Q. 69. The ratio of the clearance volume to the displacement volume of a R12 reciprocating compressor is 0.05. Specific volume at inlet and outlet of compressor are 0.04 and 0.02 m^3/kg respectively. Volumetric efficiency of the compressor is

(*a*) 95.0% (*b*) 47.5% (*c*) 38.0% (*d*) 19.0%

Ans. (*a*) Volumetric $\eta = 1 + C - C\left(\frac{V_{in}}{V_{out}}\right) = 1 + C - C\left(\frac{v_{out}}{v_{in}}\right) = 1 + 0.05 - 0.05 \times \frac{0.02}{0.04} = 0.95$

Q. 70. Consider the following statements in relation to a convergent-divergent steam nozzle operating under choked conditions :

1. In the convergent portion steam velocity is less than sonic velocity.
2. In the convergent portion steam velocity is greater than sonic velocity.
3. In the divergent portion the steam velocity is less than sonic velocity.
4. In the divergent portion the steam velocity is greater than sonic velocity.

Which of the above statements are correct ?

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

Ans. (*a*) Under choked condition, velocity in both convergent as well as divergent portion is less than sonic velocity.

Q. 71. For maximum discharge through a convergent nozzle the pressure ratio p_2/p_1 should be (where n is the isentropic expansion index)

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

Ans. (*b*) $\frac{P_2}{P_1} = \left(\frac{2}{n+1}\right)^{n/n-1}$

Q. 72. For a reaction turbine with degree of reaction equal to 50%, (V is the absolute steam velocity at inlet and α is the angle made by it to the tangent on the wheel) the efficiency is maximum when the blade speed is equal to

(*a*) $\frac{V\cos\alpha}{2}$ (*b*) $2V\cos\alpha$

(*c*) $V\cos^2\alpha$ (*d*) $V\cos\alpha$

Ans. (*d*) $V_b = V\cos\alpha$ for max η in reaction turbine with 50% reaction.

Q. 73. Match List-I (Equipment) with List-II (Application area) and select the correct answer using the codes given below the lists :

List I (Equipment)	*List II (Application area)*
A. Anticipatory gear	1. Sealing system
B. Labyrinth	2. Steam power plant
C. Inverted T-attachment	3. Turbine governing system
D. Deaerator	4. Blades

Codes :

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

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

Ans. (*b*) Correct matching is $A-3, B-1, C-4, D-2$

Q. 74. The pressure rise in the impeller of centrifugal compressor is achieved by
(*a*) the decrease in volume and diffusion action
(*b*) the centrifugal action and decrease in volume
(*c*) the centrifugal and diffusion action
(*d*) the centrifugal and push-pull action

Ans. (*b*) Pressure rises in impeller of centrifugal compressor due for centrifugal action and decrease in volume.

Q. 75. Compared to axial compressor centrifugal compressors are more suitable for
(*a*) high head, low flow rate (*b*) low head, low flow rate
(*c*) low head, high flow rate (*d*) high head, high flow rate

Ans. (*a*) Centrifugal compressor compared to axial compresor is more suited for high head and low flow rate.

Q. 76. Stalling of blades in axial-flow compressor is the phenomenon of
(*a*) air stream blocking the passage (*b*) motion of air at sonic velocity
(*c*) unsteady, periodic and reversed flow (*d*) air stream not able to follow the blade contour

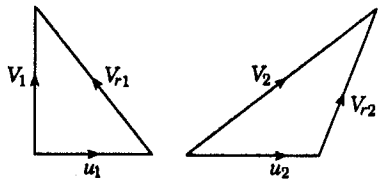
Ans. (*c*) Stalling of blades in axial flow compressor is the phenomenon of unsteady, periodic and reversed flow.

Q. 77. In a reaction turbine the head drop in fixed blade is 8kJ/kg and the total heat drop per stage is 20 kJ/kg. The degree of reaction is
(*a*) 40% (*b*) 66.7%
(*c*) 60% (*d*) 25%

Ans. (*c*) Degree of reaction $= \dfrac{\text{heat drop in moving blade}}{\text{total heat drop}} = \dfrac{20-8}{20} = \dfrac{12}{20} = 60\%$

Q. 78. The inlet and exit velocity diagrams of a turbomachine rotor are shown.

This turbomachine is
(*a*) an axial compressor with backward curved blades
(*b*) a radial compressor with backward curved blades
(*c*) a radial compressor with forward curved blades
(*d*) an axial compressor with forward curved blades



Ans. (*a*) Since $u_1 = u_2$, it is axial compressor. Since V_{r2} makes angle > 90° with u_2, it is backward curved blade.

Q. 79. In an axial flow compressor :
α_1 = exit angle from stator β_1 = inlet angle to rotor
α_2 = inlet angle to stator β_2 = outlet angle from rotor.
The condition to have a 50% degree of reaction is
(*a*) $\alpha_1 = \beta_2$ (*b*) $\alpha_2 = \beta_1$
(*c*) $\alpha_1 = \beta_2$ and $\beta_1 = \alpha_2$ (*d*) $\alpha_1 = a_2$ and $\beta_1 = \beta_2$

Ans. (*c*) For 50% degree of reaction, $\alpha_1 = \beta_2$ and $\beta_1 = \alpha_2$

Q. 80. Brayton cycle with infinite intercooling and reheating stages would approximate a
(*a*) Stirling cycle (*b*) Ericsson cycle (*c*) Otto cycle (*d*) Atkinson cycle

Ans. (*a*) If infinite intercooling and reheating can be used, isentropics can be substituted with isothermals and Brayton cycle approaches Erricson cycle.

Directions : The following 14 (Fourteen) 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. 81. *Assertion (A) :* Efficiency of a reversible engine operating temperature limits T_1 and T_2 is maximum.
Reason (R) : Efficiency of a reversible engine is greater than that of an irreversible engine.

Ans. (*b*) Both A and R are true and R is not necessarily full explanation for A.

Q. 82. *Assertion (A) :* Specific heat at constant pressure for an ideal gas is always greater than the specific heat at constant volume.
Reason (R) : Heat added at constant volume is not utilized for doing any external work.

Ans. (*a*) Heat added at constant volume is used only to increase internal energy, so R appears to be right reason for A.

Q. 83. *Assertion (A) :* The performance of a simple Rankine cycle is not sensitive to the efficiency of the feed pump.
Reason (R) : The net work ratio is practically unity for a Rankine cycle.

Ans. (*a*) Compared to output of turbine, input of BFP is negligible and hence η will not make much difference. Thus R is right reason for A.

Q. 84. *Assertion (A) :* A pintle nozzle is employed to mix the fuel properly even with the slow air movement available with many open combustion chambers in CI engines.
Reason (R) : The mixing of fuel and air is greatly affected by the nature of the air movement in the combustion chamber of CI engines.

Ans. (*a*)

Q. 85. *Assertion (A) :* Heat transfer at high temperature is dominated by radiation rather than convection.
Reason (R) : Radiation depends on fourth power of temperature while convection depends on unit power relationship.

Ans. (*a*)

Q. 86. *Assertion (A) :* It is not possible to determine LMTD in a counter flow heat exchanger with equal heat capacity rates of hot and cold fluids.
Reason (R) : Because the temperature difference is invariant along the length of the heat exchanger.

