{1/2}$ and $Re^{0.8}$ (c) $Re^{-1/2}$ and $Re^{-0.8}$ (d) $Re^{1/2}$ and $Re^{-0.8}$

**Ans.** (b)

**Q. 104.** In respect of free convection over a vertical flat plate the Nusselt number varies with Grashof number '$Gr$' as

(a) $Gr$ and $Gr^{1/4}$ for laminar and turbulent flows respectively
(b) $Gr^{1/2}$ and $Gr^{1/3}$ for laminar and turbulent flows respectively
(c) $Gr^{1/4}$ and $Gr^{1/3}$ for laminar and turbulent flows respectively
(d) $Gr^{1/3}$ and $Gr^{1/4}$ for laminar and turbulent flows respectively

**Ans.** (a)

**Q. 105.** Consider the following conditions for heat transfer (thickness of thermal boundary layer is $\delta_1$, velocity of boundary layer is $\delta$ and Prandtl number is $P_r$) :

1. $\delta_t(x) = \delta(x)$ if $P_r = 1$ 2. $\delta_t(x) >> \delta(x)$ if $P_r << 1$ 3. $\delta_t(x) << \delta(x)$ if $P_r >> 1$

Which of these conditions apply for convective heat transfer ?

(a) 1 and 2 (b) 2 and 3 (c) 1 and 3 (d) 1, 2 and 3

**Ans.** (d)

**Q. 106.** The enthalpies at the beginning of compression, at the end of compression and at the end of condensation are respectively 185 kJ/kg, 210 kJ/kg and 85 kJ/kg. The COP of the vapour compression refrigeration system is

(*a*) 0.25 (*b*) 5.4 (*c*) 4 (*d*) 1.35

**Ans.** (*c*)

**Q. 107.** Consider the following statements regarding refrigerants :

1. Refrigerant $NH_3$ is used in reciprocating compressors.
2. Refrigerant $CO_2$ is used in reciprocating compressors.
3. Refrigerant R-11 is used in centrifugal compressors.

Which of these statements are correct ?

(*a*) 1 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1, 2 and 3

**Ans.** (*d*)

**Q. 108.** The COP of a heat pump $\beta_{HP}$ and the COP of a refrigerator $\beta_{Ref}$ are related as

(*a*) $\beta_{HP} + \beta_{Ref} = 1$ (*b*) $\beta_{HP} - \beta_{Ref} = 1$ (*c*) $\beta_{Ref} - \beta_{HP} = 1$ (*d*) $\beta_{HP} - \beta_{Ref} = 0$

**Ans.** (*b*)

**Q. 109.** Consider the following statements :

The pressure in a horizontal capillary tube of a refrigeration system decreases due to the

1. frictional resistance offered by the tube wall
2. acceleration of refrigerant in the tube
3. heat transfer from the tube wall
4. decrease in the potential energy

Which of these statements are correct ?

(*a*) 1 and 4 (*b*) 2, 3 and 4 (*c*) 1, 2 and 3 (*d*) 1 and 2

**Ans.** (*d*)

**Q. 110.** The discharge pressure of the compressor in the refrigeration system goes up due to the

(*a*) lower volumetric efficiency of the compressor
(*b*) formation of scale in the condenser
(*c*) large size of the condenser
(*d*) undercharge of the refrigerant

**Ans.** (*b*)

**Q. 111.** The leakage in a Freon-based refrigeration system can be detected by using a/an

(*a*) oxy-acetylene torch (*b*) halide torch (*c*) sulphur torch (*d*) blue litmus paper

**Ans.** (*b*)

**Q. 112.** Consider the following statements :

1. Azeotropes are the mixtures of refrigerants and behave like pure substances.
2. Isomers refrigerants are compounds with the same chemical formula but have different molecular structures.
3. The formula $n + p + q = 2m$ is used for unsaturated chlorofluorocarbon compounds ($m$, $n$, $p$ and $q$ are the numbers atoms of carbon, hydrogen, fluorine and chlorine respectively)

Which of these statements are correct ?

(*a*) 1 and 3 (*b*) 2 and 3 (*c*) 1 and 2 (*d*) 1, 2 and 3

**Ans.** (*a*)

**Q. 113.** Consider the foliowing statements :

The typical air velocities in the ducts of air-conditioning systems are

1. lower in residential buildings as compared to those of public buildings
2. higher in residential buildings as compared to those of public buildings

3. higher in industrial buildings as compared to those of public buildings
4. equal in all types of buildings

Which of these statements is/are correct ?

(*a*) 1 alone (*b*) 1 and 3 (*c*) 2 and 3 (*d*) 4 alone

**Ans.** (*b*)

**Q. 114.** When warm saturated air is cooled

(*a*) excess moisture condenses

(*b*) excess moisture condenses but relative humidity remains unchanged

(*c*) excess moisture condenses and specific humidity increases but relative humidity remains unchanged.

(*d*) specific humidity increases and relative humidity decreases

**Ans.** (*a*)

**Q. 115.** When dry-bulb and wet-bulb temperatures are identical, it means that the

(*a*) air is fully saturated and dew-point temperature has reached

(*b*) air is fully saturated

(*c*) dew-point temperature has reached and humidity is 100%

(*d*) partial pressure of water vapour is equal to total pressure

**Ans.** (*b*)

**Q. 116.** Consider the following parameters :

1. Dry-bulb temperature 2. Humidity ratio
3. Air velocity 4. Solar radiation intensity

Which of these parameters are taken into account for determining effective temperature for human comfort ?

(*a*) 1 and 2 (*b*) 1 and 4 (*c*) 2, 3 and 4 (*d*) 1, 2 and 3

**Ans.** (*d*)

**Q. 117.** The desirable air velocity in the occupied zone for comfort for summer air-conditioners is in the range of

(*a*) 6 - 7 m/minute (*b*) 4 - 5 m/minute (*c*) 2 - 3 m/minute (*d*) 0.5 - 1.5 m/minute

**Ans.** (*d*)

**Q. 118.** Consider the following statements :

1. The recommended outside air required per person for an auditorium is approximately 0.25 $m^3$/min.
2. Outside air for ventilation purposes causes sensible heat load and also latent heat load.
3. The sensible heat factor for an auditorium is generally kept as 0.7.

Which of these statements are correct ?

(*a*) 1 and 2 (*b*) 2 and 3 (*c*) 1 and 3 (*d*) 1, 2 and 3

**Ans.** (*c*)

**Q. 119.** An air-conditioned room of volume 10 $m^3$ has infiltration of air equivalent to 3 air changes. Density of air is 1.2 kg/$m^3$, specific heat $C_p$ is 1 kJ/kg-K and temperature difference between room and ambient air is 20 K. The sensible heat load due to infiltrated air is

(*a*) 60 kJ/hr (*b*) 12 kJ/hr (*c*) 6 kW (*d*) 0.2 kW

**Ans.** (*d*)

**Q. 120.** If heat and mass transfer take place simultaneously, the ratio of heat transfer coefficient to the mass transfer coefficient is a function of the ratio of

(*a*) Schmidt and Reynolds numbers (*b*) Schmidt and Prandtl numbers
(*c*) Nusselt and Lewis numbers (*d*) Reynolds and Lewis numbers

**Ans.** (*a*)

## I.E.S. (Objective)

# MECHANICAL ENGINEERING–2000

## PAPER - II

**Q. 1.** In an orthogonal cutting test, the cutting force and thrust force were observed to be 1000N and 500 N respectively. If the rake angle of tool is zero, the coefficient of friction in chip-tool interface will be

(*a*) $\frac{1}{2}$ (*b*) 2 (*c*) $\frac{1}{\sqrt{2}}$ (*d*) $\sqrt{2}$

**Ans.** (*a*)

**Q. 2.** The magnitude of the cutting speed for maximum profit rate must be

(*a*) in between the speeds for minimum cost and maximum production rate

(*b*) higher than the speed for maximum production rate

(*c*) below the speed for minimum cost

(*d*) equal to the speed for minimum cost

**Ans.** (*a*)

**Q. 3.** The sequence of markings "S 14 K 14 S" on a grinding wheel represents respectively

(*a*) bond type, structure, grade, grain size and abrasive type

(*b*) abrasive type, grain size, grade, structure and bond type

(*c*) bond type, grade, structure, grain size and abrasive type

(*d*) abrasive type, structure, grade, grain size and bond type

**Ans.** (*b*)

**Q. 4.** In a tool life test, doubling the cutting speed reduces the tool life to 1/8th of the original. The Taylor's tool life index is

(*a*) $\frac{1}{2}$ (*b*) $\frac{1}{3}$ (*c*) $\frac{1}{4}$ (*d*) $\frac{1}{8}$

**Ans.** (*b*)

**Q. 5.** Match List I (Type of casting) with List II (Working principles) and select the correct answer using the codes given below the Lists :

| | *List I* | | *List II* |
|---|---|---|---|
| A. | Die casting | 1. | Molten metal is forced into the die under pressure |
| B. | Centrifugal casting | 2. | Axis of rotation does not coincide with axis of mould |
| C. | Centrifuging | 3. | Metal solidifies when mould is rotating |
| D. | Continuous casting | 4. | Continuously pouring molten metal into mould |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 3 | 2 | 4 | (*b*) | 4 | 3 | 2 | 1 |
| (*c*) | 1 | 2 | 3 | 4 | (*d*) | 4 | 2 | 3 | 1 |

**Q. 6.** Consider the following statements :

In electrochemical grinding,

1. a rubber bonded alumina grinding wheel acts as the cathode and the workpiece as the anode.
2. a copper bonded alumina grinding wheel acts as the cathode and the workpiece as the anode.
3. metal removal takes place due to the pressure applied by the grinding wheel.
4. metal removal takes place due to electrolysis.

Which of these statements are correct ?

(*a*) 1 and 3 (*b*) 2 and 4 (*c*) 2 and 3 (*d*) 1 and 3

**Ans.** (*b*)

**Q. 7.** In the rolling process, roll separating force can be decreased by

(*a*) reducing the roll diameter

(*b*) increasing the roll diameter

(*c*) providing back-up rolls

(*d*) increasing the friction between the rolls and the metal

**Ans.** (*c*)

**Q. 8.** Consider the following statements :

In forward extrusion process

1. the ram and the extruded product travel in the same direction.
2. the ram and the extruded product travel in the opposite direction.
3. the speed of travel of the extruded product is same as that of the ram.
4. the speed of travel of the extruded product is greater than that of the ram.

Which of these statements are correct ?

(*a*) 1 and 3 (*b*) 2 and 3 (*c*) 1 and 4 (*d*) 2 and 4

**Ans.** (*c*)

**Q. 9.** Which one of the following lubricants is most suitable for drawing mild steel wires ?

(*a*) Sodium stearate (*b*) Water (*c*) Lime-water (*d*) Kerosene

**Ans.** (*a*)

**Q. 10.** Which one of the following statements is correct ?

(*a*) No flux is used in gas welding of mild steel

(*b*) Borax is the commonly used flux coating on welding electrodes

(*c*) Laser beam welding employs a vacuum chamber and thus avoids use of a shielding method

(*d*) AC can be used for GTAW process

**Ans.** (*a*)

**Q. 11.** Best position of crank for blanking operation in a mechanical press is

(*a*) top dead centre (*b*) 20 degrees below top dead centre

(*c*) 20 degrees before bottom dead centre (*d*) bottom dead centre

**Ans.** (*c*)

**Q. 12.** Match List I (Process) with List II (Products/materials) and select the correct answer using the codes given below the Lists :

| *List I* | | *List II* | |
|---|---|---|---|
| A. | Die casting | 1. | Phenol formaldehyde |
| B. | Shell molding | 2. | C.I. pipes |
| C. | $CO_2$ molding | 3. | Non-ferrous alloys |
| D. | Centrifugal casting | 4. | Sodium silicate |

*Codes :*

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 1 | 3 | 4 | 2 |
| (*c*) | 3 | 1 | 2 | 4 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 3 | 1 | 4 | 2 |
| (*d*) | 1 | 3 | 2 | 4 |

**Ans.** (*b*)

**Q. 13.** Which one of the following sets of tools or tools and processes are normally employed for making large diameter holes ?
(*a*) Boring tool
(*b*) BTA tools (Boring and trepanning association) and gun drill
(*c*) Gun drill and boring tool
(*d*) Boring tools and trepanning
**Ans.** (*a*)

**Q.14.** Which one of the following processes of gear manufacture results in best accuracy of the involute gear tooth profile ?
(*a*) Milling (*b*) Hobbing
(*c*) Rotary gear shaper (*d*) Rack type gear shaper
**Ans.** (*c*)

**Q. 15.** One of the index plates of a milling machine dividing head has the following hole circles :
15; 16; 17; 18; 19; 20
A gear wheel of 34 teeth has to be milled by simple indexing method. To machine each tooth, the index crank has to be rotated through
(*a*) 17 holes in the 20-hole circle (*b*) 18 holes in the 20-hole circle
(*c*) 1 revolution and 3 holes in 17-hole circle (*d*) 1 revolution and 2 holes in 18-hole circle
**Ans.** (*c*)

**Q. 16.** Which one of the following tolerances set on inner diameter and outer diameter respectively of headed jig bush for press fit is correct ?
(*a*) G7 h 6 (*b*) F7 n6 (*c*) H 7 h 6 (*d*) F7j6
**Ans.** (*c*)

**Q. 17.** Match List I (Components of a table fan) with List II (Manufacturing processes) and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Base with stand | 1. Stamping and pressing |
| B. Blade | 2. Wire drawing |
| C. Armature coil wire | 3. Turning |
| D. Armature shaft | 4. Casting |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 4 | 3 | 2 | 1 | (*b*) | 2 | 1 | 4 | 3 |
| (*c*) | 2 | 3 | 4 | 1 | (*d*) | 4 | 1 | 2 | 3 |

**Ans.** (*d*)

**Q. 18.** Crater wear starts at some distance from the tool tip because
(*a*) cutting fluid cannot penetrate that region (*b*) stress on rake face is maximum at that region
(*c*) tool strength is minimum at that region (*d*) tool temperature is maximum at that region
**Ans.** (*b*)

**Q. 19.** Consider the following tool materials :
1. HSS 2. Cemented carbide 3. Ceramics 4. Diamond
The correct sequence of these materials in *decreasing* order of their cutting speed is
(*a*) 4, 3, 1, 2 (*b*) 4, 3, 2, 1 (*c*) 3, 4, 2, 1 (*d*) 3, 4, 1, 2
**Ans.** (*b*)

**Q. 20.** Consider the following processes :

1. Gas welding 2. Thermit welding 3. Arc welding 4. Resistance welding

The correct sequence of these processes in increasing order of their welding temperatures is

(*a*) 1, 3, 4, 2 (*b*) 1, 2, 3, 4 (*c*) 4, 3, 1, 2 (*d*) 4, 1, 3, 2

**Ans.** (*b*)

**Q. 21.** Match List I with List II and select the correct answer using the codes given below the Lists :

| *List I* | | *List II* | |
|---|---|---|---|
| (*a*) | Quick return mechanism | 1. | Lathe |
| (*b*) | Apron mechanism | 2. | Milling machine |
| (*c*) | Indexing mechanism | 3. | Shaper |
| (*d*) | Regulating wheel | 4. | Centreless grinding |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 3 | 2 | 1 | 4 |
| (*c*) | 4 | 2 | 3 | 1 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 2 | 3 | 4 | 1 |
| (*d*) | 3 | 1 | 2 | 4 |

**Ans.** (*d*)

**Q. 22.** Consider the following characteristics of a robot :

1. The tip of the robot arm moves from one point to another with its in-between path not being defined.
2. It can be used for drilling holes at difference points in a workpiece.
3. It can be used for V butt joint welding between two points.
4. The memory capacity required for its control unit is low.

Which of these are the characteristics associated with a point to point robot ?

(*a*) 1 and 2 (*b*) 1, 3 and 4 (*c*) 1, 2 and 4 (*d*) 2, 3 and 4

**Ans.** (*c*)

**Q. 23.** Match List I (Components used in jigs and fixtures) with List II (Their functions) and select the correct answer using the codes given below the Lists :

| *List I* | | *List II* | |
|---|---|---|---|
| A. | Jack pin | 1. | To guide the drill bit during machining |
| B. | V-locator | 2. | For easy removal of the workpiece from the jig or fixture after the machining operation is over |
| C. | Bushes | 3. | To locate the circular or semicircular objects in a jig or fixture |
| D. | Ejectors | 4. | To locate workpieces whose dimensions are subject to variations |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 3 | 4 | 1 | 2 |
| (*c*) | 4 | 3 | 1 | 2 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 3 | 4 | 2 | 1 |
| (*d*) | 4 | 3 | 2 | 1 |

**Ans.** (*c*)

**Q. 24.** Match List I (Scientist) with List II (Research work) and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Schewart | 1. Less function in quality |
| B. Taguchi | 2. Queuing model |
| C. Erlang | 3. Zero defect |
| | 4. Control charts |

*Codes :*

| | A | B | C | | A | B | C |
|---|---|---|---|---|---|---|---|
| (*a*) | 3 | 1 | 2 | (*b*) | 4 | 3 | 1 |
| (*c*) | 4 | 1 | 2 | (*d*) | 3 | 4 | 1 |

**Ans.** (*b*)

**Q. 25.** The management is interested to know the percentage of idle time of an equipment. The trial study showed that percentage of idle time would be 20%. The number of random observations necessary for 95% level of confidence and ± 5% accuracy is

(*a*) 6400 (*b*) 1600 (*c*) 640 (*d*) 160

**Ans.** (*d*)

**Q. 26.** Which one of the following is NOT a technique of PMTS ?

(*a*) Synthetic data (*b*) Stop-watch time study (*c*) Work factor (*d*) MTM

**Q. 27.** Rowan incentive plan is given by ($R$ = Hourly rate, $T_a$ = Actual time taken for job, $T_s$ = Standard time for job and $E$ = Earnings)

$$E = R \times T_a + \frac{(T_s - T_a)}{T_s} \times T_a \times R$$

The shape of the curves between bonus earned and percentage time saved is a

(*a*) straight line (*b*) parabola (*c*) horizontal line (*d*) vertical line

**Ans.** (*a*)

**Q. 28.** Last year, a manufacturer produced 15000 products which were sold for Rs. 300 each. At that volume, the fixed costs were Rs. 15.2 lacs and total variable costs were Rs. 21 lacs. The break even quantity of product would be

(*a*) 4000 (*b*) 7800 (*c*) 8400 (*d*) 9500

**Ans.** (*d*)

**Q. 29.** Consider the following statements regarding plant location and plant layout :

1. Qualitative factor analysis is a method of evaluating a potential-location without applying quantitative values to the decision criteria.
2. The three determinants of the type of layout are type of product, type of process and the volume of production.
3. An appliance manufacturing plant where products are made on assembly lines would be classified as job shop type of layout.

Which of these statements is/are correct ?

(*a*) 1, 2, and 3 (*b*) 1 and 2 (*c*) 2 alone (*d*) 3 alone

**Ans.** (*d*)

**Q. 30.** Routing in production planning and control refers to the

(*a*) balancing of load on machines (*b*) authorisation of work to be performed

(*c*) progress of work performed (*d*) sequence of operations to be performed

**Ans.** (*d*)

**Q. 31.** Match List I with List II and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Control charts for variables | 1 Binomial distribution |
| B. Control chart for number of non-conformities | 2. Beta distribution |
| C. Control chart for fraction rejected | 3. Normal distribution |
| D. Activity time distribution in PERT | 4. Poisson distribution |
| | 5. Exponential distribution |

*Codes :*

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 3 | 4 | 1 | 5 | (*b*) | 5 | 4 | 3 | 1 |
| (*c*) | 4 | 3 | 1 | 2 | (*d*) | 3 | 4 | 1 | 2 |

**Ans.** (*d*)

**Q. 32.** Which one of the following statements is NOT correct ?

(*a*) Assignment model is a special case of a linear programming problem

(*b*) In queuing models, Poisson arrivals and exponential services are assumed

(*c*) In transportation problems, the non-square matrix is made square by adding a dummy row or a dummy column

(*d*) In linear programming problems, dual of a dual is a primal

**Ans.** (*d*)

**Q. 33.** Consider the following statements :

1. A linear programming problem with three variables and two constraints can be solved by graphical method.
2. For solutions of a linear programming problem with mixed constraints, Big-M-method, can be employed.
3. In the solution process of a linear programming problem using Big-M-method, when an artificial variable leaves the basis, the column of the artificial variable can be removed from all subsequent tables.

Which one these statements are correct ?

(*a*) 1, 2 and 3 (*b*) 1 and 2 (*c*) 1 and 3 (*d*) 2 and 3

**Ans.** (*d*)

**Q. 34.** Arrivals at a telephone booth are considered to be Poisson with an average time of 10 minutes between one arrival and the next. The length of a phone call is assumed to be distributed exponentially with a mean of 3 minutes. The probability that a person arriving at the booth will have to wait, is

(*a*) 0.043 (*b*) 0.300 (*c*) 0.429 (*d*) 0.700

**Ans.** (*b*)

**Q. 35.** Dummy activities are used in a network to

(*a*) facilitate computation of slacks (*b*) satisfy precedence requirements

(*c*) determine project completion time (*d*) avoid use of resources

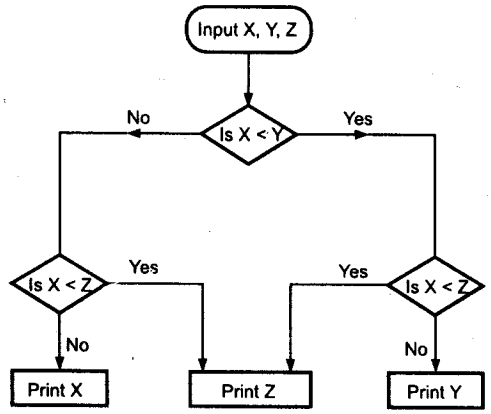
**Ans.** (*b*)

**Q. 36.** If the earliest starting time for an activity is 8 weeks, the latest finish time is 37 weeks and the duration time of the activity is 11 weeks, then the total float is equal to

(*a*) 18 weeks (*b*) 14 weeks (*c*) 56 weeks (*d*) 40 weeks

**Ans.** (*a*)

**Q. 37.** Consider the following flow chart :




The printed value $X$, $Y$ and $Z$ by the computer will be

(*a*) the highest (*b*) the middle (*c*) the lowest (*d*) none of the above

**Ans.** (*a*)

**Q. 38.** Match List I with List II and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. RAM | 1. Network of computers |
| B. ROM | 2. Software which makes the computer work |
| C. DOS | 3. Memory used for processing |
| D. LAN | 4. Memory in which user cannot write anything |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 1 | 2 | 3 | 4 |
| (*c*) | 2 | 3 | 4 | 1 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 3 | 4 | 2 | 1 |
| (*d*) | 3 | 4 | 1 | 2 |

**Ans.** (*b*)

**Q. 39.** A production system has a product type of layout in which there are four machines laid in series. Each machine does a separate operation. Every product needs all the four operations to be carried out. The designed capacity of each of the four machines is 200, 175, 160 and 210 products per day. The system capacity would be

(*a*) 210 products per day (*b*) 200 products per day

(*c*) 175 products per day (*d*) 160 products per day

**Ans.** (*d*)

**Q. 40.** Match List I (End conditions of columns) with List II (Equivalent length in terms of length of hinged-hinged column) and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Both ends hinged | 1. L |
| B. One end fixed and other end free | 2. $\sqrt{2}$ L |
| C. One end fixed and the other pin-jointed | 3. L/2 |
| D. Both ends fixed | 4. 2 L |

*Codes :*

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 3 | 4 | 2 | (*b*) | 1 | 3 | 2 | 4 |
| (*c*) | 3 | 1 | 2 | 4 | (*d*) | 3 | 1 | 4 | 2 |

**Ans.** (*b*)

**Q. 41.** Match List I with List II and select the correct answer using the codes given below the Lists :

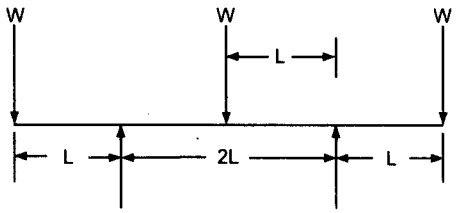
| *List I* | *List II* |
|---|---|
| A. Bending moment is constant | 1. Point of contraflexure |
| B. Bending moment is maximum or minimum | 2. Shear force changes sign |
| C. Bending moment is zero | 3. Slope of shear force diagram is zero over the portion of the beam |
| D. Loading is constant | 4. Shear force is zero over the portion of the beam |

*Codes :*

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 4 | 1 | 2 | 3 | (*b*) | 3 | 2 | 1 | 4 |
| (*c*) | 4 | 2 | 1 | 3 | (*d*) | 3 | 1 | 2 | 4 |

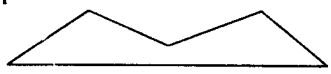
**Ans.** (*b*)

**Q. 42.**



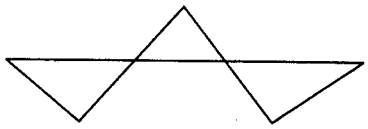

A loaded beam is shown in the above figure. The bending moment diagram of the beam is best represented as

(*a*)



(*b*)

(*c*)



(*d*)

**Ans.** (*c*)

**Q. 43.** At a certain section at a distance '*x*' from one of the supports of a simply supported beam, the intensity of loading, bending moment and shear force are $W_x$, $M_x$, and $V_x$ respectively. If the intensity of loading is varying continuously along the length of the beam, then the *invalid* relation is

(*a*) Slope $Q_x = \frac{M_x}{V_x}$

(*b*) $V_x = \frac{dM_x}{dx}$

(*c*) $W_x = \frac{d^2M_x}{dx^2}$

(*d*) $W_x = \frac{dV_x}{dx}$

**Ans.** (*d*)

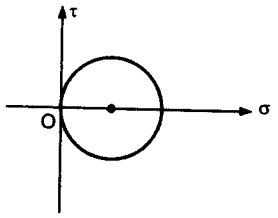
**Q. 44.** Plane stress at a point in a body is defined by principal stresses $3\sigma$ and $\sigma$. The ratio of the normal stress to the maximum shear stresses on the plane of maximum shear stress is

(*a*) 1 (*b*) 2 (*c*) 3 (*d*) 4

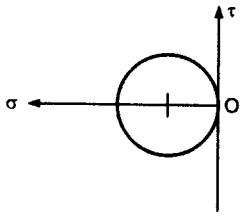
**Ans.** (*b*)

**Q. 45.** Which one of the following Mohr's circles represents the state of pure shear ?

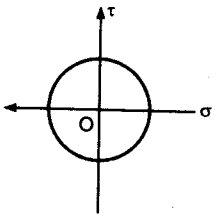
(*a*)



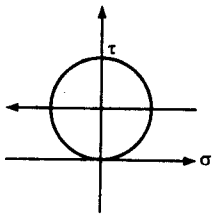

(*b*)




(*c*)




(*d*)




**Ans.** (*c*)

**Q. 46.** The state of plane stress in a plate of 100 mm thickness is given as $\sigma_{xx} = 100\ N/mm^2$, $\sigma_{yy} = 200\ N/mm^2$, Young's modulus = $300\ N/mm^2$, Poisson's ratio = 0.3 The stress developed in the direction of thickness is

(*a*) zero (*b*) $90\ N/mm^2$ (*c*) $100\ N/mm^2$ (*d*) $200\ N/mm^2$

**Ans.** (*a*)

**Q. 47.** Consider the following tools :

1. High carbon steel tools
2. High speed steel tools.
3. Ceramic tools
4. Carbide tools

Which of these tools are provided with negative rake angle ?