Ans. (*a*)

Q. 87. *Assertion (A) :* In a liquid-to-gas heat exchanger fins are provided in the gas side.
Reason (R) : The gas offers less thermal resistance than liquid.

Ans. (*c*) A is correct but not R.

Q. 88. *Assertion (A) :* A hydraulic ram is a device used to lift water from deep wells.
Reason (R) : Hydraulic ram works on the principle of water hammer.

Ans. (*c*) A is correct but not R.

Q. 89. *Assertion (A) :* COP of heat pump is more than the COP of its refrigerator version.
Reason (R) : Pumping of heat requires less work relative to extraction of heat from the evaporator.

Ans. (*a*)

Q. 90. *Assertion (A) :* In general, viscosity in liquids increases and in gases it decreases with rise in temperature.
Reason (R) : Viscosity is caused by inter-molecular forces of cohesion and due to transfer of molecular momentum between fluid layers; of which in liquids the former and in gases the later contribute the major part towards viscosity.

Ans. (*d*)

Q. 91. *Assertion (A) :* Stream lines are drawn in the flow field such that at a given instant of time they are perpendicular to the direction of flow at every point in the flow field.
Reason (R) : Equation for a stream line in a two dimensional flow is given by
$V_x\,dy - V_y\,dx = 0$.

Ans. (*b*)

Q. 92. *Assertion (A) :* The mass flow rate through a compressor for various refrigerants at same temperature and pressure, is proportional to their molecular weights.
Reason (R) : According to Avogadro's law all gases have same number of moles in a given volume at same pressure and temperature.

Ans. (*b*)

Q. 93. *Assertion (A) :* Rankine efficiency would approach Carnot cycle efficiency by providing a series a regenerative feed heating.
Reason (R) : With regenerative feed heating, expansion through the turbine approaches an isentropic process.

Ans. (*c*)

Q. 94. *Assertion (A) :* The specific speed of a Pelton turbine is low.
Reason (R) : Pelton turbine works under a high head and handles low discharge.

Ans. (*a*)

Q. 95. The sensing bulb of the thermostatic expansion valve is located at the
(*a*) exit of the evaporator (*b*) inlet of the evaporator
(*c*) exit of the condenser (*d*) inlet of the condenser

Ans. (*b*) Temperature sensor is installed at inlet to evaporator.

Q. 96. Experimental measurements on a refrigeration system indicate that rate of heat extraction by the evaporator, rate of heat rejection by the compressor body to environment are 70 kW, 90 kW and 5 kW respectively. The power input (in kW) required to operate the system is
(*a*) 15 (*b*) 20 (*c*) 25 (*d*) 75

Ans. (*c*) Power input = $90 - 70 + 5 = 25$ kW.

Q. 97. Ozone depletion by CFCs occurs by breakdown of
(*a*) chlorine atoms from refrigerant by UV radiation and reaction with ozone in troposphere
(*b*) fluorine atoms from from refrigerant by UV radiation and reaction with ozone in troposphere
(*c*) chlorine atoms from refrigerant by UV radiation and reaction with ozone in stratosphere
(*d*) fluorine atoms from refrigerant by UV radiation and reaction with ozone in stratosphere

Ans. (*c*) Ozone depletion by CFCs occurs by breakdown of chlorine atoms from refrigerant by UV radiation and reaction with ozone in stratosphere.

Q. 98. Maximum possible COP of a solar absorption refrigeration system with generator temperature of 360 K, absorber temperature of 300 K, condenser temperature of 300 K and evaporator temperature of 270 K is

(*a*) 9 (*b*) 6 (*c*) 3 (*d*) 1.5

Ans. (*d*) Max. Possible $COP = \frac{270\,(360-300)}{360\,(300-270)} = \frac{3}{4} \times 2 = 1.5$

Q. 99. In case *A*, moist air is adiabatically saturated and in case *B*, moist air is isobarically saturated. The saturation temperatures in cases *A* and *B* are respectively

(*a*) dry bulb temperature and wet bulb temperature

(*b*) dew point temperature and wet bulb temperature

(*c*) wet bulb temperature and dew point temperature

(*d*) wet bulb temperature and dry bulb temperature

Ans. (*c*) Moist air when adiabatically saturated attains wet bulb temperature, to when it is isobarically saturated, it attains dew point temperature.

Q. 100. In a system : Metabolic rate = *M*, work done by man = *W*, rate of convective, radiative and evaporative heat losses = *Q* and rate of heat storage = *S*. Then heat exchange between man and his environment is given by

(*a*) $M + W = Q + S$ (*b*) $M - W = Q - S$ (*c*) $M + W = Q - S$ (*d*) $M - W = Q + S$

Ans. (*a*) $M + W = Q + S$

Q. 101. For cooling and dehumidifying of unsaturated moist air, it must be passed over a coil at a temperature :

(*a*) of adiabatic saturation of incoming stream

(*b*) which is lower than the dew point of incoming stream

(*c*) which lies between dry bulb and wet bulb temperature

(*d*) which lies between wet bulb and dew point temperature of incoming stream

Ans. (*b*) For cooling and dehumidifying of unsaturated moist air, it must be passed over a coil having a temperature lower than the dew point of incoming stream.

Q. 102. The latent heat load in an auditorium is 25% of the sensible heat load. The value of sensible heat factor (SHF) is equal to

(*a*) 0.25 (*b*) 0.5 (*c*) 0.8 (*d*) 1.0

Ans. (*c*) $SHF = \frac{\text{sensible heat}}{\text{latent heat + sensible heat}} = \frac{1}{0.25 + 1} = 0.8$

Q. 103. For an office building the outdoor design conditions are 45°C dbt and humidity ratio of 0.015. The indoor design conditions are 25°C dbt and 0.01 humidity ratio. The supply air state is 15°C dbt and 0.007 humidity ratio. If the supply air flow rate is 1000 m^3/min and fresh air flow rate is 100 m^3/min, room sensible and room latent heat loads are, respectively.

(*a*) 408 kW and 400 kW (*b*) 408 kW and 150 kW

(*c*) 204 kW and 400 kW (*d*) 204 kW and 150 kW

Ans. (*b*) Room sensible heat $= 0.0204 \times 1000 \times (45 - 25) = 408$ kW

Room latent heat $= 50 \times 1000 \times (0.01 - 0.007) = 150$ kW

Q. 104. Hydrostatic law of pressure is given as

(*a*) $\frac{\partial p}{\partial z} = \rho g$ (*b*) $\frac{\partial p}{\partial z} = 0$ (*c*) $\frac{\partial p}{\partial z} = z$ (*d*) $\frac{\partial p}{\partial z} = \text{constant}$

Ans. (*a*) Hydrostatic law of pressure $\frac{\partial p}{\partial z} = -\rho g$

Q. 105. In a pipe-flow, pressure is to be measured at a particular cross-section using the most appropriate instrument. Match List-I (Expected pressure range) with List-II (Appropriate measuring device) and select the correct answer using the codes given below the lists :

	List I (Expected pressure range)		*List II (Appropriate measuring device)*
A.	Steady flow with small positive gauge pressure	1.	Bourdon pressure gauge
B.	Steady flow with small negative and positive gauge pressure	2.	Pressure transducer
C.	Steady flow with high gauge pressure	3.	Simple piezometer
D.	Unsteady flow with fluctuating pressure	4.	U-tube manometer