(*a*) 1 and 2 (*b*) 2 and 3 (*c*) 1 and 3 (*d*) 3 and 4

**Ans.** (*d*)

**Q. 48.** A rod of material with $E = 200 \times 10^3$ MPa and $\alpha = 10^{-3}$ mm/mm°C is fixed at both the ends. It is uniformly heated such that the increase in temperature is 30°C. The stress developed in the rod is

(*a*) $6000\ N/mm^2$ (tensile) (*b*) $6000\ N/mm^2$ (compressive)

(*c*) $2000\ N/mm^2$ (tensile) (*d*) $2000\ N/mm^2$ (compressive)

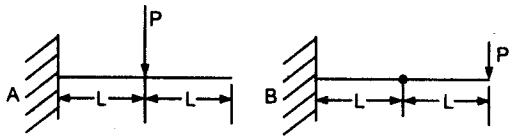
**Ans.** (*b*)

**Q. 49.** A circular solid shaft is subjected to a bending moment of 400 kN.m and a twisting moment of 300 kN.m On the basis of the maximum principal stress theory, the direct stress is $\sigma$ and according to the maximum shear stress theory, the shear stress is $\tau$. The ratio $\sigma/\tau$ is

(*a*) $\frac{1}{5}$ (*b*) $\frac{3}{9}$ (*c*) $\frac{9}{5}$ (*d*) $\frac{11}{6}$

**Ans.** (*c*)

**Q. 50.**




The two cantilevers *A* and *B* shown in the above figure have the same uniform cross-section and the same material. Free end deflection of cantilever '*A*' is δ. The value of mid- span deflection of the cantilever '*B*' is

(*a*) $\frac{1}{2}\delta$ (*b*) $\frac{2}{3}\delta$ (*c*) δ (*d*) 2δ

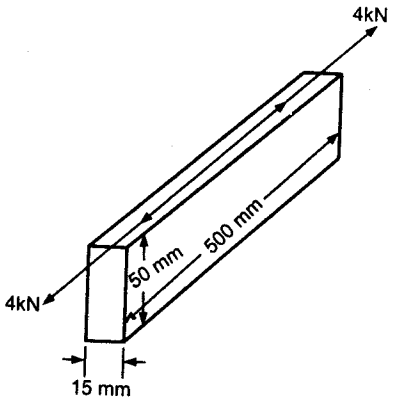
**Ans.** (*d*)

**Q. 51.** A link is under a pull which lies on one of the faces as shown in the above figure. The magnitude of maximum compressive stress in the link would be

(*a*) 21.3 N/mm$^2$ (*b*) 16.0 N/mm$^2$

(*c*) 10.7 N/mm$^2$ (*d*) zero

**Ans.** (*d*)




**Q. 52.** Two coiled springs, each having stiffness *K*, are placed in parallel. The stiffness of the combination will be

(*a*) 4 *K* (*b*) 2 *K* (*c*) $\frac{K}{2}$ (*d*) $\frac{K}{4}$

**Ans.** (*b*)

**Q. 53.** A long slender bar having uniform rectangular cross-section '$B \times H$' is acted upon by an axial compressive force. The sides *B* and *H* are parallel to *x*- and *y*-axes respectively. The ends of the bar are fixed such that they behave as pin-jointed when the bar buckles in a plane normal to *x*-axis, and they behave as built-in when the bar buckles in a plane normal to *y*-axis. If load capacity in either mode of buckling is same, then the value of *H*/*B* will be

(*a*) 2 (*b*) 4 (*c*) 8 (*d*) 16

**Ans.** (*a*)

**Q. 54.** The property by which an amount of energy is absorbed by a material without plastic deformation, is called

(*a*) toughness (*b*) impact strength (*c*) ductility (*d*) resilience

**Ans.** (*d*)

**Q. 55.** When a weight of 100 N falls on a spring of stiffness 1 kN/m from a height of 2 m, the deflection caused in the first fall is

(*a*) equal to 0.1 m (*b*) between 0.1 and 0.2 m

(*c*) equal to 0.2 m (*d*) more than 0.2 m

**Ans.** (*b*)

**Q. 56.** Which one of the following features improves the fatigue strength of a metallic material ?

(*a*) Increasing the temperature (*b*) Scratching the surface

(*c*) Overstressing (*d*) Understressing

**Ans.** (*d*)

**Q. 57.** Cermets are

(*a*) metals for high temperature use with ceramic like properties

(*b*) ceramics with metallic strength and lustre

(*c*) coated tool materials (*d*) metal-ceramic composites

**Ans.** (*c*)

**Q. 58.** Percentage of various alloying elements present in different steel materials are given below :
1. 18% W; 4% Cr; 1% V; 5% Co; 0.7% C 2. 8% Mo; 4% Cr; 2% V; 6% W; 0.7% C
3. 27% Cr; 3% Ni; 5% Mo; 0.25% C 4. 18% Cr; 8% Ni; 0.15% C
Which of these relate to that of high speed steel ?
(*a*) 1 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 2 and 4
**Ans.** (*b*)

**Q. 59.** A thin cylinder contains fluid at a pressure of 500 $N/m^2$, the internal diameter of the shell is 0.6 m and the tensile stress in the material is to be limited to 9000 $N/m^2$. The shell must have a minimum wall thickness of nearly
(*a*) 9 mm (*b*) 11 mm (*c*) 17 mm (*d*) 21 mm
**Ans.** (*c*)

**Q. 60.** From a tension test, the yield strength of steel is found to be 200 $N/mm^2$. Using a factoy of safety of 2 and applying maximum principal stress theory of failure, the permissible stress in the steel shaft subjected to torque will be
(*a*) 50 $N/mm^2$ (*b*) 57.7 $N/mm^2$ (*c*) 86.6. $N/mm^2$ (*d*) 100 $N/mm^2$
**Ans.** (*d*)

**Q. 61.** Which one of the following properties is more sensitive to increase in strain rate ?
(*a*) Yield strength (*b*) Proportional limit (*c*) Elastic limit (*d*) Tensile strength
**Ans.** (*b*)

**Q. 62.** Pearlite consists of
(*a*) 6.67% C and 93.33% ferrite (*b*) 13% Fe and 87% cementite
(*c*) 13% C and 87% ferrite (*d*) 13% cementite and 87% ferrite
**Ans.** (*d*)

**Q. 63.** Addition of vanadium to steel results in improvement of
(*a*) heat-treatability by quenching (*b*) hardenability
(*c*) fatigue strength (*d*) resistance to oxidation at elevated temperature
**Ans.** (*b*)

**Q. 64.** Atomic packing factor (APF) in the case of copper crystal is
(*a*) 0.52 (*b*) 0.68 (*c*) 0.74 (*d*) 1.633
**Ans.** (*a*)

**Q. 65.** During peritectic solidification, one liquid
(*a*) combines with one solid to form a second new solid
(*b*) solidifies into two different solids
(*c*) forms one solid
(*d*) forms one solid and another liquid
**Ans.** (*b*)

**Q. 66.** Consider the following advantages :
1. Rapid process 2. Work with keyways can be ground
3. No work holding device is required.
Which of these are the advantages of centreless grinding ?
(*a*) 1, 2 ans 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1 and 3
**Ans.** (*d*)

***Direction :*** *The following 19 (nineteen) items consist of two statements, one labelled the 'Assertion (A)' and the other labelled the 'Reason (R)'. You are to examine these two statements, and decide if the Assertion (A) and the Reason (R) are individually true and if so, whether the Reason is a correct explanation of the Assertion. Select your answers to these items using the codes given below and mark your Answer Sheet accordingly.*

*Codes :*

(*a*) Both A and R are true and R is the correct explanation of A
(*b*) Both A and R are true but R is NOT the correct explanation of A
(*c*) A is true but R is false
(*d*) A is false but R is true

**Q. 67.** *Assertion (A) :* Poisson's ratio of a material is a measure of change in dimension in one direction due to loading in the perpendicular direction.
*Reason (R) :* The nature of lateral strain in a uniaxially loaded member is opposite to that of linear strain.
**Ans.** (*a*)

**Q. 68.** *Assertion (A) :* Addition polymerization is a primary summation of individual molecules into long chains.
*Reason (R) :* In addition polymerization, the reaction produces a small molecule as by-product.
**Ans.** (*c*)

**Q. 69.** *Assertion (A) :* Normalised steel will have lower hardness than annealed steel.
*Reason (R) :* The pearlite of normalised steel is finer and has lower intermolecular space.
**Ans.** (*a*)

**Q. 70.** When a composite unit consisting of a steel rod surrounded by a cast iron tube is subjected to an axial load.
*Assertion (A) :* The ratio of normal stresses induced in both the materials is equal to the ratio of Young's moduli of respective materials.
*Reason (R) :* The composite unit of these two materials is firmly fastened together at the ends to ensure equal deformation in both the materials.
**Ans.** (*a*)

**Q. 71.** *Assertion (A) :* Cam of a specified contour is preferred to a cam with a specified follower motion.
*Reason (R) :* Cam of a specified contour has superior performance.
**Ans.** (*d*)

**Q. 72.** *Assertion (A) :* In designing the size of the flywheel, the weight of the arms and the boss are neglected.
*Reason (R) :* The flywheel absorbs energy during those periods when the turning moment is greater than the resisting moment.
**Ans.** (*b*)

**Q. 73.** *Assertion (A) :* For a radial engine containing four or more cylinders, the secondary forces are in complete balance.
*Reason (R) :* The secondary direct and reverse cranks form a balanced system in the radial engines.
**Ans.** (*a*)

**Q. 74.** *Assertion (A) :* In pre-loaded bolted joints, there is a tendency for failure to occur in the gross plate section rather than through holes.

*Reason (R) :* The effect of pre-loading is to create sufficient friction between the assembled parts so that no slippage occurs.

**Ans.** (*a*)

**Q. 75.** *Assertion (A) :* Helical gears are used for transmitting motion and power between intersecting shafts, whereas straight bevel gears are used for transmitting motion and power between two shafts intersecting each other at 90°.

*Reason (R) :* In helical gears teeth are inclined to axis of the shaft and are in the form of a helix, whereas in bevel gears, teeth are tapered both in thickness and height form one end to the other.

**Ans.** (*b*)

**Q. 76.** *Assertion (A) :* To obtain large deformations by cold working intermediate annealing is not required.

*Reason (R) :* Cold working is performed below the recrystallisation temperature of the work material.

**Ans.** (*d*)

**Q. 77.** *Assertion (A) :* Oil as a cutting fluid results in a lower coefficient of friction.

*Reason (R) :* Oil forms a thin liquid film between the tool face and chip, and it provides 'hydrodynamic lubrication'.

**Ans.** (*a*)

**Q. 78.** *Assertion (A) :* In metal cutting, the normal laws of sliding friction are not applicable.

*Reason (R) :* Very high temperature is produced at the tool-chip interface.

**Ans.** (*b*)

**Q. 79.** *Assertion (A) :* The ratio of cutting force to thrust force is very high in grinding process as compared to other machining processes.

*Reason (R) :* Random orientation and effective negative rake angles of abrasive grains increase the cutting force and adversely affect the cutting action and promote rubbing action.

**Ans.** (*a*)

**Q. 80.** *Assertion (A) :* The axis of an NC drilling machine spindle is denoted as z-axis.

*Reason (R) :* In NC machine tool, the axis perpendicular to both $x$- and $y$-axes is designated as $z$-axis.

**Ans.** (*a*)

**Q. 81.** *Assertion (A) :* Double sampling is preferred over single sampling when the quality of incoming lots is expected to be either very good or very bad.

*Reason (R) :* With double sampling, the amount of inspection required will be lesser than that in the case of single sampling.

**Ans.** (*a*)

**Q. 82.** *Assertion (A) :* Vogel's approximation method yields the best initial basic feasible solution of a transportation problem.

*Reason (R) :* Vogel's method gives allocations to the lowest cost elements of the whole matrix.

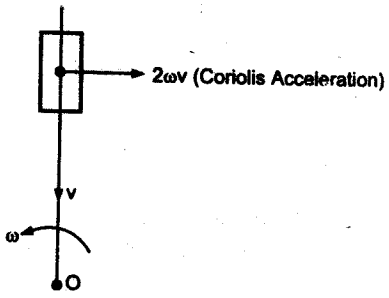
**Ans.** (*a*)

**Q. 83.** *Assertion (A) :* Master production schedule drives the whole of production and inventory control system in a manufacturing organisation.

*Reason (R) :* Master production schedule is a list of daily and weekly work released by PPC to production.

**Ans.** (*c*)

**Q. 84.** *Assertion (A) :* The direction of Coriolis acceleration shown in the given figure is correct.




*Reason (R) :* The direction of Coriolis acceleration is such that it will rotate at a velocity $v$ about its origin in the direction opposite to $\omega$.

**Ans.** (*a*)

**Q. 85.** *Assertion (A) :* While plotting control charts for variables, average of sub-groups of readings are used rather than the individual readings.

*Reason (R) :* If control charts are plotted with the individual readings, the labour of plotting the chart will increase.

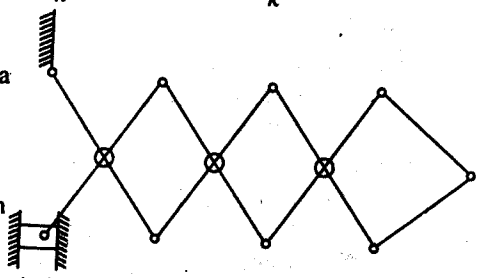
**Ans.** (*c*)

**Q. 86.** Euler's formula can be used for obtaining crippling load for a M.S. column with hinged ends. Which one of the following conditions for the slenderness ratio $\frac{l}{K}$ is to be satisfied ?

(*a*) $5 < \frac{l}{k} < 8$ (*b*) $9 < \frac{l}{k} < 18$ (*c*) $19 < \frac{l}{k} < 40$ (*d*) $\frac{l}{k} \geq 80$

**Ans.** (*c*)

**Q. 87.** The kinematic chain shown in the above figure is a



(*a*) structure
(*b*) mechanism with one degree of freedom
(*c*) mechanism with two degree of freedom
(*d*) mechanism with more than two degrees of freedom

**Ans.** (*d*)

**Q. 88.** A point on a link connecting a double slider crank chain will trace a

(*a*) straight line (*b*) circle (*c*) parabola (*d*) ellipse

**Ans.** (*b*)

**Q. 89.** A wheel is rolling on a straight level track with a uniform velocity '$v$'. The instantaneous velocity of a point on the wheel lying at the mid-point of a radius

(*a*) varies between 3 $v/2$ and $-v/2$ (*b*) varies between $v/2$ and $-v/2$
(*c*) varies between 3 $v/2$ and $-v/2$ (*d*) does not vary and is equal to $v$

**Ans.** (*b*)

**Q. 90.** A four-bar chain has

(*a*) all turning pairs
(*b*) one turning pair and the others are sliding pairs
(*c*) one sliding pair and the others are turning pairs
(*d*) all sliding pairs

**Ans.** (*a*)

**Q. 91.** Which one of the following pair is correctly matched ?

(*a*) Beauchamp tower ..... First experiments on journal bearings
(*b*) Osborne Reynolds ..... Antifriction bearings
(*c*) Somonerfeld number ..... Pivot and Coller bearings
(*d*) Ball bearings ..... Hydrodynamic lubrication

**Ans.** (*c*)

**Q. 92.** Sensitiveness of a governor is defined as

(*a*) $\frac{\text{Range of speed}}{2 \times \text{Mean speed}}$ (*b*) $\frac{2 \times \text{Mean speed}}{\text{Range of speed}}$

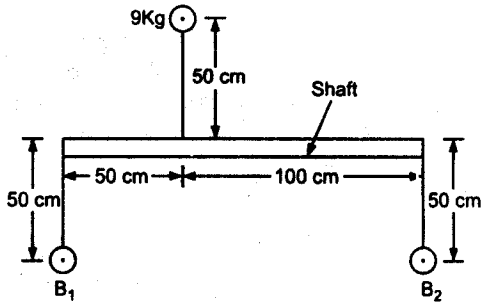
(*c*) Mean speed × Range of speed (*d*) $\frac{\text{Range of speed}}{\text{Mean speed}}$

**Ans.** (*d*)

**Q. 93.** Masses $B_1$, $B_2$ and 9 kg are attached to a shaft in parallel planes as shown in the above figure. If the shaft is rotating at 100 rpm, the mass $B_2$ is

(*a*) 3 kg (*b*) 6 kg

(*c*) 9 kg (*d*) 27 kg




**Ans.** (*a*)

**Q. 94.** The equation of motion for a damped viscous vibration is $3\ddot{x} + 9\dot{x} + 27x = 0$.

The damping factor is

(*a*) 0.25 (*b*) 0.50 (*c*) 0.75 (*d*) 1.00

**Ans.** (*b*)

**Q. 95.** A mass is suspended at the bottom of two springs in series having stiffness 10 N/mm and 5 N/mm. The equivalent spring stiffness of the two springs is nearly

(*a*) 0.3 N/mm (*b*) 3.3 N/mm (*c*) 5 N/mm (*d*) 15 N/mm

**Ans.** (*b*)

**Q. 96.** The velocity ratio in the case of the compound train of wheels is equal to

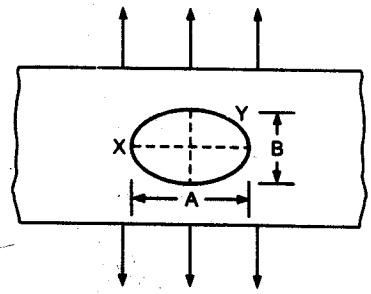
(*a*) $\frac{\text{No. of teeth on first driver}}{\text{No. of teeth on last follower}}$ (*b*) $\frac{\text{No. of teeth on last follower}}{\text{No. of teeth on first driver}}$

(*c*) $\frac{\text{Product of teeth on the drivers}}{\text{Product of teeth on the followers}}$ (*d*) $\frac{\text{Product of teeth on the followers}}{\text{Product of teeth on the drivers}}$

**Ans.** (*c*)

**Q. 97.** A loaded semi-infinite flat plate is having an elliptical hole ($A/B = 2$) in the middle as shown in the above figure. The stress concentration factor at points either $X$ or $Y$ is

(*a*) 1 (*b*) 3 (*c*) 5 (*d*) 7




**Ans.** (*c*)

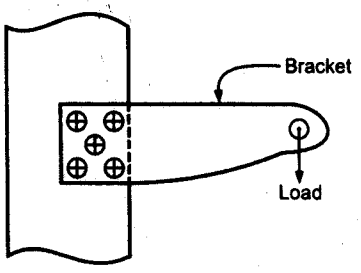
**Q. 98.** For the bracket bolted as shown in the above figure, the bolts will develop

(*a*) primary tensile stresses and secondary shear stresses

(*b*) primary shear stresses and secondary shear stresses

(*c*) primary shear stresses and secondary tensile stresses

(*d*) primary tensile stresses and secondary compressive stresses




**Ans.** (*a*)

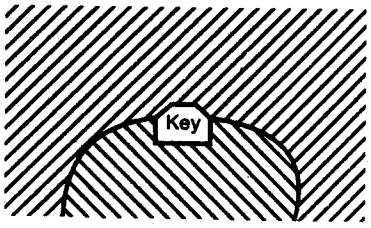
**Q. 99.** A screw thread specified by M 20 × 2.5 C as per BIS thread system means

(*a*) Metric thread of 20 mm nominal diameter and 2.5 mm pitch having coarse tolerance

(*b*) Metric thread of 20 mm root diameter and 2.5 mm pitch having coarse tolerance

(*c*) Metric thread of fine class having 20 mm root diameter and 2.5 mm pitch
(*d*) Metric thread of 20 mm shank diameter and 2.5 mm thread depth with coarse tolerance

**Ans.** (*d*)




**Q. 100.** The key shown in the above figure is a
(*a*) Barth key (*b*) Kennedy key
(*c*) Lewis key (*d*) Woodruff key

**Ans.** (*a*)

**Q. 101.** Which one of the following statements with regard to belt drives is NOT correct ?
(*a*) Increase in the angle of wrap of the belt enables more power transmission
(*b*) Maximum power is transmitted when the centrifugal tension is three times the tight side tension
(*c*) Wide and thin belt is preferable for better life than a thick and narrow one
(*d*) Crown is provided on the pulley to make the belt run centrally on the pulley

**Ans.** (*b*)

**Q. 102.** Angle of twist of a shaft of diameter 'd' is inversely proportional to
(*a*) $d$ (*b*) $d^2$ (*c*) $d^3$ (*d*) $d^4$

**Ans.** (*d*)

**Q. 103.** Which one of the following sets of parameters should be monitored for determining safe operation of journal bearing ?
(*a*) Oil pressure, bearing metal temperature and bearing vibration
(*b*) Bearing vibration, oil pressure and speed of shaft
(*c*) Bearing metal temperature and oil pressure
(*d*) Oil pressure and bearing vibration

**Ans.** (*a*)

**Q. 104.** Consider the following pairs of parts :
1. Pair of gear in mesh. 2. Belt and pulley. 3. Cylinder and piston. 4. Cam and follower.
Among these, the higher pairs are
(*a*) 1 and 4 (*b*) 2 and 4 (*c*) 1, 2 and 3 (*d*) 1, 2 and 4

**Q. 105.** Which one of the following sets of accelerations is involved in the motion of the piston inside the cylinder of a uniformly rotating cylinder mechanism ?
(*a*) Coriolis and radial acceleration (*b*) Radial and tangential acceleration
(*c*) Coriolis and gyroscopic acceleration (*d*) Gyroscopic and tangential acceleration

**Ans.** (*b*)

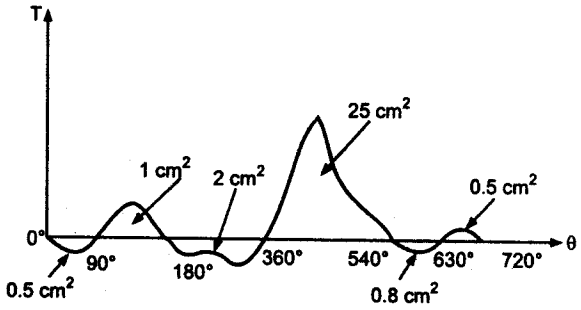
**Q. 106.** Consider the following statements :
1. Round bar in a round hole forms a turning pair
2. A square bar in a square hole forms a sliding pair
3. A vertical shaft in a foot-step bearing forms a successful constraint.
Which of these statements are correct ?
(*a*) 1 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1, 2 and 3

**Ans.** (*d*)

**Q. 107.** Consider the following pairs of types of bearings and applications :
1. Partial Journal bearing ..... Rail wagon axles
2. Full journal bearing ..... Diesel engine crank-shaft
3. Radial bearing ..... Combined radial and axial loads
Which of these pairs is/are correctly matched ?
(*a*) 1 alone (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1, 2 and 3

**Ans.** (*b*)

**Q. 108.** Consider the following statements regarding the turning moment diagram of a reciprocating engine shown in the above figure : (Scale 1 $cm^2 = 100\ N \cdot m$)




1. It is four stroke IC engine
2. The compression stroke is 0° to 180°
3. Mean turning moment $T_m = \frac{580}{\pi} N \cdot m$
4. It is a multi-cylinder engine.

Which of these statements are correct ?