Codes :

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

Ans. (*b*) correct matching is $A-1, B-4, C-3, D-2$

Q. 106. The capillary rise at 20°C in clean glass tube of 1 mm diameter containing water is approximately :

(*a*) 15 mm (*b*) 50 mm (*c*) 20 mm (*d*) 30 mm

Ans. (*d*) Capillary rise $= \dfrac{4\sigma}{g\rho d} = \dfrac{4 \times 0.071}{9.81 \times 1000 \times 0.001} \simeq 30$ mm

Q. 107. Pressure drop of water flowing through a pipe (density 1000 kg/m^3) between two points is measured by using a vertical U-tube manometer. Manometer uses a liquid with density 2000 kg/m^3. The difference in height of manometric liquid in the two limbs of the manometer is observed to be 10 cm. The pressure drop between the two points is :

(*a*) 98.1 N/m^2 (*b*) 981 N/m^2 (*c*) 1962 N/m^2 (*d*) 19620 N/m^2

Ans. (*c*) Pressure drop = $2000 \times 0.1 \times 9.81 = 1962$ N/m^2

Q. 108. Match List-I (Stability) with List-II (Conditions) and select the correct answer using the codes given below the lists :

	List I (Stability)		*List II (Conditions)*
A.	Stable equilibrium of a floating body	1.	Centre of buoyancy below the centre of gravity
B.	Stable equilibrium of a submerged body	2.	Metacentre above the centre of gravity
C.	Unstable equilibrium of a floating body	3.	Centre of buoyancy above the centre of gravity
D.	Unstable equilibrium of a submerged body	4.	Metacentre below the centre of gravity

Codes :

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

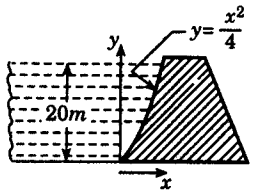
Ans. (*d*) Correct matching is $A-2, B-1, C-4, D-3$

Q. 109. A dam is having a curved surface as shown in the figure.

The height of the water retained by the dam is 20 m, density of water is 1000 kg/m^3. Assuming g as 9.81 m/s^2, the horizontal force acting on the dam per unit length is

(*a*) 1.962×10^2 N (*b*) 2×10^5 N

(*c*) 1.962×10^6 N (*d*) 3.924×10^6 N



Ans. (*c*) $F_H = \rho g A\bar{x} = 1000 \times 9.81 \times 20 \times 1 \times 10 = 1.962 \times 10^6$ N

Q. 110. The velocity potential of a velocity field is given by $\phi = x^2 - y^2 +$ const. Its stream function will be given by :

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

Ans. (*b*) Stream function $= +2xy +$ constant

Q. 111. A steamline is a line

(*a*) which is along the path of the particle

(*b*) which is always parallel to the main direction of flow

(*c*) along which there is no flow

(*d*) on which tangent drawn at any point gives the direction of velocity

Ans. (*d*) A streamline is in direction of velocity

Q. 112. Match List-I (Example) with List-II (Types of flow) and select the correct answer using the codes given below :

List I (Example)		*List II (Types of flow)*
A.	Flow in a straight long pipe with varying flow rate	1. Uniform, steady
B.	Flow of gas through the nozzle of a jet engine	2. Non-uniform, steady
C.	Flow of water through the hose of a fire fighting pump	3. Uniform, unsteady
D.	Flow in a river during tidal bore	4. Non-uniform, unsteady

Codes :

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

Ans. (*b*) Correct matching is A - 3, B - 2, C - 1, D - 4

Q. 113. Match List-I (Type of fluid) with List-II (Variation of shear stress) and select the correct answer using the codes given below the lists :

List I (Type of fluid)		*List II (Variation of shear stress)*
A.	Ideal fluid	1. Shear stress varies linearly with the rate of strain
B.	Newtonian fluid	2. Shear stress does not vary linearly with the rate of strain
C.	Non-Newtonian fluid	3. Fluid behaves like a solid until a minimum yield stress beyond which it exhibits a linear relationship between shear stress and the rate of strain
D.	Bingham plastic	4. Shear stress is zero

Codes :

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

Ans. (*d*) Correct matching is A - 4, B - 1, C - 2, D - 3

Q. 114. The equation of a velocity distribution over a plate is given by $u = 2y - y^2$ where u is the velocity in m/s at a point y metre from the plate measured perpendicularly. Assuming $\mu = 8.60$ poise, the shear stress at a point 15 cm from the boundary is

(*a*) 1.72 N/m^2 (*b*) 1.46 N/m^2 (*c*) 14.62 N/m^2 (*d*) 17.20 N/m^2

Ans. (*c*) Shear stress $= \mu\left(\frac{du}{dy}\right) = 8.60 \times (2 - 2y) = 8.6\,(2 - 0.3) = 14.62$ N/m^2

Q. 115. Match List-I (Fluid parameters) with List-II (Basic dimensions) and select the correct answer using the codes given below the lists :

List I (Fluid parameters)		*List II (Basic dimensions)*
A.	Dynamic viscosity	1. M/t^2
B.	Chezy's roughness coefficient	2. M/Lt^2
C.	Bulk modulus of elasticity	3. M/Lt
D.	Surface tension (σ)	4. $\sqrt{L}/t$

Codes :

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

Ans. (*c*) Correct matching is A - 3, B - 4, C - 2, D - 1

Q. 116. The force of impingement of a jet on a vane increases if

(*a*) the vane angle is increased (*b*) the vane angle is decreased

(*c*) the pressure is reduced (*d*) the vane is moved against the jet

Ans. (*a*) Force of impingement $\propto$ vane angle

Q. 117. Which of the following assumptions are made for deriving Bernoulli's equation ?

1. Flow is steady and incompressible
2. Flow is unsteady and compressible
3. Effect of friction is neglected and flow is along a streamline
4. Effect of friction is taken into consideration and flow is along a streamline

Select the correct answer using the codes given below :

Codes :

(*a*) 1 and 3 (*b*) 2 and 3

(*c*) 1 and 4 (*d*) 2 and 4

Ans. (*a*) For Bernoulli's equation, flow is assumed as steady and incompressible, and effect of friction is neglected and flow is along a streamline.

Q. 118. While measuring the velocity of air ($p = 1.2\ kg/m^3$), the difference in the stagnation and static pressures of a pitotstatic tube was found to be 380 Pa. The velocity at that location in m/s is

(*a*) 24.03 (*b*) 4.02 (*c*) 17.8 (*d*) 25.17

Ans. (*d*) $\frac{1}{2}\rho u^2 = 380$ and $u = \sqrt{\frac{380 \times 2}{1.2}} = 25.17$ m/s

Q. 119. The drag force exerted by a fluid on a body immersed in the fluid is due to

(*a*) pressure and viscous force (*b*) pressure and gravity force

(*c*) pressure and surface tension forces (*d*) viscous and gravity forces

Ans. (*a*) Drag force exerted by a fluid on a body immersed in the fluid is due to pressure and viscous forces.