(*a*) 1, 2 and 3 (*b*) 1, 2 and 4 (*c*) 2, 3 and 4 (*d*) 1, 3 and 4

**Ans.** (*a*)

**Q. 109.** The pitching of a ship in the ocean is an oscillatory periodic motion. A ship is pitching 6° above and 6° below with a period of 20s from its horizontal plane. Consider the following statements in this regard :

1. The motion has a frequency of oscillation (*i.e.* pitching) of 3 cycles/minute.
2. The motion has an angular frequency of 3.14 rad/s.
3. The angular velocity of precession of ship's rotor is $\pi^2/300$ rad/s.
4. The amplitude of pitching is $\pi/30$ rad.

Which of these statements are correct ?

(*a*) 1 and 2 (*b*) 1, 2 and 4 (*c*) 2, 3 and 4 (*d*) 1, 3 and 4

**Ans.** (*b*)

**Q. 110.** The critical speed of a shaft is affected by the

(*a*) diameter and the eccentricity of the shaft (*b*) span and the eccentricity of the shaft
(*c*) diameter and the span of the shaft (*d*) span of the shaft

**Ans.** (*b*)

**Q. 111.** Match List I (Applications) with List II (Joints) and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Roof girder | 1. Hook's joint |
| B. Cylinder head of an IC engine | 2. Screwed joint |
| C. Piston rod and cross head | 3. Cotter joint |
| D. Solid shaft and a plate | 4. Welded joint |
| | 5. Riveted joint |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 5 | 3 | 1 | 4 |
| (*c*) | 5 | 2 | 3 | 4 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 4 | 2 | 3 | 1 |
| (*d*) | 4 | 3 | 1 | 5 |

**Ans.** (*c*)

**Q. 112.** The following parameters are to be calculated while designing screw jack.

1. Core diameter of screw
2. Torque required to rotate the screw
3. Principal stresses
4. Height of the nut

The correct sequence of the calculation of these parameters is

(*a*) 1, 2, 4, 3 (*b*) 1, 2, 3, 4 (*c*) 2, 1, 3, 4 (*d*) 2, 1, 4, 3

**Ans.** (*c*)

**Q. 113.** Consider the following types of stresses in respect of a hoisting rope during acceleration of load :

1. Direct stress due to weight hoisted and weight of the rope
2. Bending stresses due to bending of rope over the sheave
3. Stresses due to initial tightening.
4. Acceleration stresses

Which of these are the correct types of stresses induced in a hoisting rope during acceleration of load ?

(*a*) 1, 2 and 3 (*b*) 2, 3 and 4 (*c*) 1, 2 and 4 (*d*) 1, 3 and 4

**Ans.** (*c*)

**Q. 114.** Consider the following statements regarding a centrifugal clutch :

1. It need not be unloaded before engagement.
2. It enables the prime mover to start up under no-load conditions.
3. It picks up the load gradually with the increase in speed
4. It will not slip to the point of destruction
5. It is very useful when the power unit has a low starting torque

Which of these are the advantages of centrifugal clutch ?

(*a*) 1, 2 and 4 (*b*) 1, 3 and 5 (*c*) 2, 3 and 5 (*d*) 1, 3, 4 and 5

**Ans.** (*a*)

**Q. 115.** Match List I with List II and select the correct answer using the codes given below the Lists :

| *List I* | | *List II* | |
|---|---|---|---|
| A. | Compound train | 1. | Hart mechanism |
| B. | Quick return mechanism | 2. | Coriolis force |
| C. | Exact straight line motion | 3. | Transmission of motion around bends and corners |
| D. | Approximate straight line motion | 4. | Watt mechanism |

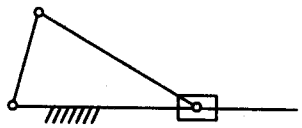
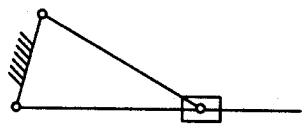
***Codes :***

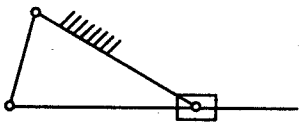
| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 1 | 2 | 3 | 4 |
| (*c*) | 3 | 4 | 1 | 2 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 3 | 2 | 1 | 4 |
| (*d*) | 1 | 4 | 3 | 2 |

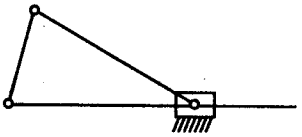
**Ans.** (*b*)

**Q. 116.** Match List I (Kinematic inversions) with List II (Applications) and select the correct answer using the codes given below the Lists :

| *List I* | | *List II* | |
|---|---|---|---|
| A. |  | 1. | Hand pump |
| B. |  | 2. | Compressor |

C. 

3. Whitworth quick return mechanism

D. 

4. Oscillating Cylinder Engine

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 3 | 4 | 2 | (*b*) | 2 | 4 | 3 | 1 |
| (*c*) | 2 | 3 | 4 | 1 | (*d*) | 1 | 4 | 3 | 2 |

**Ans.** (*c*)

**Q. 117.** Match List I (Applications) with List II (Features of vibration) and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Vibration damper | 1. Frequency of free vibration |
| B. Shock absorber | 2. Forced vibration |
| C. Frahm tachometer | 3. Damping of vibration |
| D. Oscillator | 4. Transverse vibration |
| | 5. Absorption of vibration |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 5 | 3 | 2 | 1 | (*b*) | 3 | 1 | 4 | 2 |
| (*c*) | 5 | 3 | 4 | 1 | (*d*) | 3 | 4 | 2 | 5 |

**Ans.** (*a*)

**Q. 118.** Match List I (Keys) with List II (Characteristics) and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Saddle key | 1. Strong in shear and crushing |
| B. Woodruff key | 2. Withstands tension in one direction |
| C. Tangent key | 3. Transmission of power through frictional resistance |
| D. Kennedy key | 4. Semicircular in shape |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 3 | 4 | 1 | 2 | (*b*) | 4 | 3 | 2 | 1 |
| (*c*) | 4 | 3 | 1 | 2 | (*d*) | 3 | 4 | 2 | 1 |

**Ans.** (*d*)

**Q. 119.** Match List I (Applications) with List II (Drive element) and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Automobile differential | 1. Flat belt |
| B. Bicycle | 2. V-belt |
| C. Planing machine | 3. Chain drive |
| D. Radiator fan of automobile | 4. Gear drive |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 4 | 3 | 1 | 2 | (*b*) | 1 | 3 | 4 | 2 |
| (*c*) | 4 | 2 | 1 | 3 | (*d*) | 1 | 2 | 4 | 3 |

**Ans.** (*a*)

**Q. 120.** Match List I with List II and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Unwin's formula | 1. Bearings |
| B. Wahl factor | 2. Rivets |
| C. Reynold's equation | 3. Gears |
| D. Lewis form factor | 4. Springs |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 4 | 2 | 3 | (*b*) | 2 | 3 | 1 | 4 |
| (*c*) | 1 | 3 | 2 | 4 | (*d*) | 2 | 4 | 1 | 3 |

**Ans.** (*d*)

# I.E.S. (Objective)
# MECHANICAL ENGINEERING–2001
## PAPER - I

**Q. 1.** If $p_v$ is the partial pressure of vapour, $p_s$ is the partial pressure of vapour for saturated air and $p_b$ is the barometric pressure, the relationship between relative humidity '$\phi$' and degree of saturation '$\mu$' is given by

(*a*) $\mu = \phi\left[\frac{p_b - p_s}{p_b - p_v}\right]$ (*b*) $\mu = \phi\left[\frac{p_b - p_v}{p_b - p_s}\right]$

(*c*) $\mu = \phi\frac{p_v}{p_b}$ (*d*) $\mu = \phi\frac{p_v}{p_s}$

**Ans.** (*a*)

**Q. 2.** The by-pass factor of single cooling coil in an air-conditioner is 0.7. The by-pass factor, if three such cooling coils with the same apparatus dew point are kept one behind the other, will be

(*a*) 0.210 (*b*) 0.292 (*c*) 0.343 (*d*) 0.412

**Ans.** (*c*)

**Q. 3.** Which one of the following statements is true for air conditioning duct design ?

(*a*) Static regain method is used, when the duct work is extensive, total pressure drop is low and flow is balanced

(*b*) Static regain method is used, when the duct work is extensive, total pressure drop is high and flow is unbalanced

(*c*) Equal friction method is used, when the duct work is extensive, total pressure drop is low and flow is balanced

(*d*) Equal friction method is used, when duct work is extensive, total pressure drop is low and flow is unbalanced

**Ans.** (*c*)

**Q. 4.** For an-conditioned space, RTH = 100 kW; RSHF = 0.75, volume flow rate is equal to 100 $m^3$/minute and indoor design specific humidity is 0.01 kg/(kg of dry air). The specific humidity of supply air is

(*a*) 0.010 (*b*) 0.0075 (*c*) 0.005 (*d*) 0.0025

**Ans.** (*c*)

**Q. 5.** For an air-conditioning system, the outdoor and indoor design dry bulb temperatures are 45°C and 25°C respectively. The space to be air-conditioned is 20 m × 30 m × 5 m and infiltration is estimated to be one air change. If the density and specific heat of air are 1.2 (kg of dry air)/$m^3$ and 1.02 kJ/(kg of dry air)°C, then the sensible heat load due to infiltration is, nearly

(*a*) 122.4 kW (*b*) 61.2 kW (*c*) 12.24 kW (*d*) 20.4 kW

**Ans.** (*d*)

**Q. 6.** Match List-I and List-II and select the correct answer using the codes given below the lists :

($h_m$ — mass transfer coefficient, $D$ — molecular diffusion coefficient,

$L$ — characteristic length dimension, $k$ — thermal conductivity, $\rho$ — density,

$C_p$ — specific heat at constant pressure, $\mu$ — dynamic viscosity)

| *List-I* | | *List-II* |
|---|---|---|
| A. Schmidt number | 1. | $\frac{k}{(\rho C_p D)}$ |
| B. Thermal diffusivity | 2. | $\frac{h_m L}{D}$ |
| C. Lewis number | 3. | $\frac{\mu}{\rho D}$ |
| D. Sherwood number | 4. | $\frac{k}{\rho C_p}$ |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 4 | 3 | 2 | 1 |
| (*c*) | 3 | 4 | 2 | 1 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 4 | 3 | 1 | 2 |
| (*d*) | 3 | 4 | 1 | 2 |

**Ans.** (*c*)

**Q. 7.** In the operation of four-stroke diesel engines, the term 'squish' refers to the
(*a*) injection of fuel in the precombustion chamber
(*b*) discharge of gases from the precombustion chamber
(*c*) entry of air into the combustion chamber
(*d*) stripping of fuel from the core

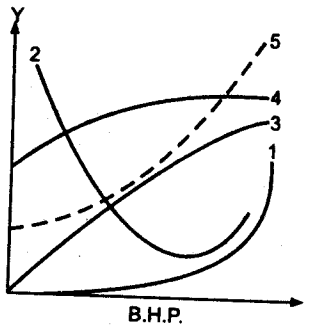
**Ans.** (*a*)

**Q. 8.** Consider the following statements regarding the advantages of fuel injection over carburetion in S.I. engines :
1. Higher power output and increased volumetric efficiency.
2. Simple and inexpensive injection equipment.
3. Longer life of injection equipment.
4. Less knocking and reduced tendency for back-fire.
Select the correct answer using the codes given below :
***Codes :***
(*a*) 1, 2 and 3 (*b*) 1, 2 and 4 (*c*) 2 and 3 (*d*) 1 and 4

**Ans.** (*d*)

**Q. 9.** Match List-I (Performance Parameter Y) with List-II (Curves labelled 1, 2, 3, 4 and 5 BHP vs. Y) regarding a C.I. engine run at constant speed and select the correct answer using the codes given below the lists :

| *List-I (Performance Parameter Y)* | *List-II (Curves BHP vs. Y)* |
|---|---|
| A. Total fuel consumption rate | |
| B. Mechanical efficiency | |
| C. Indicated power | |
| D. Brake specific fuel consumption | |



*Codes :*

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 5 | 3 | 4 | 2 | (*b*) | 1 | 3 | 4 | 2 |
| (*c*) | 5 | 4 | 2 | 3 | (*d*) | 1 | 4 | 2 | 3 |

**Ans.** (*a*)

**Q. 10.** Match List-I with List-II and select the correct answer using the codes given below the lists :

| *List-I* | *List-II* |
|---|---|
| A. Supercharging | 1. Multicylinder engine |
| B. Morse test | 2. C.I. engine |
| C. Heterogeneous combustion | 3. Calorific value |
| D. Ignition quality of petrol | 4. Aircraft engine |
| | 5. Octane number |
| | 6. Single cylinder S.I. engine |

*Codes :*

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 4 | 1 | 2 | 5 | (*b*) | 6 | 3 | 2 | 5 |
| (*c*) | 6 | 1 | 5 | 2 | (*d*) | 4 | 3 | 5 | 2 |

**Ans.** (*a*)

**Q. 11.** With reference to Turbojet and Rocket engines, consider the following statements :

1. Efficiency of Rocket engines is higher than that of Jet engines
2. Exit velocities of exhaust gases in Rocket engines are much higher than those in Jet engines
3. Stagnation conditions exist at the combustion chamber in Rocket engines
4. Rocket engines are air-breathing engines

Which of these statements are correct ?

(*a*) 1 and 2 (*b*) 1, 3 and 4 (*c*) 2, 3 and 4 (*d*) 1, 2 and 3

**Ans.** (*a*)

**Q. 12.** With respect to I.C. engine emissions, consider the following statements :

1. Evaporative emissions have no carbon monoxide and oxides of nitrogen.
2. Blow by emissions are essentially carbon monoxide and suspended particulate matter.
3. Exhaust emissions contain 100% of carbon monoxide, 100% of oxides of nitrogen and around 50-55% of hydrocarbons emitted by the engine.
4. There are no suspended particulates in the exhaust.

Of these statements

(*a*) 1 and 4 are correct (*b*) 1 and 3 are correct

(*c*) 2 and 3 are correct (*d*) 1, 2, 3 and 4 are correct

**Ans.** (*c*)

**Q. 13.** A hydrocarbon fuel was burnt with air and the Orsat analysis of the dry products of combustion yielded the following data :

| | | |
|---|---|---|
| Initial volume of dry gas sample | ... | 100 cc |
| Volume after absorption in pipette 1 containing potassium hydroxide solution | ... | 89 cc |
| Volume after absorption in pipette 2 containing solution of pyrogallic acid and potassium hydroxide | ... | 84 cc |
| Volume after absorption in pipette 3 containing cuprous chloride solution | ... | 82 cc |

The percentage (by volume) of $CO_2$ in the dry products was

(*a*) 2% (*b*) 5% (*c*) 11% (*d*) 18%

**Ans.** (*c*)

**Q. 14.** Match List-I (Material) with List-II (Use) and select the correct answer using the codes given below the lists :

| *List-I (Material)* | *List-II (Use)* |
|---|---|
| A. Graphite | 1. Coolant |
| B. Thorium-233 | 2. Moderator |
| C. Molten Sodium | 3. Fissionable material |
| D. Plutonium-239 | 4. Fissile material |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 1 | 4 | 2 | 3 |
| (*c*) | 2 | 3 | 1 | 4 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 2 | 4 | 1 | 3 |
| (*d*) | 1 | 3 | 2 | 4 |

**Ans.** (*b*)

**Q. 15.** The data given in the table refers to an engine based on Carnot cycle, where $Q_1$ = Heat received (kJ/min), $Q_2$ = Heat rejected (kJ/s), $W$ = Work output (kW)

| *S. No.* | $Q_1$ | $Q_2$ | $W$ |
|---|---|---|---|
| 1. | 1500 | 16.80 | 8.20 |
| 2. | 1600 | 17.92 | 8.75 |
| 3. | 1700 | 19.03 | 9.30 |
| 4. | 1800 | 20.15 | 9.85 |

If heat received by the engine is 2000 kJ/minute the work output will be, nearly,

(*a*) 9.98 (*b*) 10.39 (*c*) 11.54 (*d*) 10.95

**Ans.** (*d*)

**Q. 16.** A system while undergoing a cycle A — B — C — D — A has the values of heat and work transfers as given in the table :

| *Process* | $Q$ *kJ/min* | $W$ *kJ/min* |
|---|---|---|
| A — B | + 687 | + 474 |
| B — C | - 269 | 0 |
| C — D | - 199 | - 180 |
| D — A | + 75 | 0 |

The power developed in kW is, nearly,

(*a*) 4.9 (*b*) 24.5 (*c*) 49 (*d*) 98

**Ans.** (*a*)

**Q. 17.** In a new temperature scale say °ρ, the boiling and freezing points of water at one atmosphere are 100° ρ and 300° ρ respectively. Correlate this scale with the Centigrade scale. The reading of 0° ρ on the Centigrade scale is

(*a*) 0°C (*b*) 50°C (*c*) 100°C (*d*) 150°C

**Ans.** (*d*)

**Q. 18.** Match List-I (Name of entity) with List-II (Definition) and select the correct answer using the codes given below the lists :

| *List-I (Name of entity)* | | *List-II (Definition)* |
|---|---|---|
| A. | Compressibility factor | 1. $-\frac{1}{v}\left(\frac{\partial v}{\partial T}\right)_p$ |
| B. | Joule-Thomson coefficient | 2. $\left(\frac{\partial h}{\partial T}\right)_p$ |
| C. | Constant pressure specific heat | 3. $\left(\frac{\partial T}{\partial p}\right)_h$ |
| D. | Isothermal compressibility | 4. $\left(\frac{pv}{RT}\right)$ |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 2 | 1 | 4 | 3 | (*b*) | 4 | 3 | 2 | 1 |
| (*c*) | 2 | 3 | 4 | 1 | (*d*) | 4 | 1 | 2 | 3 |

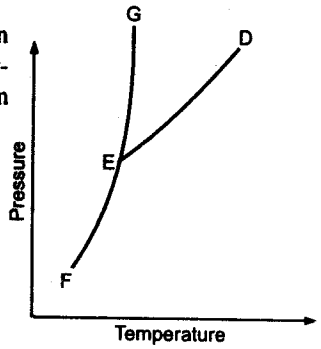
**Ans.** (*b*)

**Q. 19.** If $p_a$ and $p_v$ denote respectively the partial pressure of dry air and that of water vapour in moist air, the specific humidity of air is given by

(*a*) $\frac{p_v}{p_a + p_v}$ (*b*) $\frac{p_v}{p_a}$ (*c*) $\frac{0.622\, p_v}{p_a}$ (*d*) $\frac{0.622\, p_v}{P_a + p_v}$

**Ans.** (*c*)

**Q. 20.** Consider the phase diagram of a certain substance as shown in the given figure. Match List-I (Process) with List-II (Curves/lines) and select the correct answer using the codes given below the lists :




| *List-I (Process)* | | *List-II (Curves/lines)* |
|---|---|---|
| A. | Vaporization | 1. EF |
| B. | Fusion | 2. EG |
| C. | Sublimation | 3. ED |

***Codes :***

| | A | B | C | | A | B | C |
|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 3 | 2 | (*b*) | 1 | 2 | 3 |
| (*c*) | 3 | 2 | 1 | (*d*) | 3 | 1 | 2 |

**Ans.** (*a*)

**Q. 21.** Number of components ($C$), phase ($P$) and degrees of freedom ($F$) are related by Gibbs-phase rule as

(*a*) $C - P - F = 2$ (*b*) $F - C - P = 2$ (*c*) $C + F - P = 2$ (*d*) $P + F - C = 2$

**Ans.** (*d*)

**Q. 22.** Consider the following statements :

1. Availability is the maximum theoretical work obtainable.

2. Clapeyron's equation for dry saturated steam is given by

$$(V_g - V_f) = \frac{dT_s}{dQ}\left[\frac{h_g - h_f}{T_s}\right].$$

3. A gas can have any temperature at a given pressure unlike a vapour which has a fixed temperature at a given pressure.

4. Joule Thomson coefficient is expressed as $\mu = \left[\frac{\partial s}{\partial p}\right]_h$

Of these statements

(*a*) 1, 2 and 3 are correct (*b*) 1, 3 and 4 are correct

(*c*) 2 and 3 are correct (*d*) 1, 2 and 4 are correct

**Ans.** (*a*)

**Q. 23.** Match List-I with List-II and select the correct answer using the codes given below the lists :

| *List-I (Cycles operating between fixed temperature limits)* | *List-II (Characteristic of cycle efficiency η)* |
|---|---|
| A. Otto cycle | 1. η depends only upon temperature limits |
| B. Diesel cycle | 2. η depends only on pressure limits |
| C. Carnot cycle | 3. η depends on volume compression ratio |
| D. Brayton cycle | 4. η depends on cut-off ratio and volume compression ratio |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 3 | 4 | 1 | 2 |
| (*c*) | 3 | 2 | 1 | 4 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 1 | 4 | 3 | 2 |
| (*d*) | 1 | 2 | 3 | 4 |

**Ans.** (*a*)

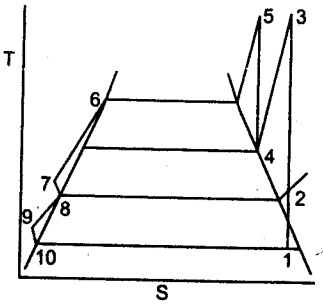
**Q. 24.** The temperature-entropy diagram for a steam turbine power plant, operating on the Rankine cycle with reheat and regenerative feed heating is shown in the given figure. If $m$ denotes the fraction of steam bled for feed heating, the work developed in the turbine per kg steam entering the turbine at state 5 is

(*a*) $(h_5 - h_4) + (1 - m)(h_3 - h_1)$

(*b*) $(h_5 - h_4) + (h_3 - h_2) + (1 - m)(h_2 - h_1)$

(*c*) $2h_5 - h_4 - h_2 + (1 - m)(h_2 - h_1)$

(*d*) $(h_5 - h_4) + (1 - m)(h_3 - h_2)$




**Ans.** (*a*)

**Q. 25.** The working temperatures in the evaporator and condenser coils of a refrigerator are – 30° C and 32° C respectively. If the actual refrigerator has a C.O.P. of 0.75 of the maximum, the required power input for a refrigerating effect of 5 kW is, nearly,

(*a*) 1.7 kW (*b*) 2.94 kW (*c*) 3.92 kW (*d*) 4.0 kW

**Ans.** (*a*)

**Q. 26.** Match List-I with List-II and select the correct answer using the codes given below the lists :

| *List-I* | | *List-II* | |
|---|---|---|---|
| A. | Air standard efficiency of Otto cycle | 1. | Mechanical efficiency |
| B. | Morse test | 2. | Diesel cycle |
| C. | Constant volume cycle | 3. | Brake thermal efficiency |
| D. | Constant pressure heat addition | 4. | Otto cycle |
| | | 5. | $1-\frac{1}{r^{(\gamma-1)}}$ |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 5 | 1 | 4 | 2 | (*b*) | 3 | 5 | 2 | 4 |
| (*c*) | 3 | 5 | 4 | 2 | (*d*) | 5 | 1 | 2 | 4 |

**Ans.** (*a*)

**Q. 27.** Match List-I (Fuels) with List-II (Characteristics/usages) and select the correct answer using the codes given below the lists :

| *List-I (Fuels)* | | *List-II (Characteristics/usages)* | |
|---|---|---|---|
| A. | Semi-bituminous coal | 1. | Methane and carbon dioxide |
| B. | High-speed diesel oil | 2. | Propane and butane |
| C. | Biogas | 3. | Calorific value of 10,600 kCal/kg |
| D. | LPG | 4. | Power plants |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 3 | 4 | 1 | 2 | (*b*) | 4 | 3 | 2 | 1 |
| (*c*) | 3 | 4 | 2 | 1 | (*d*) | 4 | 3 | 1 | 2 |

**Ans.** (*b*)

**Q. 28.** Consider the following statements :

1. Motor gasoline is a mixture of various hydrocarbons with a major proportion being aromatic hydrocarbons.
2. Compressed natural gas is mainly composed of methane.
3. Producer gas has a predominant component of hydrogen with lesser proportion of carbon monoxide.
4. Cetane number of fuel used in diesel engines in India is in the range of 80 to 90.

Which of these statements are correct ?

(*a*) 1 and 2 (*b*) 1 and 3
(*c*) 2, 3 and 4 (*d*) 1, 2, 3 and 4

**Ans.** (*b*)

**Q. 29.** Consider the following statements :

1. For the combustion of pulverised coal, 5 to 10% excess air is required.
2. Air contains 21% oxygen by weight.
3. The flue gases from a coal-fired furnace contain around 70% nitrogen by volume.
4. In the combustion of liquid fuels, the number of moles of the products are invariably greater than the number of moles of the reactants.

Of these statements

(*a*) 1, 2 and 4 are correct (*b*) 1, 3 and 4 are correct

(*c*) 2, 3 and 4 are correct (*d*) 1 and 3 are correct

**Ans.** (*a*)

**Q. 30.** Match items in List-I (Process) with those in List-II (Characteristic) and select the correct answer using the codes given below the lists :

| *List-I (Process)* | *List-II (Characteristic)* |
|---|---|
| A. Throttling process | 1. No work done |
| B. Isentropic process | 2. No change in entropy |
| C. Free expansion | 3. Constant internal energy |
| D. Isothermal process | 4. Constant enthalpy |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 4 | 2 | 1 | 3 | (*b*) | 1 | 2 | 4 | 3 |
| (*c*) | 4 | 3 | 1 | 2 | (*d*) | 1 | 3 | 4 | 2 |

**Ans.** (*a*)

**Q. 31.** A rectangular tank of square cross-section is having its height equal to twice the length of any side at the base. If the tank is filled up with a liquid, the ratio of the total hydrostatic force on any vertical wall to that at the bottom is

(*a*) 2.0 (*b*) 1.5 (*c*) 1.0 (*d*) 0.5

**Ans.** (*c*)

**Q. 32.** Differential pressure head measured by mercury oil differential manometer (specific gravity of oil is 0.9) equivalent to a 600 mm difference of mercury levels will nearly be

(*a*) 7.62 m of oil (*b*) 76.2 m of oil (*c*) 7.34 m of oil (*d*) 8.47 m of oil

**Ans.** (*d*)

**Q. 33.** A block of aluminium having mass of 12 kg is suspended by a wire and lowered until submerged into a tank containing oil of relative density 0.8. Taking the relative density of aluminium as 2.4, the tension in the wire will be (take $g = 10\ m/s^2$)

(*a*) 12000 N (*b*) 800 N (*c*) 120 N (*d*) 80 N

**Ans.** (*d*)

**Q. 34.** A barge 30 m long and 10 m wide has a draft of 3 m when floating with its sides in vertical position. If its centre of gravity is 2.5 m above the bottom, the nearest value of metacentric height is

(*a*) 3.28 m (*b*) 2.78 m (*c*) 1.78 m (*d*) zero

**Ans.** (*b*)

**Q. 35.** A cylindrical vessel having its height equal to its diameter is filled with liquid and moved horizontally at an acceleration equal to acceleration due to gravity. The ratio of the liquid left in the vessel to the liquid at static equilibrium condition is

(*a*) 0.2 (*b*) 0.4 (*c*) 0.5 (*d*) 0.75

**Ans.** (*c*)

**Q. 36.** The shear stress developed in a lubricating oil, of viscosity 9.81 poise, filled between two parallel plates 1 cm apart and moving with relative velocity of 2 m/s is

(*a*) 20 $N/m^2$ (*b*) 19.62 $N/m^2$ (*c*) 29.62 $N/m^2$ (*d*) 40 $N/m^2$

**Ans.** (*b*)

**Q. 37.** The convective acceleration of fluid in the x-direction is given by

(*a*) $u\frac{\partial u}{\partial x}+v\frac{\partial v}{\partial y}+\omega\frac{\partial \omega}{\partial z}$ (*b*) $\frac{\partial u}{\partial t}+\frac{\partial v}{\partial t}+\frac{\partial \omega}{\partial t}$

(*c*) $u\frac{\partial u}{\partial x}+u\frac{\partial v}{\partial y}+\omega\frac{\partial w}{\partial z}$ (*d*) $\mu\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+\omega\frac{\partial u}{\partial z}$

**Ans.** (*b*)

**Q. 38.** Match List-I (Types of flow) with List-II (Basic ideal flows) and select the correct answer using the codes given below the lists :

| *List-I (Types of flow)* | | *List-II (Basic ideal flows)* | |
|---|---|---|---|
| A. | Flow over a stationary cylinder | 1. | source + sink + uniform flow |
| B. | Flow over a half Rankine body | 2. | doublet + uniform flow |
| C. | Flow over a rotating body | 3. | source + uniform flow |
| D. | Flow over a Rankine oval | 4. | doublet + free vortex + uniform flow |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 4 | 3 | 2 | (*b*) | 2 | 4 | 3 | 1 |
| (*c*) | 1 | 3 | 4 | 2 | (*d*) | 2 | 3 | 4 | 1 |

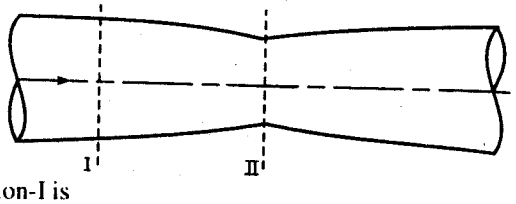
**Ans.** (*d*)

**Q. 39.** A glass tube with a 90° bend is open at both the ends. It is inserted into a flowing stream of oil, $S = 0.90$, so that one opening is directed upstream and the other is directed upward. Oil inside the tube is 50 mm higher than the surface of flowing oil. The velocity measured by the tube is, nearly,

(*a*) 0.89 m/s (*b*) 0.99 m/s (*c*) 1.40 m/s (*d*) 1.90 m/s

**Ans.** (*c*)

**Q. 40.** At location-I of a horizontal line, the fluid pressure head is 32 cm and velocity head is 4 cm. The reduction in area at location II is such that the pressure head drops down to zero. The ratio of velocities at location-II to that at location-I is




(*a*) 3 (*b*) 2.5 (*c*) 2 (*d*) 1.5

**Ans.** (*a*)

**Q. 41.** For maximum transmission of power through a pipe line with total head $H$, the head lost due to friction $h_f$ is given by

(*a*) 0.1 H (*b*) $\frac{H}{3}$ (*c*) $\frac{H}{2}$ (*d*) $\frac{2H}{3}$

**Ans.** (*b*)

**Q. 42.** Two pipelines of equal length and with diameters of 15 cm and 10 cm are in parallel and connect two reservoirs. The difference in water levels in the reservoirs is 3 m. If the friction is assumed to be equal, the ratio of the discharges due to the larger dia pipe to that of the smaller dia pipe is, nearly,

(*a*) 3.375 (*b*) 2.756 (*c*) 2.25 (*d*) 1.5

**Ans.** (*d*)

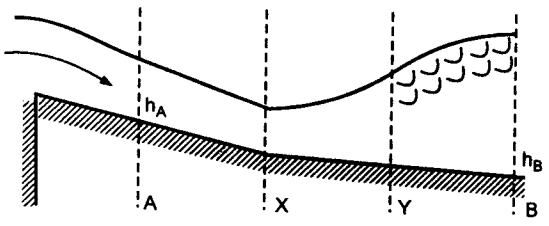
**Q. 43.** The critical depth of a rectangular channel of width 4.0 m for a discharge of 12 $m^3/s$ is nearly,

(*a*) 300 mm (*b*) 30 mm (*c*) 0.972 m (*d*) 0.674 m

**Ans.** (*c*)

**Q. 44.** An open channel flow encounters a hydraulic jump as shown in the figure. The following fluid flow conditions are observed between A and B :

1. Critical depth
2. Steady non-uniform flow
3. Unsteady non-uniform flow
4. Steady uniform flow




The correct sequence of the flow conditions in the direction of flow is

(*a*) 1, 2, 3, 4 (*b*) 1, 4, 2, 3 (*c*) 2, 1, 4, 3 (*d*) 4, 2, 3, 1

**Ans.** (*c*)

**Q. 45.** Laminar developed flow at an average velocity of 5 m/s occurs in a pipe of 10 cm radius. The velocity at 5 cm radius is

(*a*) 7.5 m/s (*b*) 10 m/s (*c*) 2.5 m/s (*d*) 5 m/s

**Ans.** (*d*)

**Q. 46.** In a fully-developed turbulent pipe flow, assuming 1/7th power law, the ratio of the mean velocity at the centre of the pipe to the average velocity of the flow is

(*a*) 2.0 (*b*) 1.5 (*c*) 1.22 (*d*) 0.817

**Ans.** (*d*)

**Q. 47.** The pressure drop in a 100 mm diameter horizontal pipe is 50 kPa over a length of 10 m. The shear stress at the pipe wall is

(*a*) 0.25 kPa (*b*) 0.125 kPa (*c*) 0.50 kPa (*d*) 25.0 kPa

**Ans.** (*c*)

**Q. 48.** The velocity distribution in the boundary layer is given as $\frac{u}{u_s} = \frac{y}{\delta}$, where $u$ is the velocity at a distance $y$ from the boundary, $\mu_s$ is the free stream velocity and $\delta$ is the boundary layer thickness at a certain distance from the leading edge of a plate. The ratio of displacement to momentum thicknesses is

(*a*) 5 (*b*) 4 (*c*) 3 (*d*) 2

**Ans.** (*c*)

**Q. 49.** For the velocity profile $\frac{u}{u_\infty} = \eta$, the momentum thickness of a laminar boundary layer on a flat plate at a distance of 1 m from leading edge for air (kinematic viscosity = $2 \times 10^{-5}$ m$^2$/s) flowing at a free stream velocity of 2 m/s is given by

(*a*) 3.16 mm (*b*) 2.1 mm (*c*) 3.16 m (*d*) 2.1 m

**Ans.** (*b*)

**Q. 50.** According to Blasius law, the local skin friction coefficient in the boundary-layer over a flat plate is given by

(*a*) $\frac{0.332}{\sqrt{R_e}}$ (*b*) $\frac{0.664}{\sqrt{R_e}}$

(*c*) $\frac{0.647}{\sqrt{R_e}}$ (*d*) $\frac{1.328}{\sqrt{R_e}}$

**Ans.** (*d*)

**Q. 51.** Match List-I with List-II and select the correct answer using the codes given below the lists :

| *List-I* | *List-II* |
|---|---|
| A. Stokes' law | 1. Strouhal number |
| B. Bluff body | 2. Creeping motion |
| C. Streamline body | 3. Pressure drag |
| D. Karman Vortex Street | 4. Skin friction drag |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 2 | 3 | 1 | 4 | (*b*) | 3 | 2 | 4 | 1 |
| (*c*) | 2 | 3 | 4 | 1 | (*d*) | 3 | 2 | 1 | 4 |

**Ans.** (*a*)

**Q. 52.** Match List-I (Dimensionless numbers) with List-II (Definition as the ratio of) and select the correct answer using the codes given below the lists :

| *List-I (Dimensionless numbers)* | *List-II (Definition as the ratio of)* |
|---|---|
| A. Reynolds number | 1. Inertia force and elastic force |
| B. Froude number | 2. Inertia force and surface tension force |
| C. Weber number | 3. Inertia force and gravity force |
| D. Mach number | 4. Inertia force and viscous force |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 2 | 3 | 4 | (*b*) | 4 | 3 | 2 | 1 |
| (*c*) | 1 | 3 | 2 | 4 | (*d*) | 4 | 2 | 3 | 1 |

**Ans.** (*b*)

**Q. 53.** The stream function in a 2-dimensional flow field is given by $\psi = xy$. The potential function is

(*a*) $\frac{(x^2+y^2)}{2}$ (*b*) $\frac{(x^2-y^2)}{2}$ (*c*) $xy$ (*d*) $x^2y + y^2x$

**Ans.** (*d*)

***Direction :*** *The following 16 (sixteen) items consist of two statements, one labelled the Asserition (A)' and the other labelled the 'Reason (R)'. You are to examine these two statements carefully and decide if the Assertion (A) and the Reason (R) are individually true and if so, whether the Reason is a correct explanation of the Assertion. Select your answers to these items using the codes given below and mark your answer sheet accordingly.*

***Codes :***

(*a*) Both A and R are true and R is the correct explanation of A
(*b*) Both A and R are true but R is NOT a correct explanation of A
(*c*) A is true but R is false
(*d*) A is false but R is true

**Q. 54.** *Assertion (A) :* A convergent-divergent nozzle may give supersonic or subsonic flow at the exit even if the throat is choked.
*Reason (R) :* Depending on the back pressure ratio $p_b/p_0$, the divergent part of the nozzle may act as a supersonic nozzle or a subsonic diffuser.

**Ans.** (*a*)

**Q. 55.** *Assertion (A) :* In a pipe line, the nature of the fluid flow depends entirely on the velocity.
*Reason (R) :* Reynolds number depends on the velocity, diameter of the pipe and kinematic viscosity of the fluid.
**Ans.** (*d*)

**Q. 56.** A capillary tube is inserted in mercury kept in an open container.
*Assertion (A) :* The mercury level inside the tube shall rise above the level of mercury outside.
*Reason (R) :* The cohesive force between the molecules of mercury is greater than the adhesive force between mercury and glass.
**Ans.** (*a*)

**Q. 57.** *Assertion (A) :* Reaction blading is commonly used in intermediate and low pressure parts of steam turbines.
*Reason (R) :* Reaction blading gives higher efficiency than impulse blading.
**Ans.** (*a*)

**Q. 58.** *Assertion (A) :* In conventional impulse steam turbine designs, only two rows of moving blades are used in a Curtis stage.
*Reason (R) :* As the number of rows of moving blades in a Curtis stage increases, the effectiveness of the later rows decreases.
**Ans.** (*a*)

**Q. 59.** *Assertion (A) :* With throttle governing of a steam turbine, the turbine power is reduced by reduction in the available heat drop together with decrease in the rate of steam flow.
*Reason (R) :* The pressure and the rate of steam flow are simultaneously decreased with the help of a throttle valve.
**Ans.** (*a*)

**Q. 60.** *Assertion (A) :* A Kaplan turbine is an axial flow reaction turbine with its vanes fixed to the hub.
*Reason (R) :* Water flows parallel to the axis of rotation of the turbine and a part of the pressure energy gets converted to kinetic energy during its flow through the vanes.
**Ans.** (*a*)

**Q. 61.** *Assertion (A) :* Effective temperature, an index of comfort, is defined as that temperature of saturated air at which one would experience the same feeling of comfort as experienced in the actual environment.
*Reason (R) :* Comfort does not depend on humidity and air velocity.
**Ans.** (*c*)

**Q. 62.** *Assertion (A) :* According to Reynolds analogy for Prandtl number equal to unity, Stanton number is equal to one half of the friction factor.
*Reason (R) :* If thermal diffusivity is equal to kinematic viscosity, the velocity and the temperature distribution in the flow will be the same.
**Ans.** (*c*)

**Q. 63.** *Assertion (A) :* Nusselt number is always greater than unity.
*Reason (R) :* Nusselt number is the ratio of two thermal resistances, one the thermal resistance which would be offered by the fluid, if it was stationary and the other, the thermal resistance associated with convective heat transfer coefficient at the surface.
**Ans.** (*b*)

**Q. 64.** *Assertion (A) :* If the enthalpy of a closed system decreases by 25 kJ while the system receives 30 kJ of energy by heat transfer, the work done by the system is 55 kJ.
*Reason (R) :* The first law energy balance for a closed system is (notations have their usual meaning)

$$\Delta E = Q - W.$$

**Ans.** (*a*)

**Q. 65.** *Assertion (A) :* In thermodynamic analysis, the concept of reversibility is that, a reversible process is the most efficient process.

*Reason (R) :* The energy transfer as heat and work during the forward process, is always identically equal to the energy transfer as heat and work, during the reversal of the process.

**Ans.** (*a*)

**Q. 66.** *Assertion (A) :* Pressurized water reactor (PWR) nuclear power plants use superheated steam.

*Reason (R) :* An increase in the superheat at constant pressure increases the cycle efficiency.

**Ans.** (*d*)

**Q. 67.** *Assertion (A) :* The air standard efficiency of the diesel cycle decreases as the load is increased.

*Reason (R) :* With increase of load, cut-off ratio increases.

**Ans.** (*d*)

**Q. 68.** *Assertion (A) :* Knocking in S.I. engines is due to auto-ignition of the end charge while knocking in C.I. engines is due to auto-ignition of the first charge.

*Reason (R) :* Spark ignition engines employ lower compression ratio than diesel engines and the fuel used has a calorific value lower than that of diesel oil.

**Ans.** (*b*)

**Q. 69.** *Assertion (A) :* The C.I. engine is found to be more efficient than an S.I. engine.

*Reason (R) :* Modern C.I. engines operate on a dual-cycle, which has an efficiency greater than the Otto cycle.

**Ans.** (*a*)

**Q. 70.** A ship with hull length of 100 m is to run with a speed of 10 m/s. For dynamic similarity, the velocity for a 1 : 25 model of the ship in a towing tank should be

(*a*) 2 m/s (*b*) 10 m/s (*c*) 20 m/s (*d*) 25 m/s

**Ans.** (*a*)

**Q. 71.** A standard 90° V-notch weir is used to measure discharge. The discharge is $Q_1$ for a height $H_1$ above the sill and $Q_2$ is the discharge for a height $H_2$. If $H_2/H_1$ is 4, then $Q_2/Q_1$ is

(*a*) 32 (*b*) $16\sqrt{2}$ (*c*) 16 (*d*) 8

**Ans.** (*a*)

**Q. 72.** A right circular cylinder is filled with a liquid upto its top level. It is rotated about its vertical axis at such a speed that halt the liquid spills out, then the pressure at the point of intersection of the axis and bottom surface is

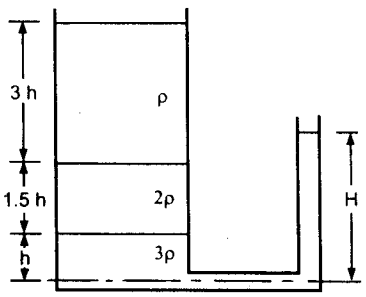
(*a*) same as before rotation (*b*) half of the value before rotation

(*c*) quarter of the value before rotation (*d*) equal to the atmospheric pressure

**Ans.** (*d*)

**Q. 73.** Three immiscible liquids of specific densities ρ, 2ρ and 3ρ are kept in a jar. The height of the liquids in the jar and at the piezometer fitted to the bottom of the jar are as shown in the given figure. The ratio H/h is

(*a*) 4 (*b*) 3.5 (*c*) 3 (*d*) 2.5




**Ans.** (*c*)

**Q. 74.** Which one of the following sequences indicates the correct order for flue gas flow in the steam power plant layout ?

(*a*) superheater, economiser, air preheater

(*b*) economiser, air preheater, superheater

(*c*) air preheater, economiser, superheater (*d*) economiser, superheater, air preheater

**Ans.** (*a*)

**Q. 75.** Which one of the following statements is ***not*** correct ? In a fluidized-bed boiler ?

(*a*) the combustion temperatures are higher than those in the conventional boilers

(*b*) inferior grade of coal can be used without slagging problems

(*c*) the formation of $NO_x$ is less than that in the conventional boilers

(*d*) the volumetric heat release rates are higher than those in the conventional boilers

**Ans.** (*d*)

**Q. 76.** Match List-I (Machines) with List-II (Features) and select the correct answer using the codes given below the lists :

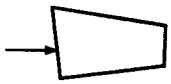
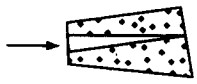
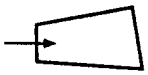
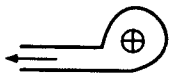
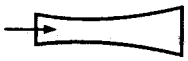
| *List-I (Machines)* | *List-II (Features)* |
|---|---|
| A. Steam engine | 1. Velocity compounding |
| B. Impulse turbine | 2. Diagram factor |
| C. Reaction turbine | 3. Continuous pressure drop |
| D. Centrifugal compressor | 4. Isentropic efficiency |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 3 | 4 | 2 | 1 | (*b*) | 2 | 1 | 3 | 4 |
| (*c*) | 2 | 4 | 3 | 1 | (*d*) | 3 | 1 | 2 | 4 |

**Ans.** (*b*)

**Q. 77.** Match List-I (Names) with List-II (Figures) and select the correct answer using the codes given below the lists :

| *List-I (Names)* | *List-II (Figures)* |
|---|---|
| A. Subsonic nozzle | 1.  |
| B. Supersonic nozzle | 2.  |
| C. Subsonic diffuser | 3.  |
| D. Centrifugal compressor | 4.  |
| | 5.  |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 3 | 4 | 2 | 5 | (*b*) | 1 | 5 | 3 | 4 |
| (*c*) | 3 | 5 | 2 | 4 | (*d*) | 1 | 4 | 3 | 5 |

**Ans.** (*b*)

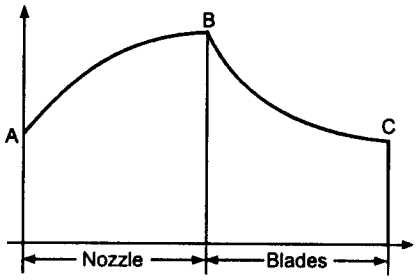
**Q. 78.** For maximum blade efficiency of a single-stage impulse turbine, the blade speed ratio, ($\alpha$ is the angle made by absolute velocity at inlet) should be

(*a*) $\cos 2\alpha$ (*b*) $\frac{\cos 2\alpha}{2}$ (*c*) $\frac{\cos \alpha}{2}$ (*d*) $\frac{2}{\cos \alpha}$

**Ans.** (*c*)

**Q. 79.** The given figure shows the variation of certain steam parameter in case of a simple impulse turbine. The curve A-B-C represents the variation of

(*a*) pressure in nozzle and blades
(*b*) velocity in nozzle and blades
(*c*) temperature in nozzle and blades
(*d*) enthalpy in nozzle and blades




**Ans.** (*b*)

**Q. 80.** If $n$ is the polytropic index of compression and $\frac{p_2}{p_1}$ is the pressure ratio for a three-stage compressor with ideal intercooling, the expression for total work of three stage is

(*a*) $\frac{3n}{(n-1)} p_1 v_1 \left\{ \left( \frac{p_2}{p_1} \right)^{(n-1)/n} - 1 \right\}$ (*b*) $\frac{n}{(n-1)} p_1 v_1 \left\{ \left( \frac{p_2}{p_1} \right)^{(n-1)/3n} - 1 \right\}$

(*c*) $\frac{n}{(n-1)} p_1 v_1 \left\{ \left( \frac{p_2}{p_1} \right)^{(n-1)/n} - 1 \right\}$ (*d*) $\frac{3n}{(n-1)} p_1 v_1 \left\{ \left( \frac{p_2}{p_1} \right)^{(n-1)/3n} - 1 \right\}$

**Ans.** (*d*)

**Q. 81.** The flow in the vaneless space between the impeller exit and diffuser inlet of a centrifugal compressor can be assumed as

(*a*) free vortex (*b*) forced vortex (*c*) solid body rotation (*d*) logarithmic spiral

**Ans.** (*b*)

**Q. 82.** Which of the following statement(s) is/are relevant to critical flow through a steam nozzle ?

1. Flow rate through the nozzle is minimum
2. Flow rate through the nozzle is maximum
3. Velocity at the throat is super sonic
4. Velocity at the throat is sonic

Select the correct answer using the codes given below :

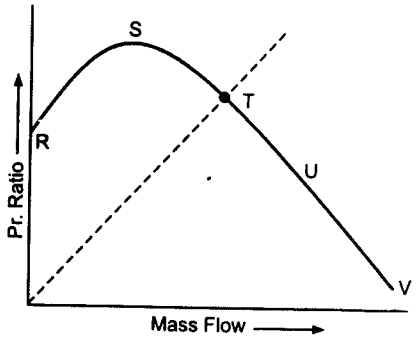
***Codes :***

(*a*) 1 alone (*b*) 1 and 3 (*c*) 2 and 4 (*d*) 4 alone

**Ans.** (*c*)

**Q. 83.** Which portion of the centrifugal compressor characteristics shown in the figure is difficult to obtain experimentally ?

(*a*) RS (*b*) ST
(*c*) TU (*d*) UV




**Ans.** (*a*)

**Q. 84.** Consider the following statements regarding the axial flow in an air compressor :

1. Surging is a local phenomenon while stalling affects the entire compressor.
2. Stalling is a local phenomenon while surging affects the entire compressor.
3. The pressure ratio of an axial compressor stage is smaller than that of a centrifugal compressor stage.

Of these statements
(*a*) 1, 2 and 3 are correct (*b*) 1 and 2 are correct
(*c*) 2 and 3 are correct (*d*) 1 and 3 are correct

**Ans.** (*d*)

**Q. 85.** The thermal efficiency of a gas turbine cycle with regeneration in terms of $T_3$ (maximum temperature), $T_1$ (minimum temperature), $r_p$ (pressure ratio) and $k = (C_p/C_v)$ is given by

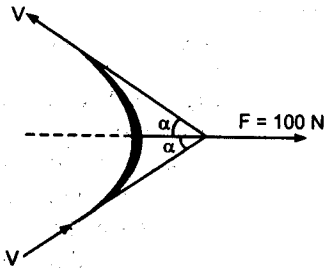
(*a*) $1 - \frac{T_1}{T_3} r_p^{\left(\frac{k}{k-1}\right)}$ (*b*) $1 - \frac{T_3}{T_1} r_p^{\left(\frac{k}{k-1}\right)}$ (*c*) $1 - \frac{T_3}{T_1} r_p^{\left(\frac{k-1}{k}\right)}$ (*d*) $1 - \frac{T_1}{T_3} r_p^{\left(\frac{k-1}{k}\right)}$

**Ans.** (*d*)

**Q. 86.** Consider the specific speed ranges of the following types of turbines :
1. Francis 2. Kaplan 3. Pelton
The sequence of their specific speed in increasing order is
(*a*) 1, 2, 3 (*b*) 3, 1, 2 (*c*) 3, 2, 1 (*d*) 2, 3, 1

**Ans.** (*b*)

**Q. 87.** A symmetrical stationary vane experiences a force 'F' of 100 N as shown in the given figure, when the mass flow rate of water over the vane is 5 kg/s with a velocity 'V' 20 m/s without friction. The angle '$\alpha$' of the vane is
(*a*) zero (*b*) 30° (*c*) 45° (*d*) 60°




**Ans.** (*d*)

**Q. 88.** In a fluid coupling, the torque transmitted is 50 kNm, when the speed of the driving and driven shaft is 900 rpm and 720 rpm respectively. The efficiency of the fluid coupling will be
(*a*) 20% (*b*) 25% (*c*) 80% (*d*) 90%

**Ans.** (*c*)

**Q. 89.** Consider the following statements regarding the fluid coupling :
1. Efficiency increases with increase in speed ratio.
2. Neglecting friction the output torque is equal to input torque.
3. At the same input speed, higher slip requires higher input torque.
Which of these statements are correct ?
(*a*) 1, 2 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1 and 3

**Ans.** (*b*)

**Q. 90.** The level of runner exit is 5 m above the tail race, and atmospheric pressure is 10.3 m. The pressure at the exit of the runner for a divergent draft tube can be
(*a*) 5 m (*b*) 5.3 m (*c*) 10 m (*d*) 10.3 m

**Ans.** (*b*)

**Q. 91.** Consider the following statements :
A surge tank provided on the penstock connected to a water turbine
1. helps in reducing the water hammer 2. stores extra water when not needed
3. provides increased demand of water
Which of these statements are correct ?
(*a*) 1 and 3 (*b*) 2 and 3 (*c*) 1 and 2 (*d*) 1, 2 and 3

**Ans.** (*d*)

**Q. 92.** If a reciprocating pump having a mechanical efficiency of 80% delivers water at the rate of 80 kg/s with a head of 30 m, the brake power of the pump is
(*a*) 29.4 kW (*b*) 20.8 kW (*c*) 15.4 kW (*d*) 10.8 kW

**Ans.** (*a*)

**Q. 93.** The gross head on a turbine is 300 m. The length of penstock supplying water from reservoir to the turbine is 400 m. The diameter of the penstock is 1 m and velocity of water through penstock is 5 m/s. If coefficient of friction is 0.0098, the net head on the turbine would be, nearly

(*a*) 310 m (*b*) 295 m (*c*) 200 m (*d*) 150 m

**Ans.** (*b*)

**Q. 94.** Consider the following statements pertaining to a centrifugal pump :

1. The manometric head is the head developed by the pump.
2. The suction pipe has, generally, a larger diameter as compared to the discharge pipe.
3. The suction pipe is provided with a foot valve and a strainer.
4. The delivery pipe is provided with a foot valve and a strainer.