Q. 120. The hydraulic mean depth (where A = area and P = wetted perimeter) is given by

(*a*) $\frac{P}{A}$ (*b*) $\frac{P^2}{A}$ (*c*) $\frac{A}{P}$ (*d*) $\sqrt{\frac{A}{P}}$

Ans. (*c*) Hydraulic mean depth = A/P.

I.E.S. (Objective)

MECHANICAL ENGINEERING–2002

PAPER - II

Q. 1. The instantaneous centre of rotation of a rigid thin disc rolling without slip on a plane rigid surface is located at

(*a*) the centre of the disc

(*b*) an infinite distance perpendicular to the plane surface

(*c*) the point of contact

(*d*) the point on the circumference situated vertically opposite to the contact point

Ans. (*a*) The instantaneous centre of rotation of a rigid thin disc without slip is located at the centre of the disc.

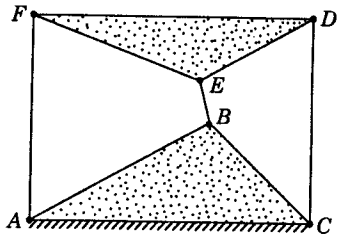
Q. 2. The choice of displacement diagram during rise or return of a follower of a cam-follower mechanism is based on dynamic considerations. For high speed cam follower mechanism, the most suitable displacement for the follower is

(*a*) cycloidal motion (*b*) simple harmonic motion

(*c*) parabolic or uniform acceleration motion (*d*) uniform motion or constant velocity motion

Ans. (*a*) Cycloidal or sine acceleration motion is best for high speeds and it gives least vibration/wear and shock.

Q. 3. A linkage is shown below in the figure in which links ABC and DEF are ternary links whereas AF, BE and CD are binary links.



The degrees of freedom of the linkage when link ABC is fixed are

(*a*) 0 (*b*) 1

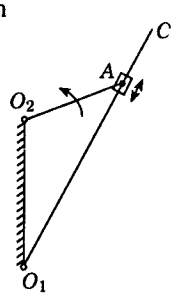
(*c*) 2 (*d*) 3

Ans. (*a*) According to Gruebler's equation $F = 3(n-1) - 2f_1$

where n = no. of links = 5, f_1 = no of pin joints = 6

$\therefore F = 3(5-1) - 2 \times 6 = 0$

Q. 4. The crank and slotted lever quick-return motion mechanism is shown in figure. The length of links O_1O_2, O_1C and O_2A are 10 cm, 20 cm and 5 cm respectively.



The quick return ratio of the mechanism is

(*a*) 3.0 (*b*) 2.75

(*c*) 2.5 (*d*) 2.0

Ans. (*d*) When $O_2A \perp O_1C$, then $O_1\hat{O}_2A = 60°$

$\therefore$ Return stroke corresponds to $60 + 60 = 120°$

$\therefore$ Quick return ratio is $240° \div 120° = 2$

Q. 5. The radius of the friction circle in a journal bearing is dependent on coefficient of friction and the

(*a*) angular velocity of the journal (*b*) radius of the journal

(*c*) magnitudes of the forces on the journal (*d*) journal and bearing clearance

Ans. (*b*) Radius of friction circle in a journal bearing is dependent on μ and radius of journal.

Q. 6. In a collar thrust bearing, the number of collars have been doubled while maintaining coefficient of friction and axial thrust same. It will result in

(*a*) same friction torque and same bearing pressure

(*b*) double friction torque and half bearing pressure

(*c*) double friction torque and same bearing pressure

(*d*) same friction torque and half bearing pressure

Ans. (*b*) Doubling no. of collars will double friction torque but bearing pressure being shared by double the collars will get halved.

Q. 7. If the rotating mass of a rim type fly wheel is distributed on another rim type fly wheel whose mean radius is half the mean radius of the former, then energy stored in the latter at the same speed will be

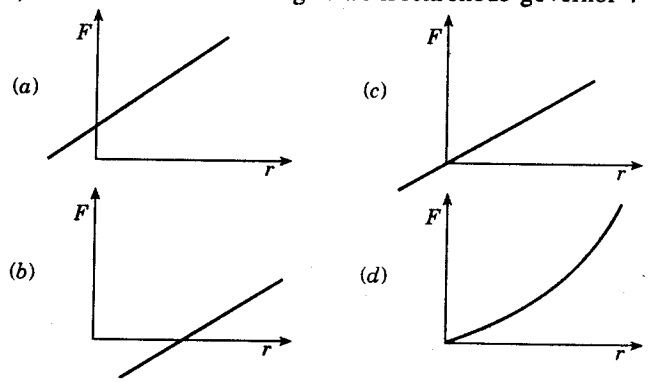
(*a*) four times the first one (*b*) same as the first one

(*c*) one-fourth of the first one (*d*) two times the first one

Ans. (*c*) Energy stored in flywheel $\propto I \propto k^2$

$\therefore$ If radius is halved, energy stored will be one-fourth.

Q. 8. The nature of the governors is shown by the graph between radius(r) of rotation and controlling force (F). Which of the following is an isochronous governor ?



Ans. (*c*) F-r curve passing through (0, 0) is isochronous.

Q. 9. In a Hartnell governor, the mass of each ball is 2.5 kg. Maximum and minimum speeds of rotation are 10 rad/s and 8 rad/s respectively. Maximum and minimum radii of rotation are 20 cm and 14 cm respectively. The lengths of horizontal and vertical arms of bell crank levers are 10 cm and 20 cm respectively. Neglecting obliquity and gravitational effects, the lift of the sleeve is

(*a*) 1.5 cm (*b*) 3.0 cm

(*c*) 6.0 cm (*d*) 12.0 cm

Ans. (*d*) Lift of sleeve $= \frac{b}{a}(r_1 - r_2) = \frac{20}{10}(20 - 14) = 12$ cm

Q. 10. A rod of uniform diameter is suspended from one of its ends in vertical plane. The mass of the rod is 'm' and length 'l', the natural frequency of this rod in Hz for small amplitude is

(*a*) $\frac{1}{2\pi}\sqrt{\frac{g}{l}}$ (*b*) $\frac{1}{2\pi}\sqrt{\frac{g}{3l}}$ (*c*) $\frac{1}{2\pi}\sqrt{\frac{2g}{3l}}$ (*d*) $\frac{1}{2\pi}\sqrt{\frac{3g}{2l}}$

Ans. (*a*) $f = \frac{1}{2\pi}\sqrt{\frac{gh}{k^2 + h^2}}$; for rod of uniform diameter, $k = l/2$, $h = l/2$; $\therefore f = \frac{1}{2\pi}\sqrt{\frac{g}{l}}$

Q. 11. The mass moment of inertia of the two rotors in a two rotor system are 100 kg m^2 and 10 kg m^2. The length of the shaft of uniform diameter between the rotors is 110 cm. The distance of node from the rotor of lower moment of inertia is

(*a*) 80 cm (*b*) 90 cm (*c*) 100 cm (*d*) 110 cm

Ans. (*c*) $l_A = \frac{I_B}{I_A + I_B} l = \frac{100}{10 + 100} \times 110 = 100$ cm

Q. 12. A shaft of 50 mm diameter and 1 m length carries a disc which has mass eccentricity equal to 190 microns. The displacement of the shaft at a speed which is 90% of critical speed in microns is

(*a*) 810 (*b*) 900 (*c*) 800 (*d*) 820

Ans. (*a*) Displacement of shaft $= \frac{e \cdot \left(\frac{\omega}{\omega_n}\right)^2}{1 - \left(\frac{\omega}{\omega_n}\right)^2} = 190 \times \frac{0.9^2}{1 - 0.9^2} = 190 \times \frac{0.81}{0.19} = 810\,\mu$

Q. 13. An epicyclic gear train has 3 shafts A, B and C. A is an input shaft running at 100 rpm clockwise. B is an output shaft running at 250 rpm clockwise. Torque on A is 50 kNm (clockwise). C is a fixed shaft. The torque to fix C

(*a*) is 20 kNm anticlockwise (*b*) is 30 kNm anticlockwise

(*c*) is 30 kNm clockwise (*d*) cannot be determined as the data is insufficient

Ans. (*a*) $T_A \omega_A = T_B \omega_B$, $50 \times 100 = T_B \times 250$ or $T_B = 20$ kNm.