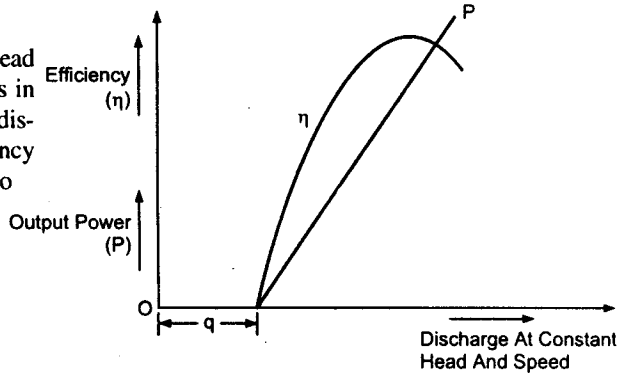
Of these statements

(*a*) 1, 2, 3 and 4 are correct (*b*) 1 and 2 are correct (*c*) 2 and 3 are correct (*d*) 1 and 3 are correct

**Ans.** (*c*)

**Q. 95.** For a water turbine, running at constant head and speed, the operating characteristic curves in the given figure show that upto a certain discharge '*q*' both output power and efficiency remain zero. The discharge '*q*' is required to

(*a*) overcome initial inertia
(*b*) overcome initial friction
(*c*) keep the hydraulic circuit full
(*d*) keep the turbine running at no load




**Ans.** (*b*)

**Q. 96.** In fluid machinery, the relationship between saturation temperature and pressure decides the process of

(*a*) flow separation (*b*) turbulent mixing (*c*) cavitation (*d*) water hammer

**Ans.** (*c*)

**Q. 97.** A centrifugal blower delivering $Q$ m$^3$/s against a heat of $H$ m is driven at half the original speed. The new head and discharge would be

(*a*) $H$ and $\frac{Q}{2}$ (*b*) $\frac{H}{4}$ and $\frac{Q}{2}$ (*c*) $\frac{H}{2}$ and $\frac{Q}{8}$ (*d*) $H$ and $\frac{Q}{4}$

**Ans.** (*b*)

**Q. 98.** The maximum number of jets generally employed in an impulse turbine without jet interference is

(*a*) 4 (*b*) 6 (*c*) 8 (*d*) 12

**Ans.** (*b*)

**Q. 99.** A hydraulic coupling transmits 1 kW of power at an input speed of 200 rpm, with a slip of 2%. If the input speed is changed to 400 rpm, the power transmitted with the same slip is

(*a*) 2 kW (*b*) 1/2 kW (*c*) 4 kW (*d*) 8 kW

**Ans.** (*a*)

**Q. 100.** A plane wall of thickness $2L$ has a uniform volumetric heat source $q^*$ (W/m$^3$). It is exposed to local ambient temperature $T_\infty$ at both the ends ($x = \pm L$). The surface temperature $T_s$ of the wall under steady-state condition (where $h$ and $k$ have their usual meanings) is given by

(*a*) $T_s = T_\infty + \frac{q^* L}{h}$ (*b*) $T_s = T_\infty + \frac{q^* L^2}{2k}$ (*c*) $T_s = T_\infty + \frac{q^* L^2}{h}$ (*d*) $T_s = T_\infty + \frac{q^* L^3}{2k}$

**Ans.** (*a*)

**Q. 101.** A flat plate has thickness 5 cm, thermal conductivity 1 W/(mK), convective heat transfer coefficients on its two flat faces of 10 W/(m$^2$K) and 20 W/(m$^2$K). The overall heat transfer co-efficient for such a flat plate is

(*a*) 5 W/(m$^2$K) (*b*) 6.33 W/(m$^2$K) (*c*) 20 W/(m$^2$K) (*d*) 30 W/(m$^2$K)

**Ans.** (*a*)

**Q. 102.** The efficiency of a pin fin with insulated tip is

(*a*) $\frac{\tanh mL}{(hA/kP)^{0.5}}$ (*b*) $\frac{\tanh mL}{mL}$ (*c*) $\frac{mL}{\tanh mL}$ (*d*) $\frac{(hA/kP)^{0.5}}{\tanh mL}$

**Ans.** (*b*)

**Q. 103.** A cylinder made of a metal of conductivity 40 W/(mK) is to be insulated with a material of conductivity 0.1 W/(mK). If the convective heat transfer coefficient with the ambient atmosphere is 5W/(m$^2$K), the critical radius of insulation is

(*a*) 2 cm (*b*) 4 cm (*c*) 8 cm (*d*) 50 cm

**Ans.** (*a*)

**Q. 104.** Nusselt number for fully developed turbulent flow in a pipe is given by $N_u = CR_e^a P_r^b$. The values of $a$ and $b$ are

(*a*) $a = 0.5$ and $b = 0.33$ for heating and cooling both

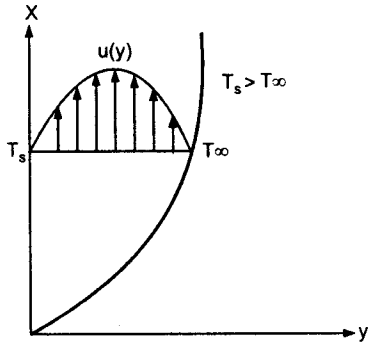
(*b*) $a = 0.5$ and $b = 0.4$ for heating and $b = 0.3$ for cooling

(*c*) $a = 0.8$ and $b = 0.4$ for heating and $b = 0.3$ for cooling

(*d*) $a = 0.8$ and $b = 0.3$ for heating and $b = 0.4$ for cooling

**Ans.** (*d*)

**Q. 105.** For natural convective flow over a vertical flat plate as shown in the given figure, the governing differential equation for momentum is




$$\left(u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) = g\beta(T - T_\infty) + \gamma\frac{\partial^2 u}{\partial y^2}$$

If equation is nondimentionalized by $U = \frac{u}{U_\infty}$,

$$V = \frac{u}{U_\infty},\quad X = \frac{x}{L},\quad y = \frac{y}{L} \text{ and } \theta = \frac{T - T_\infty}{T_s - T_\infty}$$

then the term $g\,\beta\,(T - T_\infty)$, is equal to

(*a*) Grashof number (*b*) Prandtl number (*c*) Rayleigh number (*d*) $\frac{\text{Grashof number}}{(\text{Reynolds number})^2}$

**Ans.** (*c*)

**Q. 106.** The shape factor of a hemispherical body placed on a flat surface with respect to itself is

(*a*) zero (*b*) 0.25 (*c*) 0.5 (*d*) 1.0

**Ans.** (*d*)

**Q. 107.** Which one of the following heat exchangers gives parallel straight line pattern of temperature distribution for both cold and hot fluid ?

(*a*) Parallel-flow with unequal heat capacities (*b*) Counter-flow with equal heat capacities

(*c*) Parallel-flow with equal heat capacities (*d*) Counter-flow with unequal heat capacities

**Ans.** (*b*)

**Q. 108.** In a counter-flow heat exchanger, the hot fluid is cooled from 110° C to 80° C by a cold fluid which gets heated from 30° C to 60° C. LMTD for the heat exchanger is

(*a*) 20° C (*b*) 30° C (*c*) 50° C (*d*) 80° C

**Ans.** (*b*)

**Q. 109.** In a counterflow heat exchanger, the product of specific heat and mass flow rate is same for the hot and cold fluids. If NTU is equal to 0.5, then the effectiveness of the heat exchanger is
(*a*) 1.0 (*b*) 0.5 (*c*) 0.33 (*d*) 0.2
**Ans.** (*d*)

**Q. 110.** For flow over a flat plate the hydrodynamic boundary layer thickness is 0.5 mm. The dynamic viscosity is $25 \times 10^{-6}$ Pa s, specific heat is 2.0 kJ/(kg K) and thermal conductivity is 0.05 W/(m-K). The thermal boundary layer thickness would be
(*a*) 0.1 mm (*b*) 0.5 mm (*c*) 1 mm (*d*) 2 mm
**Ans.** (*d*)

**Q. 111.** An enclosure consists of the four surfaces 1, 2, 3 and 4. The view factors for radiation heat transfer (where the subscripts 1, 2, 3, 4 refer to the respective surfaces) are $F_{11} = 0.1$, $F_{12} = 0.4$ and $F_{13} = 0.25$. The surface areas $A_1$ and $A_4$ are 4 $m^2$ and 2 $m^2$ respectively. The view factor $F_{41}$ is
(*a*) 0.75 (*b*) 0.50 (*c*) 0.25 (*d*) 0.10
**Ans.** (*c*)

**Q. 112.** The working temperatures in evaporator and condenser coils of a refrigerator are – 23° C and 27° C respectively. The COP of the refrigerator is 0.8 of the maximum COP. For a power input of 1 kW, the refrigeration effect produced will be
(*a*) 4 kW (*b*) 5 kW (*c*) 8 kW (*d*) 2.5 kW
**Ans.** (*a*)

**Q. 113.** For a heat pump working on vapour compression cycle, enthalpy values of the working fluid at the end of heat addition process, at the end of compression process, at the end of heat rejection process, and at the end of isenthalpic expansion process are 195 kJ/kg, 210 kJ/kg, and 90 kJ/kg respectively. The mass flow rate is 0.5 kg/s. Then the heating capacity of heat pump is, nearly
(*a*) 7.5 kW (*b*) 45 kW (*c*) 52.2 kW (*d*) 60 kW
**Ans.** (*d*)

**Q. 114.** A one ton capacity water cooler cools water steadily from 35° C to 20° C. The specific heat of water is 4.18 kJ/(kg K). The water flow rate will be, nearly,
(*a*) 13.33 l/hr (*b*) 3.33 l/hr (*c*) 200 l/hr (*d*) 250 l/hr
**Ans.** (*c*)

**Q. 115.** Match List-I (Refrigerant) with List-II (Chemical constituent) and select the correct answer using the codes given below the lists :

| *List-I (Refrigerant)* | *List-II (Chemical constituent)* |
|---|---|
| A. R — 12 | 1. Trichlorotrifluorethane ($CCl_2FCClF_2$) |
| B. R — 22 | 2. Difluoro monochloro methane ($CHF_2Cl$) |
| C. R — 717 | 3. Ammonia ($NH_3$) |
| D. R — 113 | 4. Difluoro dichloro methane ($CCl_2F_2$) |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 3 | 2 | 4 | 1 | (*b*) | 4 | 2 | 3 | 1 |
| (*c*) | 3 | 1 | 4 | 2 | (*d*) | 4 | 1 | 3 | 2 |

**Ans.** (*b*)

**Q. 116.** In a cooling tower, the minimum temperature to which water can be cooled is equal to the
(*a*) dew point temperature of the air at the inlet
(*b*) dry bulb temperature of the air at the inlet
(*c*) thermodynamic wet bulb temperature of the air at the inlet
(*d*) mean of the dew point and dry bulb temperature of the air at the inlet
**Ans.** (*a*)

**Q. 117.** Match List-I (Expansion device) with List-II (Operation) and select the correct answer using the codes given below the lists :

| *List-I (Expansion device)* | | *List-II (Operation)* |
|---|---|---|
| A. | Float valve | 1. Constant degree of superheat at evaporator exit pressure |
| B. | Automatic expansion valve | 2. Constant degree of superheat at evaporator inlet pressure |
| C. | Internally equalized thermostatic expansion valve | 3. Constant level of refrigerant in the evaporator |
| D. | Externally equalized thermostatic expansion valve | 4. Constant pressure in the evaporator |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 2 | 4 | 3 | (*b*) | 3 | 2 | 4 | 1 |
| (*c*) | 3 | 4 | 2 | 1 | (*d*) | 1 | 4 | 2 | 3 |

**Ans.** (*c*)

**Q. 118.** A solar-absorption refrigeration system has generator temperature of 87° C, evaporator temperature of – 3° C, condenser and absorber temperatures of 27° C each, then its maximum possible COP is
(*a*) 10.0 (*b*) 9.0 (*c*) 1.80 (*d*) 1.50
**Ans.** (*d*)

**Q. 119.** Consider the following statements :
Subcooling in the condenser of a refrigeration system is advisable when
1. expansion valve is at a higher elevation than condenser
2. there is a large pressure drop in the line connecting condenser to the expansion valve
3. the refrigeration effect is to be increased
4. the compressor work is to be reduced
Which of these statements are correct ?
(*a*) 1 and 2 (*b*) 1, 3 and 4 (*c*) 2, 3 and 4 (*d*) 1, 2 and 3
**Ans.** (*c*)

**Q. 120.** Consider the following statements :
When dry bulb and thermodynamic wet bulb temperatures are same;
1. humidity ratio is 100%
2. partial pressure of water vapour equals total pressure
3. air is fully saturated
4. dew point temperature is reached
Select the correct statement(s) using the codes given below :
***Codes :***
(*a*) 3 alone (*b*) 1 and 2 (*c*) 3 and 4 (*d*) 1, 2, 3 and 4
**Ans.** (*d*)

## I.E.S. (Objective)

# MECHANICAL ENGINEERING–2001

# PAPER - II

**Q. 1.** When the intensity of pressure is uniform in a flat pivot bearing of radius $r$, the friction force is assumed to act at

(*a*) $r$ (*b*) $r/2$ (*c*) $2r/3$ (*d*) $r/3$

**Ans.** (*c*)

**Q. 2.** Consider a harmonic motion $x = 1.25 \sin (5t - \pi/6)$ cm. Match List-I with List-II and select the correct answer using the codes given below the lists :

| *List I* | | *List II* | |
|---|---|---|---|
| A. | Amplitude (cm) | 1. | $5/2\pi$ |
| B. | Frequency (cycle/s) | 2. | 1.25 |
| C. | Phase angle (rad) | 3. | 1/5 |
| D. | Time period (s) | 4. | $\pi/6$ |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 4 | 1 | 2 | 3 | (*b*) | 2 | 3 | 4 | 1 |
| (*c*) | 4 | 3 | 2 | 1 | (*d*) | 2 | 1 | 4 | 3 |

**Ans.** (*b*)

**Q. 3.** Which of the following pairs of devices and their functions are correctly matched ?

| | | |
|---|---|---|
| 1. Flywheel | .... | For storing kinetic energy |
| 2. Governors | .... | For controlling speeds |
| 3. Lead screw in lathe | .... | For providing feed to the slides |
| 4. Fixtures | .... | For locating workpiece and guiding tools |

Select the correct answer using the codes given below :

***Codes :***

(*a*) 1, 3 and 4 (*b*) 2 and 3 (*c*) 1 and 2 (*d*) 2 and 4

**Ans.** (*c*)

**Q. 4.** Match List-I with List-II and select the correct answer using the codes given below the Lists. (Notations have their usual meanings) :

| *List I* | | *List II* | |
|---|---|---|---|
| A. | Law of correct steering | 1. | $f = 3(n - 1) - 2j$ |
| B. | Displacement relation of Hook's joint | 2. | $x = R\left[(1 - \cos\theta) + \frac{\sin^2\theta}{2n}\right]$ |
| C. | Relation between kinematic pairs and links | 3. | $\cot\phi - \cot\theta = c/b$ |
| D. | Displacement equation of reciprocating engine piston | 4. | $\tan\theta = \tan\phi \cos\alpha$ |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 4 | 3 | 2 | (*b*) | 1 | 2 | 3 | 4 |
| (*c*) | 3 | 4 | 1 | 2 | (*d*) | 3 | 2 | 1 | 4 |

**Ans.** (*c*)

**Q. 5.** Force required to accelerate a cylindrical body which rolls without slipping on a horizontal plane (mass of cylindrical body is $m$, radius of the cylindrical surface in contact with plane is $r$, radius of gyration of body is $k$ and acceleration of the body is $a$) is

(*a*) $m\,(k^2/r^2 + 1)\,.\,a$ (*b*) $(mk^2/r^2)\,.\,a$ (*c*) $mk^2\,.\,a$ (*d*) $(mk^2/r + 1)\,.\,a$

**Ans.** (*a*)

**Q. 6.** Consider the following statements regarding motions in machines :

1. Tangential acceleration is a function of angular velocity and the radial acceleration is a function of angular acceleration.
2. The resultant acceleration of a point $A$ with respect to a point $B$ on a rotating link is perpendicular to $AB$.
3. The direction of the relative velocity of a point $A$ with respect to a point $B$ on a rotating link is perpendicular to $AB$.

Which of these statements is/are correct ?

(*a*) 1 alone (*b*) 2 and 3 (*c*) 1 and 2 (*d*) 3 alone

**Ans.** (*d*)

**Q. 7.** Consider the following statements :

In petrol engine mechanism, the piston is at its dead centre position when piston

1. acceleration is zero
2. acceleration is maximum
3. velocity is zero
4. velocity is infinity

Which of these statements are correct ?

(*a*) 1 and 4 (*b*) 1 and 3 (*c*) 2 and 3 (*d*) 2 and 4

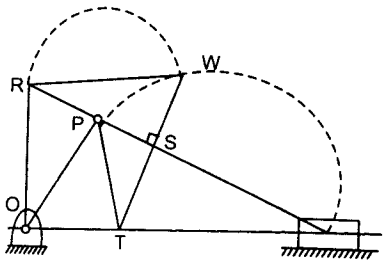
**Ans.** (*c*)

**Q. 8.** The speed of driving shaft of a Hooke's joint of angle 19.5° (given sin 19.5° = .33, cos 19.5° = .94) is 500 r.p.m. The maximum speed of the driven shaft is nearly

(*a*) 168 r.p.m. (*b*) 444 r.p.m. (*c*) 471 r.p.m. (*d*) 531 r.p.m.

**Ans.** (*d*)

**Q. 9.** The given figure shows the Klein's construction for acceleration of the slider-crank mechanism




Which one of the following quadrilaterals represents the required acceleration diagram ?

(*a*) *ORST* (*b*) *OPST*

(*c*) *ORWT* (*d*) *ORPT*

**Ans.** (*b*)

**Q. 10.** The spigot of a cotter joint has a diameter of $D$ and carries a slot for cotter. The permissible crushing stress is $x$ times the permissible tensile stress for the material of spigot where $x > 1$. The joint carries an axial load $P$. Which one of the following equations will give the diameter of the spigot ?

(*a*) $D = 2\sqrt{\dfrac{P}{\pi\sigma_t}\,\dfrac{x-1}{x}}$ (*b*) $D = 2\sqrt{\dfrac{P}{\pi\sigma_t}\,\dfrac{x+1}{x}}$

(*c*) $D = \dfrac{2}{\pi}\sqrt{\dfrac{P}{\sigma_t}\,\dfrac{x+1}{x}}$ (*d*) $D = \dfrac{2P}{\pi\sigma_t}\sqrt{x+1}$

**Ans.** (*b*)

**Q. 11.** The screw and nut in a broaching machine are changed from square thread to Acme thread. The power requirement of the machine at the same r.p.m. will

(*a*) remain same (*b*) decrease (*c*) increase (*d*) depend on the operator

**Ans.** (*c*)

**Q. 12.** The creep in a belt drive is due to the

(*a*) material of the pulleys (*b*) material of the belt

(*c*) unequal size of the pulleys (*d*) unequal tension on tight and slack sides of the belt

**Ans.** (*d*)

**Q. 13.** The designation $6 \times 7$ of a wire rope means

(*a*) 6 wires (*b*) 7 wires (*c*) 13 wires (*d*) 42 wires

**Ans.** (*b*)

**Q. 14.** A servomotor is connected through a gear ratio of 10 (*i.e.*, motor speed : load side speed = 10 : 1) to a load having moment of inertia $J$. The equivalent parameter referred to motor shaft side is

(*a*) $J_{eq} = 0.01\ J$ (*b*) $J_{eq} = 10\ J$ (*c*) $J_{eq} = 0.1\ J$ (*d*) $J_{eq} = 100\ J$

**Ans.** (*a*)

**Q. 15.** Match List-I with List-II and select the correct answer using the codes given below the lists :

| *List-I* | *List-II* |
|---|---|
| A. Cam and follower | 1. Grubler's rule |
| B. Screw pair | 2. Grashof's linkage |
| C. 4-bar mechanism | 3. Pressure angle |
| D. Degree of freedom of planar mechanism | 4. Single degree of freedom |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 3 | 4 | 2 | 1 |
| (*c*) | 1 | 4 | 2 | 3 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 1 | 2 | 4 | 3 |
| (*d*) | 3 | 2 | 4 | 1 |

**Ans.** (*a*)

**Q. 16.** Consider the following statements :

When two gears are meshing, the clearance is given by the

1. difference between dedendum of one gear and addendum of the mating gear.
2. difference between total and the working depth of a gear tooth.
3. distance between the bottom land of one gear and the top land of the mating gear.
4. difference between the radii of the base circle and the dedendum circle.

Which of these statements are correct ?

(*a*) 1, 2 and 3 (*b*) 2, 3 and 4 (*c*) 1, 3 and 4 (*d*) 1, 2 and 4

**Ans.** (*d*)

**Q. 17.** A body of mass $m$ and radius of gyration $k$ is to be replaced by two masses $m_1$ and $m_2$ located at distances $h_1$ and $h_2$ from the CG of the original body. An equivalent dynamic system will result, if

(*a*) $h_1 + h_2 = k$ (*b*) $h_1^2 + h_2^2 = k^2$ (*c*) $h_1 h_2 = k^2$ (*d*) $\sqrt{h_1 h_2} = k^2$

**Ans.** (*c*)

**Q. 18.** Match List-I with List-II and select the correct answer using the codes given below the lists :

| *List-I* | *List-II* |
|---|---|
| A. Undercutting | 1. Beam strength |
| B. Addendum | 2. Interference |
| C. Lewis equation | 3. Large speed reduction |
| D. Worm and wheel | 4. Intersecting axes |
| | 5. Module |

*Codes :*

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 2 | 5 | 1 | 3 |
| (*c*) | 1 | 3 | 4 | 5 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 1 | 5 | 4 | 3 |
| (*d*) | 2 | 3 | 1 | 5 |

**Ans.** (*a*)

**Q. 19.** The natural frequency of transverse vibration of a massless beam of length $L$ having a mass $m$ attached at its midspan is given by ($EI$ is the flexural rigidity of the beam)

(*a*) $\left(\frac{mL^3}{48EI}\right)^{\frac{1}{2}}$ rad/s (*b*) $\left(\frac{48mL^3}{EI}\right)^{\frac{1}{2}}$ rad/s (*c*) $\left(\frac{48EI}{mL^3}\right)^{\frac{1}{2}}$ rad/s (*d*) $\left(\frac{3EI}{mL^3}\right)^{\frac{1}{2}}$ rad/s

**Ans.** (*c*)

**Q. 20.** A ball-bearing is characterized by basic static capacity = 11000 N and dynamic capacity = 18000 N. This bearing is subjected to equivalent static load = 5500 N. The bearing loading ratio and life in million revolutions respectively are

(*a*) 3.27 and 52.0 (*b*) 3.27 and 35.0 (*c*) 2.00 and 10.1 (*d*) 1.60 and 4.1

**Ans.** (*c*)

**Q. 21.** Match List-I with List-II and select the correct answer using the codes given below the lists :

*List-I*

A. 6 d.o.f. system
B. 1 d.o.f. system
C. 2 d.o.f. system
D. Multi d.o.f. system

*List-II*

1. Vibrating beam
2. Vibration absorber
3. A rigid body in space
4. Pure rolling of a cylinder

*Codes :*

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 1 | 2 | 4 | 3 |
| (*c*) | 3 | 2 | 4 | 1 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 1 | 4 | 2 | 3 |
| (*d*) | 3 | 4 | 2 | 1 |

**Ans.** (*a*)

**Q. 22.** A shaft carries a weight $W$ at the centre. The CG of the weight is displaced by an amount $e$ from the axis of the rotation. If $y$ is the additional displacement of the CG from the axis of rotation due to the centrifugal force, then the ratio of $y$ to $e$ (where $\omega_c$ is the critical speed of shaft and $\omega$ is the angular speed of shaft) is given by

(*a*) $\frac{1}{\left[\frac{\omega_c}{\omega}\right]^2 + 1}$ (*b*) $\frac{1}{\left[\frac{\omega_c}{\omega}\right]^2 - 1}$ (*c*) $\left[\frac{\omega_c}{\omega}\right]^2 + 1$ (*d*) $\frac{\omega}{\left[\frac{\omega_c}{\omega}\right]^2 - 1}$

**Ans.** (*b*)

**Q. 23.** In a simple gear train, if the number of idler gears is odd, then the direction of motion of driven gear will

(*a*) be same as that of the driving gear
(*b*) be opposite to that of the driving gear
(*c*) depend upon the number of teeth on the driving gear
(*d*) depend upon the total number of teeth on all gears of the train

**Ans.** (*a*)

**Q. 24.** When a vehicle travels on a rough road whose undulations can be assumed to be sinusoidal, the resonant conditions of the base excited vibrations, are determined by the
(*a*) mass of the vehicle, stiffness of the suspension spring, speed of the vehicle, wavelength of the roughness curve
(*b*) speed of the vehicle only
(*c*) speed of the vehicle and the stiffness of the suspension spring
(*d*) amplitude of the undulations

**Ans.** (*a*)

**Q. 25.** During torsinal vibration of a shaft, the node is characterized by the
(*a*) maximum angular velocity (*b*) maximum angular displacement
(*c*) maximum angular acceleration (*d*) zero angular displacement

**Ans.** (*d*)

**Q. 26.** Match List-I (Bearings) with List-II (Applications) and select the correct answer using the codes given below the lists :

| *List I* | | *List II* | |
|---|---|---|---|
| A. | Cylindrical roller | 1. | Radial loads |
| B. | Ball-bearing | 2. | Machine needs frequent dismantling and assembling |
| C. | Taper rolling bearing | 3. | Radial loads with lesser thrust |
| D. | Angular contact ball-bearing | 4. | Shock loads |
| | | 5. | Axial expansion of shaft due to rise in temperature |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 4 | 3 | 1 | 5 | (*b*) | 1 | 3 | 2 | 5 |
| (*c*) | 4 | 1 | 2 | 3 | (*d*) | 5 | 4 | 1 | 3 |

**Ans.** (*c*)

**Q. 27.** A system has viscous damped output. There is no steady-state lag if input is
(*a*) unit step displacement (*b*) step velocity
(*c*) harmonic (*d*) step velocity with error-rate damping

**Ans.** (*c*)

**Q. 28.** A motor car has wheel base of 280 cm and the pivot distance of front stub axles is 140 cm. When the outer wheel has turned through 30°, the angle of turn of the inner front wheel for correct steering will be
(*a*) 60° (*b*) $\cot^{-1} 2.23$ (*c*) $\cot^{-1} 1.23$ (*a*) 30°

**Ans.** (*c*)

**Q. 29.** Match List-I (Properties) with List-II (Units) and select the correct answer using the codes given below the lists :

| *List I* | | *List II* | |
|---|---|---|---|
| A. | Dynamic viscosity | 1. | Pa |
| B. | Kinematic viscosity | 2. | $m^2/s$ |
| C. | Torsional stiffness | 3. | $Ns/m^2$ |
| D. | Modulus of rigidity | 4. | Nm |
| | | 5. | N/m |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 3 | 2 | 4 | 1 |
| (*c*) | 3 | 4 | 2 | 3 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 5 | 2 | 4 | 3 |
| (*d*) | 5 | 4 | 2 | 1 |

**Ans.** (*a*)

**Q. 30.** In a multi-plate clutch with $n_o$ number of outer discs and $n_i$ number of inner discs, the number of pairs of active surfaces is

(*a*) $n_i + n_o$ (*b*) $n_i + n_o + 1$ (*c*) $n_i + n_o - 1$ (*d*) $n_i + n_o - 2$

**Ans.** (*c*)

**Q. 31.** A full journal bearing having clearance to radius ratio of 1/100, using a lubricant with $\mu = 28 \times 10^{-3}$ Pa s supports the shaft journal running at $N$ = 2400 r.p.m. If bearing pressure is 1.4 MPa, the Sommerfeld number is

(*a*) $8 \times 10^{-3}$ (*b*) $8 \times 10^{-5}$ (*c*) 0.48 (*d*) $0.48 \times 10$

**Ans.** (*a*)

**Q. 32.** A sliding contact bearing is operating under stable condition. The pressure developed in oil film is $p$ when the journal rotates at $N$ r.p.m. The dynamic viscosity of lubricant is $\mu$ and effective coefficient of friction between bearing and journal of diameter D is $f$. Which one of the following statements is correct for the bearing ?

(*a*) $f$ is directly proportional to $\mu$ and $p$

(*b*) $f$ is directly proportional to $\mu$ and $N$

(*c*) $f$ is inversely proportional to $p$ and $D$

(*d*) $f$ is directly proportional to $\mu$ and inversely proportional to $N$

**Ans.** (*b*)

**Q. 33.** In a slider-crank mechanism, the maximum acceleration of slider is obtained when the crank is

(*a*) at the inner dead centre position

(*b*) at the outer dead centre position

(*c*) exactly midway position between the two dead centres

(*d*) slightly in advance of the midway position between the two dead centres

**Ans.** (*b*)

***Direction :*** *The following thirteen (13) items consist of two statements, one labelled the 'Assertion (A)' and the other labelled the 'Reason (R)'. You are to examine these two statements carefully and decide if the Assertion (A) and the Reason (R) are individually true and if so, whether the Reason is a correct explanation of the Assertion. Select your answers to these items using the codes given below and mark your Answer Sheet accordingly.*

***Codes :***

(*a*) Both A and R are true and R is the correct explanation of A

(*b*) Both A and R are true but R is NOT the correct explanation of A

(*c*) A is true but R is false

(*d*) A is false but R is true

**Q. 34.** *Assertion (A) :* There is a danger of locomotive wheels being lifted above rails at certain speeds.

*Reason (R) :* Lifting of the locomotive wheel above rails at certain speed is due to gyroscopic action.

**Ans.** (*c*)

**Q. 35.** *Assertion (A) :* A statically and dynamically balanced system of multiple rotors on a shaft can rotate smoothly even at the 'critical speeds' of the system.
*Reason (R) :* Total balancing eliminates all the 'in plane' and 'out of plane' unbalanced forces of the system.
**Ans.** (*d*)

**Q. 36.** *Assertion (A) :* Inertia force always acts through the centroid of the body and is directed opposite to the acceleration of the centroid.
*Reason (R) :* It has always a tendency to retard the motion.
**Ans.** (*a*)

**Q. 37.** *Assertion (A) :* The supply of fuel is automatically regulated by governor according to the engine speed.
*Reason (R) :* The automatic function is the application of d' Alembert's principle.
**Ans.** (*c*)

**Q. 38.** *Assertion (A) :* For similar materials having the same maximum permissible tension V-belt transmits more power than flat belt with same velocity ratio and centre distance.
*Reason (R) :* As two sides of V-belt are in contact with side faces of pulley groove, larger contact area gives greater effective frictional force.
**Ans.** (*a*)

**Q. 39.** *Assertion (A) :* In design of arms of a pulley, in belt drive, the cross-section of the arm is elliptical with minor axis placed along the plane of rotation.
*Reason (R) :* Arms of a pulley in belt drive are subjected to complete reversal of stresses and is designed for bending in the plane of rotation.
**Ans.** (*d*)

**Q. 40.** *Assertion (A) :* In a boiler shell with riveted construction, the longitudinal seam is jointed by butt joint.
*Reason (R) :* A butt joint is stronger than a lap joint in a riveted construction.
**Ans.** (*c*)

**Q. 41.** *Assertion (A) :* Diamond tools can be used at high speeds.
*Reason (R) :* Diamond tools have very low coefficient of friction.
**Ans.** (*c*)

**Q. 42.** *Assertion (A) :* Hard wheels are chosen for grinding hard metals.
*Reason (R) :* In hard wheels only the abrasive grains are retained for long time.
**Ans.** (*d*)

**Q. 43.** *Assertion (A) :* Buttress thread is a modified square thread profile which is employed on the lead screw of machine tools.
*Reason (R) :* Frequent engagement and disengagement of lead screw for automatic feed is not possible with perfect square threads, therefore, the square profile has to be modified.
**Ans.** (*a*)

**Q. 44.** *Assertion (A) :* No separate feed motion is required during broaching.
*Reason (R) :* The broaching machines are generally hydraulically operated.
**Ans.** (*b*)

**Q. 45.** *Assertion (A) :* In Dodge Romig sampling tables, the screening inspection of rejected lots is also included.
*Reason (R) :* Dodge Romig plans are indexed at an LTPD of 10 per cent.
**Ans.** (*c*)

**Q. 46.** *Assertion (A) :* Time series analysis technique of sales-forecasting can be applied to only medium and short-range forecasting.

*Reason (R) :* Qualitative information about the market is necessary for long-range forecasting.

**Ans.** (*a*)

**Q. 47.** In production, planning and control, the document which authorizes the start of an operation on the shop floor is the

(*a*) Dispatch order (*b*) Route plan (*c*) Loading chart (*d*) Schedule

**Ans.** (*a*)

**Q. 48.** In a study to estimate the idle time of a machine, out of 100 random observations the machine was found idle on 40 observations. The total random observations required for 95% confidence level and ± 5% accuracy are

(*a*) 384 (*b*) 600 (*c*) 2400 (*d*) 9600

**Ans.** (*a*)

**Q. 49.** Flow process chart contains

(*a*) inspection and operation

(*b*) inspection, operation and transportation

(*c*) inspection, operation, transportation and dealy

(*d*) inspection, operation, transportation, delay and storage

**Ans.** (*d*)

**Q. 50.** A new facility has to be designed to do all the welding for 3 products : *A*, *B* and *C*. Per unit welding time for each product is 20 s, 40 s and 50 s respectively. Daily demand forecast for product *A* is 450, for *B* is 360 and for *C* is 240. *A* welding line can operate efficiently for 220 minutes a day. Number of welding lines required is

(*a*) 5 (*b*) 4 (*c*) 3 (*d*) 2

**Ans.** (*c*)

**Q. 51.** Consider the following statements :

Control chart of variables provides the

1. basic variability of the quality characteristic.
2. consistency of performance.
3. number of products falling outside the tolerance limits.

Which of these statements are correct ?

(*a*) 1, 2 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1 and 3

**Ans.** (*b*)

**Q. 52.** Match List-I (OR-technique) with List-II (Model) and select the correct answer using the codes given below the Lists :

| *List I* | | *List II* | |
|---|---|---|---|
| A. | Branch and Bound technique | 1. | PERT and CPM |
| B. | Expected value approach | 2. | Integer programming |
| C. | Smoothing and Levelling | 3. | Queuing theory |
| D. | Exponential distribution | 4. | Decision theory |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 2 | 1 | 4 | 3 | (*b*) | 2 | 4 | 1 | 3 |
| (*c*) | 3 | 4 | 1 | 2 | (*d*) | 3 | 1 | 4 | 2 |

**Ans.** (*a*)

**Q. 53.** Match List-I with List-II and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Decision making under complete certainty | 1. Delphi approach |
| B. Decision making under risk | 2. Maximax criterion |
| C. Decision making under complete uncertainty | 3. Transportation model |
| D. Decision making based on expert opinion | 4. Decision tree |

***Codes :***

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 3 | 4 | 1 | 2 | (*b*) | 4 | 3 | 2 | 1 |
| (*c*) | 3 | 4 | 2 | 1 | (*d*) | 4 | 3 | 1 | 2 |

**Ans.** (*c*)

**Q. 54.** During manufacture of cement, the handling of limestone is done by
(*a*) belt conveyor (*b*) bucket conveyor (*c*) overhead crane (*d*) fork-lift crane

**Ans.** (*b*)

**Q. 55.** Consider the following statements regarding linear programming :
1. Dual of a dual is the primal.
2. When two minimum ratios of the right-hand side to the coefficient in the key column are equal, degeneracy may take place.
3. When an artificial variable leaves the basis, its column can be deleted from the subsequent Simplex tables.

Select the correct answer from the codes given below :

***Codes :***

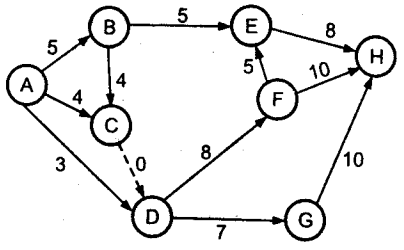
(*a*) 1, 2 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1 and 3

**Ans.** (*c*)

**Q. 56.** Latest start time of an activity in CPM is the
(*a*) latest occurrence time of the successor event minus the duration of the activity
(*b*) earliest occurrence time for the predecessor event plus the duration of the activity
(*c*) latest occurrence time of the successor event
(*d*) earliest occurrence time for the predecessor event

**Ans.** (*a*)

**Q. 57.** For the network shown in the given figure, the earliest expected completion time of the project is
(*a*) 26 days (*b*) 27 days
(*c*) 30 days (*d*) indeterminable




**Ans.** (*c*)

**Q. 58.** Arrivals at a telephone booth are considered to be according to Poisson distribution, with an average time of 10 minutes between one arrival and the next. The length of a phone call is assumed to be distributed exponentially with mean of 3 minutes. The probability that a person arriving at the booth will have to wait, is

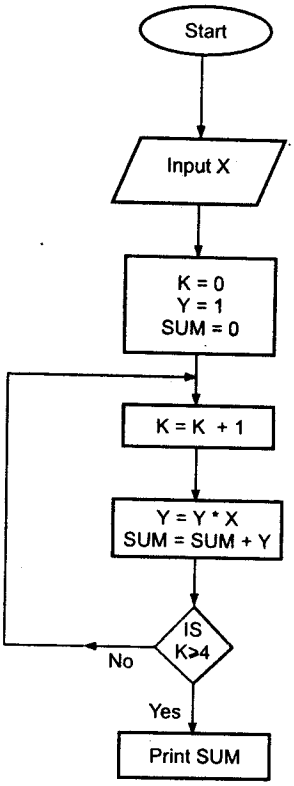
(*a*) $\frac{3}{10}$ (*b*) $\frac{7}{10}$ (*c*) $\frac{7}{30}$ (*d*) $\frac{13}{30}$

**Ans.** (*a*)

**Q. 59.** For the given flowchart, if input X = 3, then the printed value of SUM is

(*a*) 12 (*b*) 39 (*c*) 120 (*d*) 363

**Ans.** (*a*)




**Q. 60.** Which of the following hand-motion belongs to 'Therbligs' in motion study ?

1. Unavoidable delay 2. Pre-position 3. Select 4. Reach

Select the correct answer from the codes given below :

***Codes :***

(*a*) 1 and 4 (*b*) 1 and 2 (*c*) 1, 2 and 3 (*d*) 2, 3 and 4

**Ans.** (*c*)

**Q. 61.** Which one of the following combinations is valid for product layout ?

(*a*) General purpose machine and skilled labour
(*b*) General purpose machine and unskilled labour
(*c*) Special purpose machine and semi-skilled labour
(*d*) Special purpose machine and skilled labour

**Ans.** (*c*)

**Q. 62.** Match List-I with List-II and select the correct answer using the codes given below the lists :

| *List I* | | *List II* | |
|---|---|---|---|
| A. | OC curve | 1. | Acceptance sampling |
| B. | AOQL | 2. | Dodge Roming table |
| C. | Binomial distribution | 3. | *p*-charts |
| D. | Normal curve | 4. | Control charts for variables |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 1 | 2 | 3 | 4 |
| (*c*) | 4 | 2 | 3 | 1 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 1 | 3 | 2 | 4 |
| (*d*) | 4 | 3 | 2 | 1 |

**Ans.** (*a*)

**Q. 63.** Dispatching function of production, planning and control is

(*a*) the dispatch of finished goods on order
(*b*) the movement of in-process material from shop to shop
(*c*) authorising a production work order to be launched
(*d*) the dispatch of bills and invoice to the customers

**Ans.** (*c*)

**Q. 64.** Match List-I (Charts) with List-II (Operations/Informations) and select the correct answer using the codes given below the Lists :

| *List I* | *List II* |
|---|---|
| A. Standard process sheet | 1. Operations involving assembly and inspection without machine |
| B. Multiple activity chart | 2. Operations involving the combination of men and machines |
| C. Right and left hand operation chart | 3. Work measurement |
| D. SIMO chart | 4. Basic information for routing |
| | 5. Therbligs |

*Codes :*

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 4 | 3 | 1 | 2 | (*b*) | 1 | 2 | 4 | 5 |
| (*c*) | 1 | 3 | 4 | 2 | (*d*) | 4 | 2 | 1 | 5 |

**Ans.** (*b*)

**Q. 65.** If $\alpha$ is the rake angle of the cutting tool, $\phi$ is the shear angle and $V$ is the cutting velocity, then the velocity of chip sliding along the shear plane is given by

(*a*) $\frac{V\cos\alpha}{\cos(\phi-\alpha)}$ (*b*) $\frac{V\sin\alpha}{\cos(\phi-\alpha)}$ (*c*) $\frac{V\cos\alpha}{\sin(\phi-\alpha)}$ (*d*) $\frac{V\sin\alpha}{\sin(\phi-\alpha)}$

**Ans.** (*a*)

**Q. 66.** Match List-I (Cutting Tools) with List-II (Applications) and select the correct answer using the codes given below the lists :

| *List I* | *List II* |
|---|---|
| A. Trepanning tool | 1. For surface finishing by honing |
| B. Side milling cutter | 2. For machining gears |
| C. Hob cutter | 3. For cutting keyways in shafts |
| D. Abrasive sticks | 4. For drilling large diameter holes |

*Codes :*

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 3 | 2 | 4 | (*b*) | 4 | 3 | 2 | 1 |
| (*c*) | 1 | 2 | 3 | 4 | (*d*) | 4 | 2 | 3 | 1 |

**Ans.** (*b*)

**Q. 67.** Dry and compressed air is used as cutting fluid for machining

(*a*) steel (*b*) aluminium (*c*) cast iron (*d*) brass

**Ans.** (*c*)

**Q. 68.** For cutting of brass with single-point cutting tool on a lathe, tool should have

(*a*) negative rake angle (*b*) positive rake angle
(*c*) zero rake anlge (*d*) zero side relief angle

**Ans.** (*c*)

**Q. 69.** Power consumption in metal cutting is mainly due to

(*a*) tangential component of the force (*b*) longitudinal component of the force
(*c*) normal component of the force (*d*) friction at the metal-tool interface

**Ans.** (*a*)

**Q. 70.** In a shaper machine, the mechanism for tool feed is

(*a*) Geneva mechanism (*b*) Whitworth mechanism
(*c*) Ratchet and Pawl mechanism (*d*) Ward- Leonard system

**Ans.** (*c*)

**Q. 71.** Match List-I (Components) with List-II (Manufacturing Processes) and select the correct answer using the codes given below the lists :

| *List I* | *List II* |
|---|---|
| A. Car body (metal) | 1. Machining |
| B. Clutch lining | 2. Casting |
| C. Gears | 3. Sheetmetal pressing |
| D. Engine block | 4. Powder metallurgy |

*Codes :*

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 3 | 4 | 2 | 1 |
| (*c*) | 4 | 3 | 2 | 1 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 4 | 3 | 1 | 2 |
| (*d*) | 3 | 4 | 1 | 2 |

**Ans.** (*d*)

**Q. 72.** The marking on a grinding wheel is '51 A 36 L 5 V 93'. The code '36' represents the
(*a*) structure (*b*) grade (*c*) grain- size (*d*) manufacturer's number
**Ans.** (*c*)

**Q. 73.** In the forging operation, fullering is done to
(*a*) draw out the material (*b*) bend the material (*c*) upset the material (*d*) extrude the material
**Ans.** (*a*)

**Q. 74.** The main purpose of chaplets is
(*a*) to ensure directional solidification (*b*) to provide efficient venting
(*c*) for aligning the mold boxes (*d*) to support the cores
**Ans.** (*d*)

**Q. 75.** Scab is a
(*a*) sand casting defect (*b*) machining defect (*c*) welding defect (*d*) forging defec
**Ans.** (*a*)

**Q. 76.** Specific cutting energy is more in grinding process compared to turning because
(*a*) grinding (cutting) speed is higher
(*b*) the wheel has multiple cutting edges (grains)
(*c*) ploughing force is significant due to small chip size
(*d*) grinding wheel undergoes continuous wear
**Ans.** (*b*)

**Q. 77.** The maximum heat in resistance welding is at the
(*a*) tip of the positive electrode (*b*) tip of the negative electrode
(*c*) top surface of the plate at the time of electric contact with the electrode
(*d*) interface between the two plates being joined
**Ans.** (*d*)

**Q. 78.** Arc blow is more common in
(*a*) a.c. welding (*b*) d.c. welding with straight polarity
(*c*) d.c. welding with bare electrodes (*d*) a.c. welding with bare electrodes
**Ans.** (*c*)

**Q. 79.** Pinch effect in welding is the result of
(*a*) expansion of gases in the arc (*b*) electromagnetic forces
(*c*) electric force (*d*) surface tension of the molten metal
**Ans.** (*a*)

**Q. 80.** In manual arc welding, the equipment should have drooping characteristics in order to maintain
(*a*) voltage constant when arc length changes (*b*) current constant when arc length changes
(*c*) temperature in the arc constant (*d*) weld pool red-hot
**Ans.** (*a*)

**Q. 81.** In arc welding, d.c. reverse polarity is used to bear greater advantage in
(*a*) overhead welding (*b*) flat welding of lap joints
(*c*) edge welding (*d*) flat welding of butt joints
**Ans.** (*b*)

**Q. 82.** Which of the following assumptions are correct for cold rolling ?
1. The material is plastic.
2. The arc of contact is circular with a radius greater than the radius of the roll.
3. Coefficient of friction is constant over the arc of contact and acts in one direction throughout the arc of contact.

Select the correct answer using the codes given below :
***Codes :***
(*a*) 1 and 2 (*b*) 1 and 3 (*c*) 2 and 3 (*d*) 1, 2 and 3
**Ans.** (*c*)

**Q. 83.** A strip is to be rolled from a thickness of 30 mm to 15 mm using a two-high mill having rolls of diameter 300 mm. The coefficient of friction for unaided bite should nearly be
(*a*) 0.35 (*b*) 0.5 (*c*) 0.25 (*d*) 0.07
**Ans.** (*c*)

**Q. 84.** Which of the following statements are the salient features of hydrostatic extrusion ?
1. It is suitable for soft and ductile material.
2. It is suitable for high-strength super-alloys.
3. The billet is inserted into the extrusion chamber and pressure is applied by a ram to extrude the billet through the die.
4. The billet is inserted into the extrusion chamber where it is surrounded by a suitable liquid. The billet is extruded through the die by applying pressure to the liquid.