Torque on *C* will be same as on B but in reverse direction *i.e.* anticlockwise.

Q. 14. Which of the following is a closed-loop control system ?

(*a*) Traffic control on the roads by lights where the timing mechanism is present irrespective of the intensity of traffic.

(*b*) Switching off the street lights of a tower at a predetermined time by a time-switch irrespective of the fact that the sun rises at a different time each day

(*c*) Switching off an electric heater by a time-switch irrespective of whether the dish has been prepared or not

(*d*) Human body

Ans. (*d*) Human body functions in closed loop control system.

Q. 15. A screw jack is said to be self-locking if its efficiency is

(*a*) less than 50% (*b*) equal to 50%

(*c*) more than 50% (*d*) 100%

Ans. (*a*) For a screw jack to be self locking, η should be < 50%.

Q. 16. If *P* is the pitch of square thread, then the depth of thread *d* is given by

(*a*) 0.5 *P* (*b*) *P* (*c*) 1.5 *P* (*d*) 2.0 *P*

Ans. (*a*) Depth of square thread = width of groove = *P*/2

Q. 17. The arm of a radial drilling machine is being raised at a speed of 3.9 m/min by single start square threads of 6 mm pitch and 30 mm diameter. The speed of the screw

(*a*) is 650 rpm (*b*) is 180 rpm

(*c*) is 130 rpm (*d*) cannot be determined as the data is insufficient

Ans. (*a*) Speed of screw $= \frac{3.9 \times 1000}{6} = 650$ rpm.

Q. 18. A cotter joint is used when no relative motion is permitted between the rods joined by the cotter. It is capable of transmitting

(*a*) twisting moment (*b*) an axial tensile as well as compressive load

(*c*) the bending moment (*d*) only compressive axial load

Ans. (*b*) Cotter joint is capable of transmitting axial as well as compressive load.

Q. 19. In a fillet welded joint, the weakest area of the weld is

(*a*) toe (*b*) root (*c*) throat

Ans. (*c*) The weakest area in a fillet welded joint is throat.

Q. 20. The power transmitted by a belt is dependent on the centrifugal effect in the belt. The maximum power can be transmitted when the centrifugal tension is

(*a*) 1/3 of tension (T_1) on the tight side (*b*) 1/3 of total tension (T_x) on the tight side

(*c*) 1/3 of the tension (T_2) on the slack side (*d*) 1/3 of sum of tensions T_1 and T_2 *i.e.* $\frac{1}{3}(T_1 + T_2)$

Ans. (*a*) Maximum power by belt is transmitted when $T_C = 1/3 \times T_1$.

Q. 21. The length of the belt in the case of a cross-belt drive is given in terms of centre distance between pulleys (C), diameters of the pulleys D and d as

(*a*) $2C + \frac{\pi}{2}(D+d) + \frac{(D+d)^2}{4C}$ (*b*) $2C + \frac{\pi}{2}(D-d) + \frac{(D+d)^2}{4C}$

(*c*) $2C + \frac{\pi}{2}(D+d) + \frac{(D-d)^2}{4C}$ (*d*) $2C + \frac{\pi}{2}(D-d) + \frac{(D-d)^2}{4C}$

Ans. (*a*) Length of belt in cross belt is $2C + \frac{\pi}{2}(D+d) + \frac{(D+d)^2}{4C}$

Q. 22. A shaft can safely transmit 90 kW while rotating at a given speed. If this shaft is replaced by a shaft of diameter double of the previous one and rotated at half the speed of the previous, the power that can be transmitted by the new shaft is

(*a*) 90 kW (*b*) 180 kW (*c*) 360 kW

Ans. (*c*) $P \propto T\omega \propto d^3\omega$

$\therefore$ Doubling d and halfing ω will mean power rating is increased 4 times.

Q. 23. A cold rolled steel shaft is designed on the basis of maximum shear stress theory. The principal stresses induced at its critical section are 60 MPa and – 60 MPa respectively. If the yield stress for the shaft material is 360 MPa, the factor of safety of the design is

(*a*) 2 (*b*) 3

(*c*) 4 (*d*) 6

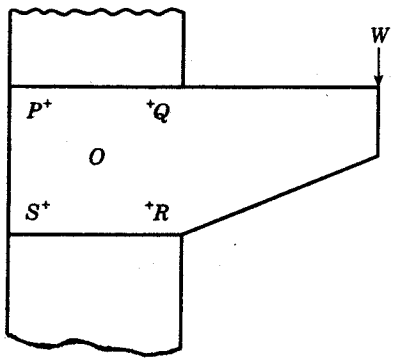


Fig. A

Ans. (*d*) Maximum shear stress $= \frac{f_{n1} - f_{n2}}{2} = \frac{60 + 60}{2} = 60$

$\therefore FS = 360/60 = 6$

Q. 24. An eccentrically loaded riveted joint is shown with 4 rivets at P, Q, R and S. (Fig. A)

Which of the rivets are the most loaded ?

(*a*) P and Q (*b*) Q and R

(*c*) R and S (*d*) S and P

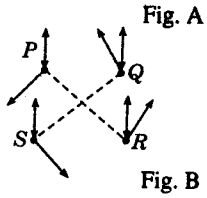


Fig. B

Ans. (*b*) Direct shear force and force to resist bending are shown in Figure B. It may be seen that resultant of these forces will be maximum at Q and R which have least angle between two forces.

Q. 25. The bolts in a rigid flanged coupling connecting two shafts transmitting power are subjected to

(*a*) shear force and bending moment (*b*) axial force

(*c*) torsion and bending moment (*d*) torsion

Ans. (*a*) Bolts in a rigid coupling are subjected to shear force due to torque & bending moment due to initial tightening.

Q. 26. When a helical compression spring is cut into two equal halves, the stiffness of each of the resulting springs will be

(*a*) unaltered (*b*) double (*c*) one-half (*d*) one-fourth

Ans. (*b*) Stiffness of a spring cut into 2 gets doubled.

Q. 27. While calculating the strees induced in a closed coil helical spring. Wahl's factor must be considered to account for

(*a*) the curvature and stress concentration effect (*b*) shock loading

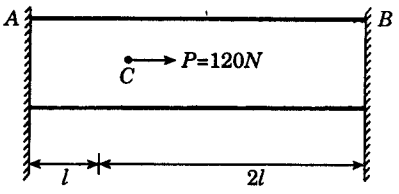
(*c*) poor service conditions (*d*) fatigue loading

Ans. (*a*) Wahl's factor accounts of curvature and stress concentration effect.