Select the correct answer using the codes given below :
***Codes :***
(*a*) 1 and 3 (*b*) 1 and 4 (*c*) 2 and 3 (*d*) 2 and 4
**Ans.** (*c*)

**Q. 85.** The spindle speed range in a general purpose lathe is divided into steps which approximately follow
(*a*) arithmetic progression (*b*) geometric progression
(*c*) harmonic progression (*d*) logarithmic progression
**Ans.** (*b*)

**Q. 86.** The indexing of the turret in a single-spindle automatic lathe is done using
(*a*) Geneva mechanism (*b*) Ratchet and Pawl mechanism
(*c*) Rack and pinion mechanism (*d*) Whitworth mechanism
**Ans.** (*a*)

**Q. 87.** Martensite is a super-saturated solution of carbon in
(*a*) alpha iron (*b*) beta iron (*c*) gamma iron (*d*) delta iron
**Ans.** (*a*)

**Q. 88.** Which one of the following sets of elements are quickacting clamping elements for fixtures ?
(*a*) Wedge and Cam (*b*) Cam and Toggle
(*c*) Toggle and Wedge (*d*) Wedge, Cam and Toggle
**Ans.** (*a*)

**Q. 89.** The correct sequence of creep deformation in a creep curve in order of their elongation is
(*a*) steady state, transient, accelerated (*b*) transient, steady state, accelerated
(*c*) transient, accelerated, steady state (*d*) accelerated, steady state, transient
**Ans.** (*a*)

**Q. 90.** Oxyacetylene reducing flame is used while carrying out the welding on
(*a*) mild steel (*b*) high carbon steel (*c*) grey cast iron (*d*) alloy steels
**Ans.** (*a*)

**Q. 91.** For the same internal diameter, wall thickness, material and internal pressure, the ratio of maximum stress, induced in a thin cylindrical and in a thin spherical pressure vessel will be
(*a*) 2 (*b*) 1/2 (*c*) 4 (*d*) 1/4
**Ans.** (*a*)

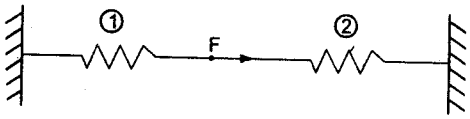
**Q. 92.** Nodular grey cast iron is obtained from the grey cast iron by adding a small amount of
(*a*) Manganese (*b*) Phosphorus (*c*) Magnesium (*d*) Chromium
**Ans.** (*c*)

**Q. 93.** Wire diameter, mean coil diameter and number of turns of a closely-coiled steel spring are $d$, $D$ and $N$ respectively and stiffness of the spring is $K$. A second spring is made of same steel but with wire diameter, mean coil diameter and number of turns $2d$, $2D$ and $2N$ respectively. The stiffness of the new spring is
(*a*) $K$ (*b*) $2K$ (*c*) $4K$ (*d*) $8K$
**Ans.** (*a*)

**Q. 94.** Which one of the following pairs of axis lengths ($a, b, c$) and interaxial angles ($\alpha, \beta, \gamma$) represents the tetragonal crystal system ?
(*a*) $a = b = c$ ; $\alpha = \beta = \gamma = 90°$ (*b*) $a = b \neq c$ ; $\alpha = \beta = \gamma = 90°$
(*c*) $a \neq b \neq c$ ; $\alpha = \beta = \gamma = 90°$ (*d*) $a = b = c$ ; $\alpha = \beta = \gamma \neq 90°$
**Ans.** (*b*)

**Q. 95.** Consider the following quenching media :
1. Oil 2. Water 3. Water + NaOH 4. Brine
The correct sequence of these media in order of increasing hardness of steel undergoing heat treatment is
(*a*) 1, 3, 2, 4 (*b*) 2, 1, 3, 4 (*c*) 1, 2, 3, 4 (*d*) 4, 3, 2, 1
**Ans.** (*a*)

**Q. 96.** Two identical springs labelled as 1 and 2 are arranged in series and subjected to force F as shown in the given figure




Assume that each spring constant is K. The strain energy stored in spring 1 is
(*a*) $\frac{F^2}{2K}$ (*b*) $\frac{F^2}{4K}$ (*c*) $\frac{F^2}{8K}$ (*d*) $\frac{F^2}{16K}$
**Ans.** (*b*)

**Q. 97.** A rod having cross-sectional area $100 \times 10^{-6}$ m$^2$ is subjected to a tensile load. Based on the Tresca failure criterion, if the uniaxial yield stress of the material is 200 MPa, the failure load is
(*a*) 10 kN (*b*) 20 kN (*c*) 100 kN (*d*) 200 kN
**Ans.** (*b*)

**Q. 98.** If diameter of a long column is reduced by 20%, the percentage of reduction in Euler buckling load is
(*a*) 4 (*b*) 36 (*c*) 49 (*d*) 59
**Ans.** (*d*)

**Q. 99.** With one fixed end and other free end, a column of length $L$ buckles at load $P_1$. Another column of same length and same cross-section fixed at both ends buckles at load $P_2$. The ratio of $P_2/P_1$ is
(*a*) 1 (*b*) 2 (*c*) 4 (*d*) 16
**Ans.** (*d*)

**Q. 100.** In a two-dimensional problem, the state of pure shear at a point is characterized by
(*a*) $\varepsilon_x = \varepsilon_y$ and $\gamma_{xy} = 0$ (*b*) $\varepsilon_x = -\varepsilon_y$ and $\gamma_{xy} \neq 0$ (*c*) $\varepsilon_x = 2\varepsilon_y$ and $\gamma_{xy} \neq 0$ (*d*) $\varepsilon_x = 0.5\varepsilon_y$ and $\gamma_{xy} = 0$

**Ans.** (*b*)

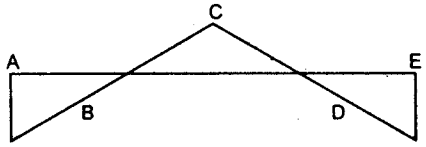
**Q. 101.** The principal stresses $\sigma_1$, $\sigma_2$ and $\sigma_3$ at a point respectively are 80 MPa, 30 MPa and – 40 MPa. The maximum shear stress is
(*a*) 25 MPa (*b*) 35 MPa (*c*) 55 MPa (*d*) 60 MPa

**Ans.** (*a*)

**Q. 102.** The Poisson's ratio of a material which has Young's modulus of 120 GPa and shear modulus of 50 GPa, is
(*a*) 0.1 (*b*) 0.2 (*c*) 0.3 (*d*) 0.4

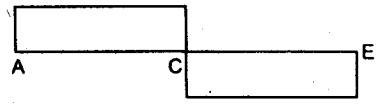
**Ans.** (*b*)

**Q. 103.** Bending moment distribution in a built beam is shown in the given figure

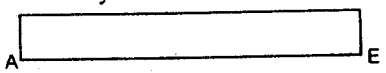



The shear force distribution in the beam is represented by

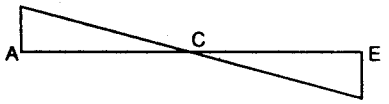
(*a*)



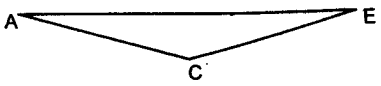

(*b*)




(*c*)




(*d*)




**Ans.** (*a*)

**Q. 104.** A thick cylinder is subjected to internal pressure of 100 N/mm$^2$. If hoop stress developed at the outer radius of the cylinder is 100 N/mm$^2$, the hoop stress developed at the inner radius is
(*a*) 100 N/mm$^2$ (*b*) 200 N/mm$^2$ (*c*) 300 N/mm$^2$ (*d*) 400 N/mm$^2$

**Ans.** (*b*)

**Q. 105.** The outside diameter of a hollow shaft is twice that of its inside diameter. The torque-carrying capacity of this shaft is $M_{t_1}$. A solid shaft of the same material has the diameter equal to the outside diameter of the hollow shaft. The solid shaft can carry a torque of $M_{t_2}$. The ratio $M_{t_1}/M_{t_2}$ is
(*a*) $\frac{15}{16}$ (*b*) $\frac{3}{4}$ (*c*) $\frac{1}{2}$ (*d*) $\frac{1}{16}$

**Ans.** (*a*)

**Q. 106.** Which one of the following pairs is correctly matched ?
(*a*) Solid solution strengthening .... Increasing density of dislocations
(*b*) Dispersion hardening .... Creating strained region in the crystal
(*c*) Strain-hardening .... Creating particles to resist the movement of dislocations
(*d*) Precipitation-hardening .... Creating particles by decreasing solubility of one phase in another

**Ans.** (*d*)

**Q. 107.** The alloy steel designated as 40 Cr 18 Ni 2 by Bureau of Indian Standards contains
(*a*) 0.4% C, 18% Cr and 2% Ni (*b*) 4.0% C, 1.8% Cr and 0.2% Ni
(*c*) 0.4% C, 1.8% Cr and 2% Ni (*d*) 0.4% C, 1.8% Cr and 0.2% Ni

**Ans.** (*a*)

**Q. 108.** 'Tempering' of quenched martensitic steel is necessary to improve the
(*a*) hardness of the metal (*b*) surface texture of the metal
(*c*) corrosion resistance of the metal (*d*) ductility of the metal
**Ans.** (*d*)

**Q. 109.** The molecular weight of vinyl chloride is 62.5. Thus the molecular weight of a polyvinyl chloride with a degree of polymerisation of 20000 is
(*a*) $\frac{20000}{62.5}$ (*b*) $\frac{62.5}{20000}$ (*c*) $62.5 \times 20000$ (*d*) 20000
**Ans.** (*c*)

**Q. 110.** Carbide-tipped cutting tools are manufactured by powder- metal technology process and have a composition of
(*a*) Zirconium-Tungsten (35%-65%) (*b*) Tungsten carbide-Cobalt (90%-10%)
(*c*) Aluminium oxide- Silica (70%-30%) (*d*) Nickel-Chromium-Tungsten (30%-15%-55%)
**Ans.** (*b*)

**Q. 111.** Match List-I (Name of the Element) with List-II (Crystal Structure) and select the correct answer using the codes given below the lists :

| *List I* | *List II* |
|---|---|
| A. Fluorspar | 1. Body-centered cubic |
| B. Alpha-Iron | 2. Hexagonal close packed |
| C. Silver | 3. Simple cubic |
| D. Zinc | 4. Face-centered cubic |

***Codes :***

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 3 | 2 | 4 | 1 |
| (*c*) | 4 | 2 | 3 | 1 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 4 | 1 | 3 | 2 |
| (*d*) | 3 | 1 | 4 | 2 |

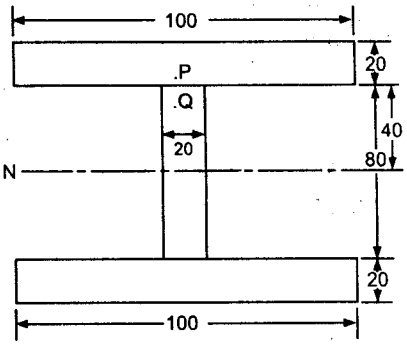
**Ans.** (*d*)

**Q. 112.** Which of the following factors govern solubility of two non-ferrous metals both in liquid state, as well as in solid state ?
1. Crystal structure 2. Relative size factor
3. Chemical-affinity factor 4. Relative valence factor
Select the correct answer using the codes given below :
***Codes :***
(*a*) 1, 2 and 3 (*b*) 2, 3 and 4 (*c*) 1 and 4 (*d*) 1, 2, 3 and 4
**Ans.** (*b*)

**Q. 113.** A body having weight of 1000 N is dropped from a height of 10 cm over a close-coiled helical spring of stiffness 200 N/cm. The resulting deflection of spring is nearly
(*a*) 5 cm (*b*) 16 cm (*c*) 35 cm (*d*) 100 cm
**Ans.** (*b*)

**Q. 114.** The diameter of shaft *A* is twice the diameter of shaft *B* and both are made of the same material. Assuming both the shafts to rotate at the same speed, the maximum power transmitted by *B* is
(*a*) the same as that of A (*b*) half of A
(*c*) 1/8th of A (*d*) 1/4th of A
**Ans.** (*c*)

**Q. 115.** The given figure (all dimensions are in mm) shows an I-section of the beam




The shear stress at point $P$ (very close to the bottom of the flange) is 12 MPa. The stress at point $Q$ in the web (very close to the flange) is

(*a*) indeterminable due to incomplete data (*b*) 60 MPa

(*c*) 18 MPa (*d*) 12 MPa

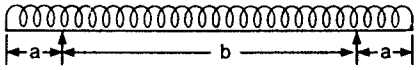
**Ans.** (*d*)

**Q. 116.** A close-coiled helical spring is made of 5 mm diameter wire coiled to 50 mm mean diameter. Maximum shear stress in the spring under the action of an axial force is 20 N/mm$^2$. The maximum shear stress in a spring made of 3 mm diameter wire coiled to 30 mm mean diameter, under the action of the same force will be nearly

(*a*) 20 N/mm$^2$ (*b*) 33.3 N/mm$^2$ (*c*) 55.6 N/mm$^2$ (*d*) 92.6 N/mm$^2$

**Ans.** (*c*)

**Q. 117.** A horizontal beam carrying uniformly distributed load is supported with equal overhangs as shown in the given figure

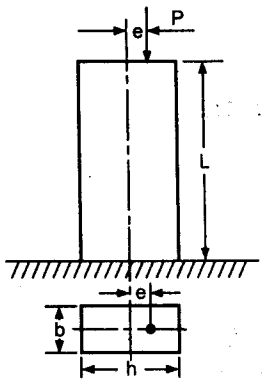



The resultant bending moment at the mid-span shell be zero if $a/b$ is

(*a*) 3/4 (*b*) 2/3 (*c*) 1/2 (*d*) 1/3

**Ans.** (*c*)

**Q. 118.** A short column of symmetric cross-section made of a brittle material is subjected to an eccentric vertical load $P$ at an eccentricity $e$. To avoid tensile stress in the short column, the eccentricity $e$ should be less than or equal to




(*a*) $h/12$ (*b*) $h/6$ (*c*) $h/3$ (*d*) $h/2$

**Ans.** (*b*)

**Q. 119.** A thin cylindrical shell is subjected to internal pressure $p$. The Poisson's ratio of the material of the shell is 0.3. Due to internal pressure, the shell is subjected to circumferential strain and axial strain. The ratio of circumferential strain to axial strain is

(*a*) 0.425 (*b*) 2.25 (*c*) 0.225 (*d*) 4.25

**Ans.** (*d*)

**Q. 120.** A cantilever of length $L$, moment of inertia $I$, Young's modulus $E$ carries a concentrated load $W$ at the middle of its length. The slope of cantilever at the free end is

(*a*) $\frac{WL^2}{2EI}$ (*b*) $\frac{WL^2}{4EI}$ (*c*) $\frac{WL^2}{8EI}$ (*d*) $\frac{WL^2}{16EI}$

**Ans.** (*a*)

# I.E.S. (Objective)

# MECHANICAL ENGINEERING–2002

## PAPER - I

**Q. 1.** Which of the following is/are related to measure the discharge by a rectangular notch ?

1. $\frac{2}{3} Cd \cdot b\sqrt{2g} \cdot H^2$
2. $\frac{2}{3} Cd \cdot b\sqrt{2g} \cdot H^{3/2}$
3. $\frac{2}{3} Cd \cdot b\sqrt{2g} \cdot H^{5/2}$
4. $\frac{2}{3} Cd \cdot b\sqrt{2g} \cdot H^{1/2}$

Select the correct answer from the codes given below :

**Codes :**

(*a*) 1 and 3 (*b*) 2 and 3 (*c*) 2 alone (*d*) 4 alone

**Ans.** (*b*) Measure of discharge by a rectangular notch

$$= \frac{2}{3} Cd\, b\sqrt{2g}\, H^{3/2}$$

**Q. 2.** The critical value of Reynolds number for transition from laminar to turbulent boundary layer in external flows is taken as

(*a*) 2300 (*b*) 4000 (*c*) $5 \times 10^5$ (*d*) $3 \times 10^6$

**Ans.** (*a*) Critical value of Reynolds number for transition from laminar to turbulent layer in external flows is taken as 2300.

**Q. 3.** The boundary layer flow separates from the surface if

(*a*) $\frac{du}{dy} = 0$ and $\frac{dp}{dx} = 0$ (*b*) $\frac{du}{dy} = 0$ and $\frac{dp}{dx} > 0$

(*c*) $\frac{du}{dy} = 0$ and $\frac{dp}{dx} < 0$ (*d*) the boundary layer thickness is zero

**Ans.** (*b*) Boundary layer flow separates from surface if velocity is zero & pressure increases.

**Q. 4.** The laminar boundary layer thickness, $\delta$ at any point $x$ for flow over a flat plate is given by $\delta/x =$

(*a*) $\frac{0.664}{\sqrt{\text{Re}_x}}$ (*b*) $\frac{1.328}{\sqrt{\text{Re}_x}}$ (*c*) $\frac{1.75}{\sqrt{\text{Re}_x}}$ (*d*) $\frac{5.0}{\sqrt{\text{Re}_x}}$

**Ans.** (*d*) $\frac{\delta}{x} = 5.0/\sqrt{\text{Re}_x}$

**Q. 5.** Volumetric flow rate $Q$, acceleration due to gravity $g$ and head $H$ form a dimensionless group, which is given by

(*a*) $\frac{\sqrt{gH^2}}{Q}$ (*b*) $\sqrt{\frac{Q}{gH}}$ (*c*) $\frac{Q}{\sqrt{g^3 H}}$ (*d*) $\frac{Q}{\sqrt{g^2 H}}$

**Ans.** (*a*) Dimensionless group for $g$, $H$ and $Q$ is $\sqrt{gH^5}/Q$

**Q. 6.** A model test is to be conducted in a water tunnel using a 1 : 20 model of a submarine, which is to travel at a speed of 12 km/h deep under sea surface. The water temperature in the tunnel is maintained, so that its kinematic viscosity is half that of sea water. At what speed is the model test to be conducted to produce useful data for the prototype ?

(*a*) 12 km/h (*b*) 240 km/h (*c*) 24 km/h (*d*) 120 km/h

**Ans.** (*d*) $\frac{V_s L_s}{\gamma_s} = \frac{V_m L_m}{\gamma_m}$, $V_m = V_s \cdot \frac{L_s}{L_m} \cdot \frac{\gamma_m}{\gamma_s} = 12 \times 20 \times \frac{1}{2} = 120$ km/h

**Q. 7.** A model test is to be conducted for an under water structure, which is likely to be exposed to strong water currents. The significant forces are known to be dependent on structure geometry, fluid velocity, fluid density and viscosity, fluid depth and acceleration due to gravity. Choose from the codes given below, which of the following numbers must match for the model with that of the prototype :

1. Mach number
2. Weber number
3. Froude number
4. Reynolds number

**Codes :**

(*a*) 3 alone (*b*) 1, 2, 3 and 4 (*c*) 1 and 2 (*d*) 3 and 4

**Ans.** (*d*) Since gravitational and viscosity forces are significant in this case, Froude & Reynold numbers must match for model and prototype.

**Q. 8.** During subsonic, adiabatic flow of gases in pipes with friction, the flow properties go through particular mode of changes. Match List-I (Flow properties) with List-II (Mode of changes) and select the correct answer using the codes given below the lists :

| *List I* (*Flow Properties*) | *List II* (*Mode of changes*) |
|---|---|
| A. Pressure | 1. Increases in flow direction |
| B. Density | 2. Decreases with flow direction |
| C. Temperature | |
| D. Velocity | |

**Codes :**

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 1 | 2 | 2 | (*b*) | 2 | 2 | 2 | 1 |
| (*c*) | 2 | 2 | 1 | 2 | (*d*) | 2 | 1 | 1 | 2 |

**Ans.** (*c*) In subsonic, adiabatic flow in pipe with friction, temperature increases with flow direction and pressure, density and velocity decrease.

**Q. 9.** Which of the following statements is/are true in case of one-dimensional flow of perfect gas through a converging-diverging nozzle ?

1. The exit velocity is always supersonic
2. The exit velocity can be subsonic or supersonic
3. If the flow is isentropic, the exit velocity must be supersonic
4. If the exit velocity is supersonic, the flow must be isentropic

Select the correct answer from the codes given below :

**Codes :**

(*a*) 2 and 4 (*b*) 2, 3 and 4 (*c*) 1, 3 and 4 (*d*) 2 alone

**Ans.** (*a*) Statements (2) and (4) are correct.

**Q. 10.** In a normal shock in a gas :

(*a*) the stagnation pressure remains the same on both sides of the shock
(*b*) the stagnation density remains the same on both sides of the shock
(*c*) the stagnation temperature remains the same on both sides of the shock
(*d*) the Mach number remains the same on both sides of the shock

**Ans.** (*c*) In a normal shock in a gas, the stagnation temperature remains same on both sides of the shock.

**Q. 11.** A normal shock
(*a*) causes a disruption and reversal of flow pattern
(*b*) may occur only in a diverging passage
(*c*) is more severe than an oblique shock
(*d*) moves with a velocity equal to the sonic velocity

**Ans.** (*c*) A normal shock is more severe than an oblique shock.

**Q. 12.** Fluid flow machines are using the principle of either (*i*) supply energy to the fluid, or (*ii*) extracting energy from the fluid. Some fluid flow machines are a combination of both (*i*) and (*ii*). They are classified as
(*a*) compressors (*b*) hydraulic turbines
(*c*) torque converters (*d*) wind mills

**Ans.** (*c*) Torque converter does both the functions.

**Q. 13.** Consider the following statements :
1. Pelton wheel is a tangential flow impulse turbine.
2. Francis turbine is an axial flow reaction turbine.
3. Kaplan turbine is a radial flow reaction turbine.
Which of the above statements is/are correct ?
**Codes :**
(*a*) 1 and 3 (*b*) 1 alone (*c*) 2 alone (*d*) 3 alone

**Ans.** (*b*) Statement about Pelton wheel alone is correct.

**Q. 14.** Match List-I (Hydraulic Turbine) with List-II (Application Area) and select the correct answer using the codes given below the lists :

| *List I* (*Hydraulic Turbine*) | *List II* (*Application Area*) |
|---|---|
| A. Pelton Turbine | 1. Low head, large discharge |
| B. Francis Turbine | 2. Medium head, medium discharge |
| C. Kaplan Turbine | 3. High head, low discharge |

**Codes :**

| | A | B | C |
|---|---|---|---|
| (*a*) | 2 | 3 | 1 |
| (*c*) | 3 | 1 | 2 |

| | A | B | C, |
|---|---|---|---|
| (*b*) | 2 | 1 | 3, |
| (*d*) | 3 | 2 | 1, |

**Ans.** (*d*) Pelton — High head, low discharge, Kaplan-low head, large discharge, Francis - medium head & discharge.

**Q. 15.** Efficiency of Pelton wheel shall be maximum if the ratio of jet velocity to tangential velocity of the wheel is
(*a*) 1/2 (*b*) 1 (*c*) 2 (*d*) 4

**Ans.** (*c*) For maximum efficiency of Pelton wheel, jet velocity should be twice the wheel velocity.

**Q. 16.** The maximum efficiency in the case of Pelton wheel is (angle of deflection of the jet $= 180 - \beta$)
(*a*) $\frac{1-\cos\beta}{2}$ (*b*) $\frac{1+\cos\beta}{2}$ (*c*) $\frac{\cos\beta}{2}$ (*d*) $\frac{1+\cos\beta}{4}$

**Ans.** (*b*) Max. $\eta = \frac{1+\cos\beta}{2}$.

**Q. 17.** If $H$ is the head available for a hydraulic turbine, the power, speed and discharge, respectively are proportional to

(*a*) $H^{1/2}, H^{1/2}, H^{3/2}$ (*b*) $H^{3/2}, H^{1/2}, H^{1/2}$

(*c*) $H^{1/2}, H^{3/2}, H^{1/2}$ (*d*) $H^{3/2}, H^{1/2}, H$

**Ans.** (*b*) Power $\propto H^{3/2}$, speed & discharge are $\propto H^{1/2}$

**Q. 18.** In the phenomenon of cavitation, the characteristic fluid property involved is

(*a*) surface tension (*b*) viscosity

(*c*) bulk modulus of elasticity (*d*) vapour pressure

**Ans.** (*d*) In cavitation, vapour pressure of fluid is characteristic property.

**Q. 19.** A pump running at 1000 RPM consumes 1 kW and generates head of 10 m of water. When it is operated at 2000 RPM, its power consumption and head generated would be

(*a*) 4 kW, 50 m of water (*b*) 6 kW, 20 m of water

(*c*) 3 kW, 30 m of water (*d*) 8 kW, 40 m of water

**Ans.** (*d*) $H \propto N^2$ and $HP \propto N^3$

**Q. 20.** A centrifugal pump gives maximum efficiency when its blades are

(*a*) bent forward (*b*) bent backward

(*c*) straight (*d*) wave shaped

**Ans.** (*b*) Centrifugal pump has maximum efficiency when its blades are bent backwards.

**Q. 21.** In utilizing scaled models in the designing of turbomachines, which of the following relationship must be satisfied ?

(*a*) $\frac{H}{ND^3} = \text{constant}$ ; $\frac{Q}{N^2D^2} = \text{constant}$ (*b*) $\frac{Q}{D^2\sqrt{H}} = \text{constant}$ ; $\frac{H}{N^3D} = \text{constant}$

(*c*) $\frac{P}{QH} = \text{constant}$ ; $\frac{H}{N^2D^2} = \text{constant}$ (*d*) $\frac{NQ^{\frac{1}{2}}}{H^{\frac{3}{2}}} = \text{constant}$ ; $\frac{NP^{\frac{1}{2}}}{H^{\frac{3}{4}}} = \text{constant}$

**Ans.** (*d*) $\frac{N\sqrt{Q}}{H^{3/2}}$ and $\frac{N\sqrt{P}}{H^{3/4}}$ as constants need to be satisfied for design of turbomachines.