Q. 28. A straight bar is fixed at edges *A* and *B*. Its elastic modulus is *E* and cross-section is *A*. There is a load *P* = 120 N acting at *C*. Determine the reactions at the ends.

(*a*) 60 N at A, 60 N at B (*b*) 30 N at A, 90 N at B

(*c*) 40 N at A, 80 N at B (*d*) 80 N at A, 40 N at B



Ans. (*a*) Since both ends are fixed rigidly, any axial load is equally shared.

Q. 29. For a given material, the modulus of rigidity is 100 GPa and Poisson's ratio is 0.25. The value of modulus of elasticity in GPa is

(*a*) 125 (*b*) 150 (*c*) 200 (*d*) 250

Ans. (*d*) $E = 2C\left(1 + \frac{1}{m}\right) = 2 \times 100\,(1 + 0.25) = 250$ GPa

Q. 30. A rigid beam of negligible weight is supported in a horizontal position by two rods of steel and aluminium, 2 m and 1 m long having values of cross-sectional areas 1 cm^2 and 2 cm^2 and E of 200 GPa and 100 GPa respectively. A load *P* is applied as shown in the figure.

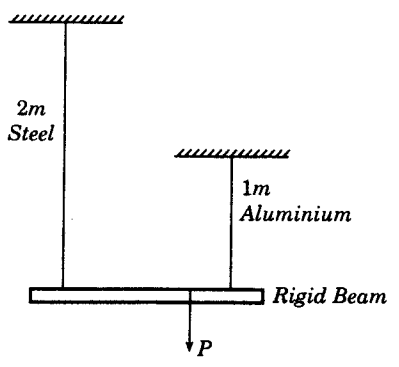
If the rigid beam is to remain horizontal, then

(*a*) the forces on both rods should be equal

(*b*) the force on aluminium rod should be twice the force on steel

(*c*) the force on the steel rod should be twice the force on aluminium

(*d*) the force *P* must be applied at the centre of the beam

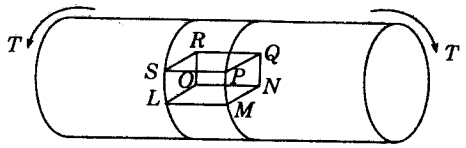


Ans. (*b*) Elongation in both rods should be same to keep beam horizontal

$$\frac{P_s l_s}{A_s E_s} = \frac{P_A l_A}{A_A E_A}$$

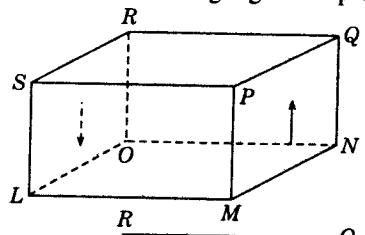
$$\frac{P_s}{P_A} = \frac{1}{2} \times \frac{1}{2} \times \frac{200}{100} = \frac{1}{2}$$

Q. 31. A shaft is subjected to torsion as shown.

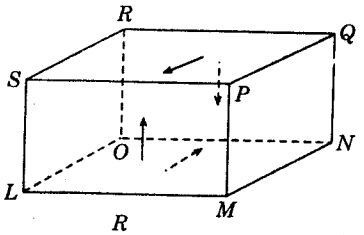


Which of the following figures represents the shear stress on the element LMNOPQRS ?

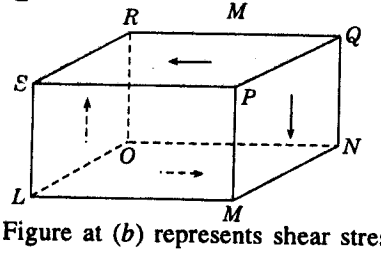
(*a*)



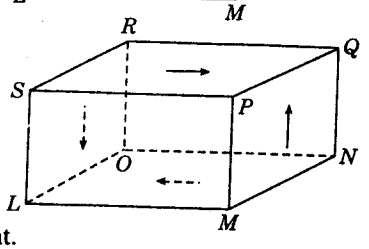
(*b*)



(*c*)

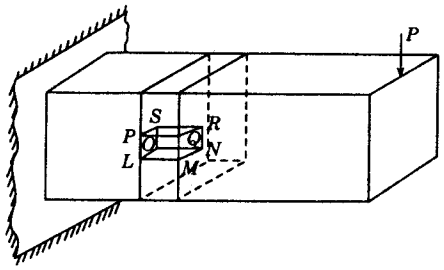


(*d*)



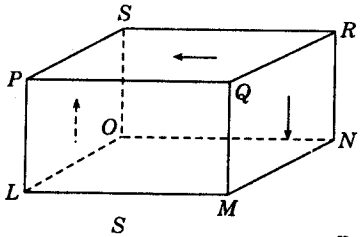
Ans. (*b*) Figure at (*b*) represents shear stress on element.

Q. 32.

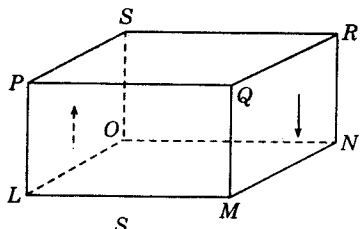


A cantilever is loaded by a concentrated load *P* at the free end as shown. The shear stress in the element LMNOPQRS is under consideration. Which of the following figures represents the shear stress directions in the cantilever ?

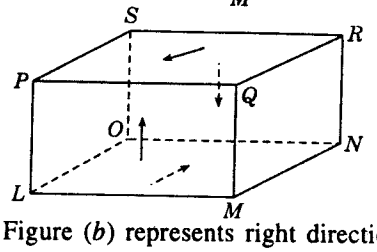
(*a*)



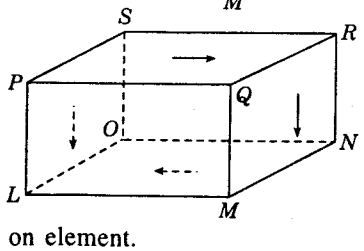
(*b*)



(*c*)



(*d*)



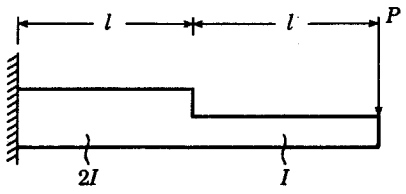
Ans. (*b*) Figure (*b*) represents right direction of shearing on element.

Q. 33. A thin cylinder of radius r and thickness t when subjected to an internal hydrostatic pressure P causes a radial displacement u, then the tangential strain caused is

(*a*) $\frac{du}{dr}$ (*b*) $\frac{1}{r}\cdot\frac{du}{dt}$ (*c*) $\frac{u}{r}$ (*d*) $\frac{2u}{r}$

Ans. (*a*) Tangential strain $= du/dr$

Q. 34.



$I = 375 \times 10^{-6}\ \text{m}^4$
$l = 0.5\ \text{m}$
$E = 200\ \text{GPa}$

Determine the stiffness of the beam shown in the above figure.