**Q. 22.** The correct sequence of the centrifugal pump components through which the fluid flows is

(*a*) Impeller, Suction pipe, Foot valve and strainer, Delivery pipe

(*b*) Foot valve and strainer, Suction pipe, Impeller, Delivery pipe

(*c*) Impeller, Suction pipe, Delivery pipe, Foot valve and strainer

(*d*) Suction pipe, Delivery pipe, Impeller, Foot valve and strainer

**Ans.** (*b*) Correct sequence is valve, strainers, suction pipe, impeller, delivery pipe.

**Q. 23.** A centrifugal pump driven by a directly coupled 3 kW motor of 1450-rpm speed, is proposed to be connected to another motor of 2900-rpm speed. The power of the motor should be

(*a*) 6 kW (*b*) 12 kW (*c*) 18 kW (*d*) 24 kW

**Ans.** (*d*) $P \propto (N_2/N_1)^3$ and $P = 3 \times 2^3 = 24$ kW.

**Q. 24.** A draft tube is used in a reaction turbine

(*a*) to guide water downstream without splashing

(*b*) to convert residual pressure energy into kinetic energy

(*c*) to convert residual kinetic energy into pressure energy

(*d*) to streamline the flow in the tailrace

**Ans.** (*c*) Draft tube in reaction turbine converts residual K.E. into pressure energy.

**Q. 25.** A hydraulic press has a ram of 20 cm diameter and a plunger of 5 cm diameter. The force required at the plunger to lift a weight of $16 \times 10^4$ N shall be :

(*a*) $256 \times 10^4$ N (*b*) $64 \times 10^4$ N (*c*) $4 \times 10^4$ N (*d*) $1 \times 10^4$ N

**Ans.** (*d*) Force at plunger $= 16 \times 10^4 \times \left(\frac{5}{20}\right)^2 = 1 \times 10^4$ N

**Q. 26.** Blowing down of boiler water is the process to

(*a*) reduce the boiler pressure
(*b*) increase the steam temperature
(*c*) control the solids concentration in the boiler water
(*d*) control the drum level

**Ans.** (*c*) Blow down of boiler water controls the solid concentration.

**Q. 27.** A device which is used to drain off water from steam pipes without escape of steam is called

(*a*) Steam separator (*b*) Steam trap
(*c*) Pressure reducing valve (*d*) Injector

**Ans.** (*b*) Steam trap enables water to be drained off with escape of steam.

**Q. 28.** Match List-I (Type of coal) with List-II (Coal properties) and select the correct answer using the codes given below the lists :

| *List I* (*Type of Coal*) | *List II* (*Coal properties*) |
|---|---|
| A. Lignite | 1. Artificial fuel derived from coal |
| B. Anthracite | 2. Contains inflammable gas (volatile matter) and burns with flame |
| C. Bituminous | 3. Very hard and high heating value |
| D. Coke | 4. High ash content and less volatile matter |

**Codes :**

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 2 | 3 | 4 | 1 | (*b*) | 4 | 1 | 2 | 3 |
| (*c*) | 2 | 1 | 4 | 3 | (*d*) | 4 | 3 | 2 | 1 |

**Ans.** (*a*) A-2-B-3, C-4, D-1 is right matching.

**Q. 29.** Pressure reaches a value of absolute zero

(*a*) at a temperature of – 273 K
(*b*) under vacuum condition
(*c*) at the earth's centre
(*d*) when molecular momentum of system becomes zero

**Ans.** (*d*) Absolute zero pressure is attained when molecular momentum of system is zero.

**Q. 30.** A reversible engine operates between temperatures $T$ and $T_2$. The energy rejected by this engine is received by a second reversible engine at temperature $T_2$ and rejected to a reservoir at temperature $T_3$. If the efficiencies of the engines are same then the relationship between $T_1$, $T_2$ and $T_3$ is given by

(*a*) $T_2 = \frac{(T_1 + T_3)}{2}$ (*b*) $T_2 = \sqrt{(T_1^2 + T_3^2)}$ (*c*) $T_2 = \sqrt{T_1 T_3}$ (*d*) $T_2 = \frac{(T_1 + 2T_3)}{3}$

**Ans.** (*c*) $1 - \frac{T_2}{T_1} = 1 - \frac{T_3}{T_2}$ or $T_2^2 = T_1 T_3$

**Q. 31.** The heat absorbed or rejected during a polytropic process is equal to

(*a*) $\left(\frac{\gamma-n}{\gamma-1}\right)^{\frac{1}{2}} \times$ work done (*b*) $\left(\frac{\gamma-n}{n-1}\right) \times$ work done

(*c*) $\left(\frac{\gamma-n}{\gamma-1}\right) \times$ work done (*d*) $\left(\frac{\gamma-n}{\gamma-1}\right)^{2} \times$ work done

**Ans.** (*c*) Heat during polytropic process $= \frac{\gamma-n}{\gamma-1} \times$ work done

**Q. 32.** A system comprising of a pure substance executes reversibly a cycle 1-2-3-4-1 consisting of two isentropic and two isochoric processes as shown in the Fig. 1.

Which one of the following is the correct representation of this cycle on the temperature-entropy coordinates ?

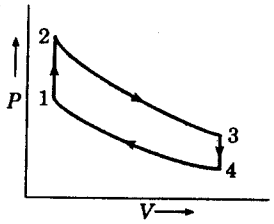
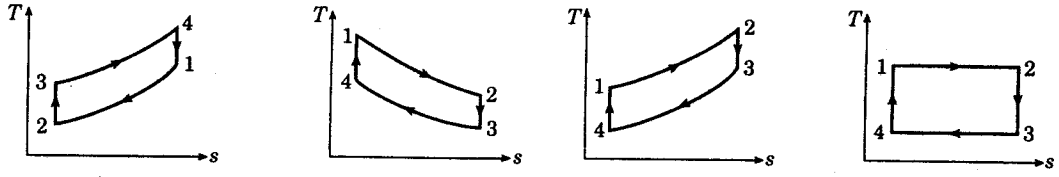


Fig. 1.



(*a*) (*b*) (*c*) (*d*)

**Ans.** (*c*) Curve at (C) is right one.

**Q. 33.** With increase of pressure, the latent heat of steam

(*a*) remains same (*b*) increases

(*c*) decreases (*d*) behaves unpredictably

**Ans.** (*c*) With increase of pressure, LH of steam decreases (Refer shape of Mollier diagram).

**Q. 34.** Consider the following statements regarding the throttling process of wet steam :

1. The steam pressure and temperature decrease but enthalpy remains constant.
2. The steam pressure decreases, the temperature increases but enthalpy remains constant.
3. The entropy, specific volume, and dryness fraction increase.
4. The entropy increases but the volume and dryness fraction decrease.

Which of the above statements are correct ?

(*a*) 1 and 4 (*b*) 2 and 3 (*c*) 1 and 3 (*d*) 2 and 4

**Ans.** (*b*) During throttling of wet steam, pressure decreases, temperature, entropy, sp. volume, dryness fraction increase, and enthapy remains constant.

**Q. 35.** Availability function for a closed system is expressed as :

(*a*) $\phi = u + p_o v - T_o S$ (*b*) $\phi = du + p_o dv + T_o ds$

(*c*) $\phi = du + p_o dv - T_o ds$ (*d*) $\phi = u + p_o v + T_o S$

**Ans.** (*c*) Availability function for a closed system is $\phi = du + p_o dV - T_o dS$

**Q. 36.** $T\,ds$ equation can be expressed as :

(*a*) $T_{ds} = C_v\,dT + \frac{T\beta\,dv}{k}$ (*b*) $T_{ds} = C_v\,dT + \frac{T}{k}\,dv$

(*c*) $T_{ds} = C_v\,dT + \frac{Tk}{\beta}\,dv$ (*d*) $T_{ds} = C_v\,dT + \frac{T\beta}{k}\,dp$

**Ans.** (*a*) $T_{ds} = C_v\,dT + T\beta\,dv/k$.

**Q. 37.** A reversible heat engine receives 6 kJ of heat from thermal reservoir at temperature 800 K, and 8 kJ of heat from another thermal reservoir at temperature 600 K. If it rejects heat to a third thermal reservoir at temperature 100 K, then the thermal efficiency of the engine is approximately equal to :

(*a*) 65% (*b*) 75% (*c*) 80% (*d*) 85%

**Ans.** (*d*) Heat is received at $(800 \times 6 + 600 \times 8)/14 = 685°K$

$\therefore \eta = (685 - 100)/685 \simeq 85\%$

**Q. 38.** The value of compressibility factor for an ideal gas may be

1. less or more than one
2. equal to one
3. zero
4. less than zero

The correct value(s) is/are given by

(*a*) 1 and 2 (*b*) 1 and 4 (*c*) 3 only (*d*) 1 only

**Ans.** (*d*) Value of compressibility factor may be less or more than one.

**Q. 39.** Which one of the following functions represents the Clapeyron equation pertaining to the change of phase of a pure substance ?

(*a*) $f(T, p, h_{fg})$ (*b*) $f(T, p, h_{fg}, v_{fg})$ (*c*) $f(T, p, h_{fg}, s_{fg})$ (*d*) $f(T, p, h_{fg}, s_{fg}, v_{fg})$

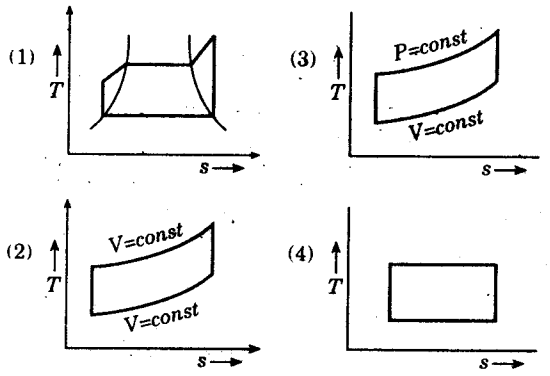
**Ans.** (*b*) Clapeyron equation : $f(T, p, h_{fg}, V_{fg})$

**Q. 40.** In an air standard Otto cycle, $r$ is the volume compression ratio and $\gamma$ is an adiabatic index $\left(\frac{C_p}{C_v}\right)$, the air standard efficiency is given by

(*a*) $\eta = 1 - \frac{1}{r^{\gamma-1}}$ (*b*) $\eta = 1 - \frac{1}{r^{\gamma}}$ (*c*) $\eta = 1 - \frac{1}{r^{\frac{\gamma-1}{\gamma}}}$ (*d*) $\eta = 1 - \frac{1}{r^{\frac{\gamma-1}{2r}}}$

**Ans.** (*a*) $\eta_{otto} = 1 - \frac{1}{r^{\gamma-1}}$

**Q. 41.**




The correct sequence of the given four cycles on T-s plane in Figures (1), (2), (3), (4) is

(*a*) Rankine, Otto, Carnot and Diesel (*b*) Rankine, Otto, Diesel and Carnot

(*c*) Otto, Rankine, Diesel and Carnot (*d*) Otto, Rankine, Carnot and Diesel

**Ans.** (*b*) 1- Rankine, 2-eato, 3-Diesel, 4-Carnot

**Q. 42.** The main advantage of a reheat Rankine cycle is

(*a*) reduced moisture content in L.P. side of turbine

(*b*) increased efficiency

(*c*) reduced load on condenser
(*d*) reduced load on pump

**Ans.** (*a*) Main advantage of rehaeating is to reduce moisture content in LP blading.

**Q. 43.** The order of values of thermal efficiency of Otto, Diesel and Dual cycle, when they have equal compression ratio and heat rejection, is given by
(*a*) $\eta_{otto} > \eta_{diesel} > \eta_{dual}$ (*b*) $\eta_{diesel} > \eta_{dual} > \eta_{otto}$
(*c*) $\eta_{dual} > \eta_{diesel} > \eta_{otto}$ (*d*) $\eta_{otto} > \eta_{dual} > \eta_{diesel}$

**Ans.** (*d*) For same compression ratio and heat rejected, $\eta_{otto} > \eta_{dual} > \eta_{diesel}$

**Q. 44.** In air-standard Diesel cycle ; $r$ is the compression ratio, $\rho$ is the fuel cut-off ratio and $\gamma$ is the adiabatic index $\left(\frac{C_p}{C_v}\right)$. Its air standard efficiency is given by

(*a*) $\eta = 1 - \left\{\frac{1}{\gamma r^{\gamma}} \cdot \frac{(\rho^{\gamma} - 1)}{(\rho - 1)}\right\}$ (*b*) $\eta = 1 - \left\{\frac{1}{\gamma r^{\gamma-1}} \cdot \frac{(\rho^{\gamma-1} - 1)}{(\rho - 1)}\right\}$

(*c*) $\eta = 1 - \left\{\frac{1}{\gamma r^{\gamma-1}} \cdot \frac{(\rho^{\gamma} - 1)}{(\rho - 1)}\right\}$ (*d*) $\eta = 1 - \left\{\frac{1}{\gamma r^{\gamma}} \cdot \frac{(\rho^{\gamma-1} - 1)}{(\rho - 1)}\right\}$

**Ans.** (*c*) $\eta_{diesel} = 1 - \left\{\frac{1}{\gamma r^{\gamma-1}} \cdot \frac{(\rho^{\gamma} - 1)}{(\rho - 1)}\right\}$

**Q. 45.** Stoichiometric air-fuel ratio by volume for combustion of methane in air is :
(*a*) 15 : 1 (*b*) 17.16 : 1 (*c*) 9.52 : 1 (*d*) 10.58 : 1

**Ans.** (*b*) Stoichiometric air-fuel ratio by volume of combustion of methane in air is 17.16:1.

**Q. 46.** Auto-ignition time for petrol-air mixture is minimum when the ratio of actual fuel-air ratio and chemically correct fuel-air ratio is
(*a*) 0.8 (*b*) 1.0 (*c*) 1.2 (*d*) 1.5

**Ans.** (*b*) Auto-ignition time is minimum for chemically correct fuel air ratio.

**Q. 47.** Consider the following statements regarding knock rating of SI engine fuels :
1. Iso-octane is assigned a rating of zero octane number.
2. Normal heptane is assigned a rating of hundred octane number.
3. Iso-octane is assigned a rating of hundred octane number.
4. Normal heptane is assigned a rating of zero octane number.
Which of the above statements are correct ?
(*a*) 1 and 2 (*b*) 2 and 3 (*c*) 3 and 4 (*d*) 4 and 1

**Ans.** (*c*) Statements 3 and 4 are correct.

**Q. 48.** In spark ignition engines knocking can be reduced by :
(*a*) increasing the compression ratio (*b*) increasing the cooling water temperature
(*c*) retarding the spark advance (*d*) increasing the inlet air temperature

**Ans.** (*c*) In SI engines knock is encouraged by advanced spark timing.

**Q. 49.** The tendency of knocking in CI engine reduces by
(*a*) high self-ignition temperature of fuel (*b*) decrease in jacket water temperature
(*c*) injection of fuel just before TDC (*d*) decrease in injection pressure

**Ans.** (*c*) In CI engine, tendency of knocking is reduced by injection of fuel just before TDC.

**Q. 50.** Consider the following statements relevant to the ignition system of SI engine :
1. Too small a dwell angle will lead to the burning of condenser and contact points.
2. Too small a dwell angle will result in misfiring.

3. Too large a dwell angle will result in burning of condenser and contact points.
4. Too large a dwell angle will result in misfiring.

Which of the above statements are correct ?

(*a*) 1 and 2 (*b*) 2 and 3 (*c*) 3 and 4 (*d*) 4 and 1

**Ans.** (*c*) Statements 3 and 4 are correct.

**Q. 51.** The volumetric efficiency of a well designed S.I. engine is in the range of

(*a*) 40%—50% (*b*) 50%—60% (*c*) 60%—70% (*d*) 70%—90%

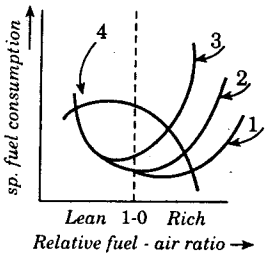
**Ans.** (*d*) Volumetric $\eta$ of well designed S.I. engine is of the order of 70-90%.

**Q. 52.**

Variation of specific fuel consumption with fuel-air ratio for spark ignition engine is represented by which of the curves shown above ?

(*a*) curve 1 (*b*) curve 2

(*c*) curve 3 (*d*) curve 4




**Ans.** (*c*) Curve 3 is correct because specific fuel consumption is minimum for lean mixture.

**Q. 53.** For a jet propulsion unit, ideally the ratio of compressor work and turbine work is

(*a*) 2 (*b*) 1

(*c*) not related to each other (*d*) unpredictable

**Ans.** (*b*) For jet proportion unit, ideally the compressor work and turbine work are equal.

**Q. 54.** A 0.5 m thick plane wall has its two surfaces kept at 300°C and 200°C. Thermal conductivity of the wall varies linearly with temperature and its values at 300°C and 200°C are 25 W/mK and 15 W/mK, respectively. Then the steady heat flux through the wall is

(*a*) 8 kW/m$^2$ (*b*) 5 kW/m$^2$ (*c*) 4 kW/m$^2$ (*d*) 3 kW/m$^2$

**Ans.** (*c*) Average thermal conductivity $k_m = \dfrac{25+15}{2} = 20$ W/mK

$$\frac{Q}{A} = \frac{k_m (t_1 - t_2)}{\Delta x} = \frac{20 \times (300-200)}{0.5} = 4 \text{ kW/m}^2$$

**Q. 55.** A 320 cm high vertical pipe at 150°C wall temperature is in a room with still air at 10°C. This pipe supplies heat at the ratio of 8 kW into the room air by natural convection. Assuming laminar flow, the height of the pipe needed to supply 1 kW only is

(*a*) 10 cm (*b*) 20 cm (*c*) 40 cm (*d*) 80 cm

**Ans.** (*b*) $Q \propto h \times l$, and $h \propto \left(\dfrac{\Delta T}{l}\right)^{1/4}$ ; $\therefore \quad Q \propto l^{3/4}$ ; or $\dfrac{8}{1} = \left(\dfrac{320}{L}\right)^{3/4}$ and $L = 20$ cm.

**Q. 56.** The average Nusselt number in laminar natural convection from a vertical wall at 180°C with still air at 20°C is found to be 48. If the wall temperature becomes 30°C, all other parameters remaining same, the average Nusselt number will be

(*a*) 8 (*b*) 16 (*c*) 24 (*d*) 32

**Ans.** (*c*) $Nu_{av} \propto Gr^{1/4}$ and $Gr \propto \Delta T$

Thus ratio of Grashoft number in two cases is $\propto \dfrac{30-20}{180-20} \propto \dfrac{1}{16}$

$\therefore \quad Nu_{av} \propto \left(\dfrac{1}{16}\right)^4 \propto \dfrac{1}{2}$, $\quad \therefore Nu_{av}$ for second case $= \dfrac{48}{2} = 24.$

**Q. 57.** A fluid of thermal conductivity 1.0 W/m-K flows in fully developed flow with Reynolds number of 1500 through a pipe of diameter 10 cm. The heat transfer coefficient for uniform heat flux and uniform wall temperature boundary conditions are, respectively,

(*a*) 36.57 and 43.64 $\frac{W}{m^2K}$ (*b*) 43.64 and 36.57 $\frac{W}{m^2K}$

(*c*) 43.64 $\frac{W}{m^2K}$ for both the cases (*d*) 36.57 $\frac{W}{m^2K}$ for both the cases

**Ans.** (*b*) For constant heat flux as per Bayley, $h = 4.364\frac{k}{D} = 4.364 \times \frac{1.0}{0.1} = 43.64\frac{W}{m^2K}$,

and for constant wall surface temperature, $h = 3.66\frac{k}{D} = 3.66 \times \frac{1.0}{0.1} = 36.6\frac{W}{m^2K}$

**Q. 58.** Two large parallel grey plates with a small gap, exchange radiation at the rate of 1000 $W/m^2$ when their emissivities are 0.5 each. By coating one plate, its emissivity is reduced to 0.25. Temperatures remain unchanged. The new rate of heat exchange shall become

(*a*) 500 $W/m^2$ (*b*) 600 $W/m^2$ (*c*) 700 $W/m^2$ (*d*) 800 $W/m^2$

**Ans.** (*b*) $Q = 1000 \times \dfrac{\frac{2}{\varepsilon_1} - 1}{\left(\frac{1}{\varepsilon_1} - 1\right) + \left(\frac{1}{\varepsilon_2} - 1\right) + 1} = \dfrac{1000 \times \left(\frac{2}{0.5} - 1\right)}{\frac{1}{0.5} - 1 + \frac{1}{0.25} - 1 + 1} = \dfrac{3 \times 10^3}{5} = 600\,\dfrac{W}{m^2}$

**Q. 59.** Two long parallel plates of same emissivity 0.5 are maintained at different temperatures and have radiation heat exchange between them. The radiation shield of emissivity 0.25 placed in the middle will reduce radiation heat exchange to

(*a*) $\frac{1}{2}$ (*b*) $\frac{1}{4}$ (*c*) $\frac{3}{10}$ (*d*) $\frac{3}{5}$

**Ans.** (*c*) Reduction in radiation heat exchange due to introduction of shield

$$= \frac{\frac{2}{\varepsilon_1} - 1}{2\left(\frac{1-\varepsilon_1}{\varepsilon_1}\right) + 2\left(\frac{1-\varepsilon_2}{\varepsilon_2}\right) + 2} = \frac{\frac{2}{0.5} - 1}{2 \times \frac{0.5}{0.5} + 2 \times \frac{0.75}{0.25} + 2} = \frac{3}{10}$$

**Q. 60.** Match List-I (Type of radiation) with List-II (Characteristic) and select the correct answer using the codes given below the lists :

| *List I (Type of radiation)* | | *List II (Characteristic)* | |
|---|---|---|---|
| A. | Black body | 1. | Emissivity does not depend on wavelength |
| B. | Grey body | 2. | Mirror like reflection |
| C. | Specular | 3. | Zero reflectivity |
| D. | Diffuse | 4. | Intensity same in all directions |

**Codes :**

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 2 | 1 | 3 | 4 | (*b*) | 3 | 4 | 2 | 1 |
| (*c*) | 2 | 4 | 3 | 1 | (*d*) | 3 | 1 | 2 | 4 |

**Ans.** (*d*) Correct matching is $A-3, B-1, C-2, D-4$.

**Q. 61.** Match List-I (Type of heat transfer) with List-II (Governing dimensionless parameter) and select the correct answer using the codes given below the lists :

| *List I (Type of heat transfer)* | *List II (Governing dimensionless parameter)* |
|---|---|
| A. Forced convection | 1. Reynolds, Grashof and Prandtl number |
| B. Natural convection | 2. Reynolds and Prandtl number |
| C. Combined free and forced convection | 3. Fourier modulus and Biot number |
| D. Unsteady conduction with convention at surface | 4. Prandtl number and Grashof number |

**Codes :**

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 2 | 1 | 4 | 3 |
| (*c*) | 2 | 4 | 1 | 3 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 3 | 4 | 1 | 2 |
| (*d*) | 3 | 1 | 4 | 2 |

**Ans.** (*c*) Correct matching is $A-2, B-4, C-1, D-3$.

**Q. 62.** The insulated tip temperature of a rectangular longitudinal fin having an excess (over ambient) root temperature of $\theta_o$ is

(*a*) $\theta_o \tanh(ml)$ (*b*) $\dfrac{\theta_o}{\sinh(ml)}$ (*c*) $\dfrac{\theta_o \tanh(ml)}{(ml)}$ (*d*) $\dfrac{\theta_o}{\cosh(ml)}$

**Ans.** (*c*) Insulated tip temperature $= \dfrac{\theta_0 \tan h\,(ml)}{(ml)}$.

**Q. 63.** Consider the following statements pertaining to large heat transfer rate using fins :

1. Fins should be used on the side where heat transfer coefficient is small.
2. Long and thick fins should be used.
3. Short and thin fins should be used.
4. Thermal conductivity of fin material should be large.

Which of the above statements are correct ?

(*a*) 1, 2 and 3 (*b*) 1, 2 and 4 (*c*) 2, 3 and 4 (*d*) 1, 3 and 4

**Ans.** (*d*) Only wrong statement is that long and thick fins should be used.

**Q. 64.** Using thermal-electrical analogy in heat transfer, match List-I (Electrical quantities) with List-II (Thermal quantities) and select the correct answer using the codes given below the lists :

| *List I (Electrical quantities)* | *List II (Thermal quantities)* |
|---|---|
| A. Voltage | 1. Thermal resistance |
| B. Current | 2. Thermal capacity |
| C. Resistance | 3. Heat flow |
| D. Capacitance | 4. Temperature |

**Codes :**

| | A | B | C | D |
|---|---|---|---|---|
| (*a*) | 2 | 3 | 1 | 4 |
| (*c*) | 2 | 1 | 3 | 4 |

| | A | B | C | D |
|---|---|---|---|---|
| (*b*) | 4 | 1 | 3 | 2 |
| (*d*) | 4 | 3 | 1 | 2 |

**Ans.** (*a*) Correct matching is $A-2, B-3, C-1, D-4$.

**Q. 65.** Prandtl number of a flowing fluid greater than unity indicates that hydrodynamic boundary layer thickness is

(*a*) greater than thermal boundary layer thickness

(*b*) equal to thermal boundary layer thickness

(*c*) greater than hydrodynamic boundary layer thickness

(*d*) independent of thermal boundary layer thickness

**Ans.** (*a*) If $P_r > 1$, then hydrodynamic boundary layer thickness > thermal boundary layer thickness.

**Q. 66.** A standard vapour compression refrigeration cycle consists of the following 4 thermodynamic processes in sequence :

(*a*) isothermal expansion, isentropic compression, isothermal compression and isentropic expansion

(*b*) constant pressure heat addition, isentropic compression, constant pressure heat rejection and isentropic expansion

(*c*) constant pressure heat addition, isentropic compression, constant pressure heat rejection and constant enthalpy expansion

(*d*) isothermal expansion, constant pressure heat addition, isothermal compression and constant pressure heat rejection

**Ans.** (*c*) Correct sequence of vapour compression refrigeration cycle is :

Constant pressure heat addition, Isentropic compression, constant pressure heat rejection, and constant enthapy expansion.

**Q. 67.** Subcooling heat exchanger is used in a refrigeration cycle. The enthalpies at condenser outlet and evaporator outlet are 78 and 182 kJ/kg respectively. The enthalpy at outlet of isentropic compressor is 230 kJ/kg and enthalpy of subcooled liquid is 68 kJ/kg. The COP of the cycle is

(*a*) 2.37 (*b*) 2.16 (*c*) 3.0 (*d*) 3.5

**Ans.** (*a*) $$COP = \frac{\text{enthalpy at evaporator outlet} - \text{enthalpy of sub-cooled liquid}}{\text{enthalpy at outlet of compressor} - \text{enthalpy at evaporator outlet}}$$

$$= \frac{182 - 68}{230 - 182} = \frac{114}{48} = 2.37$$

**Q. 68.** Match List-I (refrigeration equipment) with List-II (Characteristic) and select the correct answer using the codes given below the lists :

| *List I (Refrigeration equipment)* | | *List II (Characteristic)* | |
|---|---|---|---|
| A. | Hermetically sealed compressor | 1. | Capillary tube |
| B. | Semi-hermetically sealed compressor | 2. | Both compressor and motor enclosed in a shell or casing |
| C. | Open type compressor | 3. | Both compressor and motor enclosed in a shell or casing with a removable cylinder cover |
| D. | Expansion device | 4. | Driving motor not enclosed in a shell or casing and connected to the shaft driving the compressor |

**Codes :**

| | A | B | C | D | | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|
| (*a*) | 1 | 4 | 3 | 2 | (*b*) | 2 | 3 | 4 | 1 |
| (*c*) | 1 | 3 | 4 | 2 | (*d*) | 2 | 4 | 3 | 1 |

**Ans.** (*b*) Right matching is $A - 2, B - 3, C - 4, D - 1$