(*a*) 12×10^{10} N/m (*b*) 10×10^{10} N/m (*c*) 4×10^{10} N/m (*d*) 8×10^{10} N/m

Ans. (*a*) Deflection $\delta = \frac{1}{EI}\left[\frac{Pl^3}{2}\right]$

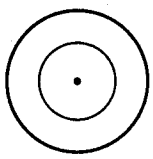
$$\therefore \text{Stiffness} = \frac{P}{\delta} = \frac{2EI}{l^3} = \frac{2 \times 200 \times 10^9 \times 375 \times 10^{-6}}{0.5^2} = 12 \times 10^{10}\ \text{N/m}$$

Q. 35. Strain energy stored in a body of volume V subjected to uniform stress s is

(*a*) $\frac{sE}{V}$ (*b*) $\frac{sE^2}{V}$ (*c*) $\frac{sV^2}{E}$ (*d*) $\frac{s^2V}{2E}$

Ans. (*d*) Strain energy stored $= \frac{s^2V}{2E}$

Q. 36. A thick open ended cylinder as shown in the figure, is made of a material with permissible normal and shear stresses 200 MPa and 100 MPa respectively. The ratio of permissible pressure based on the normal and shear stress is



(*a*) 9/5 (*b*) 8/5
(*c*) 7/5 (*d*) 4/5

Ans. (*b*) Max. hoop stress $= p_i(d_o^2 + d_i^2)/(d_0^2 - d_i^2)$,

$$\therefore \quad p_i = 200 \times (0.2^2 - 0.1^2)/(0.2^2 + 0.1^2) = 200 \times 0.03/0.05 = 120\ \text{MPa}$$

Max. shear stress $= p_i d_o^2/(d_o^2 - d_i^2)$,

and $$p_i = 100 \times 0.03/0.04 = 75\ \text{MPa}$$

$$\therefore \quad \text{Ratio} = 120/75 = 8/5$$

Q. 37. T.T.T. diagram indicates time and temperature transformation of

(*a*) Cementite (*b*) Pearlite (*c*) Ferrite (*d*) Austenite

Ans. (*d*) T.T.T. diagram indicates time and temperature parameters for austenite.

Q. 38. The correct composition of austenitic stainless steel used for domestic utensils is

(*a*) 0.08% C, 18% Cr, 8% Ni, 2% Mn, 1% Si

(*b*) 0.08% C, 24% Cr, 12% Ni, 2% Mn, 1% Si

(*c*) 0.15% C, 12% Cr, 0.5% Ni, 1% Mn, 1% Si
(*d*) 0.30% C, 12% Cr, 0.4% Ni, 1% Mn, 1% Si

Ans. (*c*) Composition of S.S. for domestic use is at (*c*).

Q. 39. Which one of the following is true ?
(*a*) Structure of metallic materials consists of atoms having valence of 5, 6 or 7
(*b*) Ceramic materials have long range electron matrix bond
(*c*) Polymers are composed of long chain of repeating molecules
(*d*) Ceramics are weaker than metals because of weak electrostatic bond

Ans. (*c*) Polymers are composed of long chain of repeating molecules.

Q. 40. In the grain-size determination using standard charts, the relation between the given size number n and the average number of grains 'N' per square inch at a magnification of 100 X is
(*a*) $N = 2^n$ (*b*) $N = 2^{n-1}$ (*c*) $N = 2^{n+1}$ (*d*) $N = 2^n + 1$

Ans. (*a*) $N = 2^n$

Q. 41. Chemicals attack atoms within grain boundaries preferentially because they have
(*a*) lower energy than those in the grains (*b*) higher energy than those in the grains
(*c*) higher number of atoms than in the grains (*d*) lower number of atoms than in the grains

Ans. (*d*) Chemicals attack grain boundaries because of low number of atoms.

Q. 42. As per Gibb's phase rule, if number of components is equal to 2 then the number of phases will be
(*a*) ≤ 2 (*b*) ≤ 3 (*c*) ≤ 4 (*d*) ≤ 5

Ans. (*c*) As per Gibb's phase rule, number of phases + degrees of freedom – no. of components = 2

$\therefore$ $P = 2 + C - F = 4 - F$ *i.e.* $P \leq 4$

Q. 43. The rate of production of a powder metallurgy part depends on
(*a*) flow rate of powder (*b*) green strength of compact
(*c*) apparent density of compact (*d*) compressibility of powder

Ans. (*d*) Rate of production of a powder metallurgy part *i.e.* sintering time depends on compressibility of powder.

Q. 44. In a machining process, the percentage of heat carried away by the chips is typically
(*a*) 5% (*b*) 25% (*c*) 50% (*d*) 75%

Ans. (*d*) Chips carry upto 75% of heat.

Q. 45. In economics of machining, which one of the following costs remains constant ?
(*a*) Machining cost per piece (*b*) Tool changing cost per piece
(*c*) Tool handling cost per piece (*d*) Tool cost per piece

Ans. (*b*) Tool changing cost per piece remains constant.

Q. 46. Which one of the following is the hardest cutting tool material next only to diamond ?
(*a*) Cemented carbides (*b*) Ceramics
(*c*) Silicon (*d*) Cubic boron nitride

Ans. (*d*) CBN is hardest cutting tool after diamond.

Q. 47. Crater wear on tools always starts at some distance from the tool tip because at that point
(*a*) cutting fluid does not penetrate (*b*) normal stress on rake face is maximum
(*c*) temperature is maximum (*d*) tool strength is minimum

Ans. (*c*) Crater starts away from tool tip where temperature is maximum.

Q. 48. A 31.8 mm H.S.S. drill is used to drill a hole in a cast iron block 100 mm thick at a cutting speed 20 m/min and feed 0.3 mm/rev. If the overtravel of drill is 4 mm and approach 9 mm, the time required to drill the hole is
(*a*) 1 min 40 s (*b*) 1 min 44 s (*c*) 1 min 49 s (*d*) 1 min 53 s

Ans. (*d*) $V = \pi dN$, or $20 = 3.14 \times 0.0318 \times N$, $N = 200.3$ rpm.

$$\text{Time for drilling} = \frac{100 + 4 + 9}{0.30 \times 200.3} = 1.889 = 1 \text{ min } 53 \text{ s}$$

Q. 49. The value of surface roughness '*h*' obtained during the turning operation at a feed '*f*' with a round nose tool having radius '*r*' is given as
(*a*) $\frac{f}{8r}$ (*b*) $\frac{f^2}{8r}$ (*c*) $\frac{f^3}{8r}$ (*d*) $\frac{f^3}{8r^2}$

Ans. (*b*) Surface roughness $h \propto f^2/8r$

Q. 50. A side and face cutter 125 mm diameter has 10 teeth. It operates at a cutting speed of 14 m/min with a table traverse 100 mm/min. The feed per tooth of the cutter is
(*a*) 10 mm (*b*) 2.86 mm (*c*) 0.286 mm (*d*) 0.8 mm

Ans. (*c*) $\pi DN = 14$, $N = \frac{14000}{3.14 \times 125} = 35.65$

$$\text{Feed for tooth} = \frac{\text{table traverse}}{\text{N} \times \text{no. of teeth}} = \frac{100}{35.65 \times 10} = 0.286 \text{ mm}$$

Q. 51. Which one is ***not*** a method of reducing cutting forces to prevent the overloading of press ?
(*a*) Providing shear on die (*b*) Providing shear on punch
(*c*) Increasing die clearance (*d*) Stepping punches

Ans. (*d*) Stepping punches do not reduce cutting force.

Q. 52. In which one of the following welding techniques is vacuum environment required ?
(*a*) Ultrasonic welding (*b*) Laser beam welding
(*c*) Plasma arc welding (*d*) Electron beam welding

Ans. (*d*) Vacuum is required for EBM

Q. 53. In rolling a strip between two rolls, the position of the neutral point in the arc of contact does ***not*** depend on
(*a*) amount of reduction (*b*) diameter of the rolls
(*c*) coefficient of friction (*d*) material of the rolls

Ans. (*d*) Position of neutral point in rolling a strip between two rolls does not depend on material of rolls.

Q. 54. In a machine tool gear box, the smallest and largest spindles are 100 rpm and 1120 rpm respectively. If there are 8 speeds in all, the fourth speed will be
(*a*) 400 rpm (*b*) 280 rpm (*c*) 800 rpm (*d*) 535 rpm

Ans. (*a*) 4th speed $\simeq (1120/100)^{4/7} = 400$

Q. 55. In a CNC machine tool, encoder is used to sense and control
(*a*) table position (*b*) table velocity (*c*) spindle speed (*d*) coolant flow

Ans. (*a*) Encoder is used to sense and control the table position.

Q. 56. In the tolerance specification 25 D 6, the letter D represents
(*a*) grade of tolerance (*b*) upper deviation (*c*) lower deviation (*d*) type of fit

Ans. (*c*) Letter D refers to low deviation for hole.

Q. 57. Repetitive fast speed activities can be effectively analysed by taking photograph at
(*a*) low speed and screening at low speed (*b*) high speed and screening at high speed
(*c*) high speed and screening at low speed (*d*) low speed and screening at high speed

Ans. (*c*) Repetitive fast speed activities can be effectively analysed by taking photographs at high speed and screening at low speed.

Q. 58. The reason for diversification is to
(*a*) reduce production cost (*b*) balance low demand high capacity situation
(*c*) satisfy more customers (*d*) improve capacity utilization

Ans. (*b*) Diversification is needed for balancing low demand and high capacity situation.

Q. 59. The proper sequence of activities for material requirement planning are
(*a*) master production schedule, capacity planning, MRP and order release
(*b*) order release, master production schedule, MRP and capacity planning
(*c*) master production schedule, order release, capacity planning and MRP
(*d*) capacity planning, master production schedule, MRP and order release

Ans. (*d*) (*d*) is correct choice.

Q. 60. Economic Order Quantity is the quantity at which the cost of carrying is
(*a*) minimum (*b*) equal to the cost of ordering
(*c*) less than the cost of ordering (*d*) cost of over-stocking

Ans. (*a*) Economic order quantity refers to minimum cost of carrying

Q. 61. A shop owner with an annual constant demand of 'A' units has ordering costs of Rs. 'P' per order and carrying costs Rs. 'I' per unit per year. The economic order quantity for a purchasing model having no shortage may be determined from

(*a*) $\sqrt{\frac{24P}{AI}}$ (*b*) $\sqrt{\frac{24AP}{I}}$ (*c*) $\sqrt{\frac{2AP}{I}}$ (*d*) $\sqrt{\frac{2AI}{P}}$

Ans. (*c*) $MOQ = \sqrt{2AP/I}$

Q. 62. Which one of the following is true in respect of production control for continuous or assembly line production ?
(*a*) Control is achieved by PERT network
(*b*) Johnson algorithm is used for sequencing
(*c*) Control is on one work centre only
(*d*) Control is on flow of identical components through several operations

Ans. (*d*) For continuous production, control is on flow of identical components through several operations.

Q. 63. Which one of the following is the preferred logical sequence in the development of a new product ?
(*a*) Technical feasibility, social acceptability and economic viability
(*b*) Social acceptability, economic viability and technical feasibility
(*c*) Economic viability, social acceptability and technical feasibility
(*d*) Technical feasibility, economic viability and social acceptability

Ans. (*b*) For new product, correct sequence for development is - social acceptability, economic viability and technical feasibility.

Q. 64. Which one of the following is assumed for timing the activities in PERT network ?
(*a*) α distribution (*b*) β distribution
(*c*) Binomial distribution (*d*) Erlangian distribution

Ans. (*c*) Binomial distribution is assumed for timing the activities in PERT network.

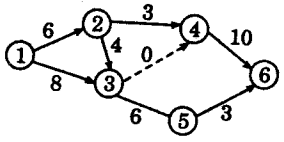
Q. 65. The three time estimates of a PERT activity are : optimistic time = 8 min, most likely time = 10 min and pessimistic time = 14 min. The expected time of the activity would be

(*a*) 10.00 min (*b*) 10.33 min

(*c*) 10.66 min (*d*) 11.00 min

Ans. (*b*) Expected time $= \frac{t_o + 4\,t_e + t_p}{6} = \frac{8 + 4 \times 10 + 14}{6} = \frac{62}{6} = 10.33$ min

Q. 66. For the network shown in the figure, the variance along the critical path is 4.



The probability of completion of the project in 24 days is

(*a*) 68.2% (*b*) 84.1% (*c*) 95.4% (*d*) 97.7%

Ans. (*b*) Probability for completing in 24 days corresponds to 1σ more them central line, *i.e.* (50 + 34.1)% = 84.1%.

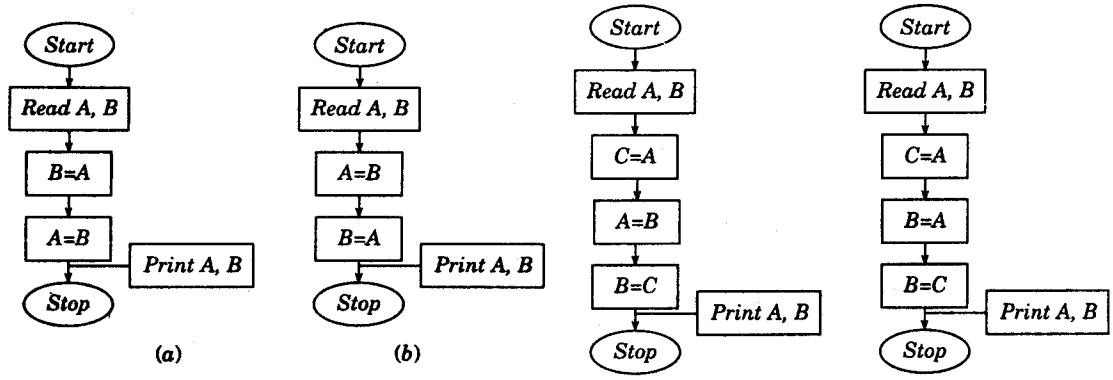
Q. 67. The curve representing the level of achievement with reference to time is known as

(*a*) Performance curve (*b*) Operating characteristic curve

(*c*) S-curve (*d*) Learning curve

Ans. (*d*) Curve between level of achievement with reference to time is called learning curve.

Q. 68. Which one of the following flow charts is correct for swapping values of A and B ?



Ans. (*b*)

Q. 69. $I = 1, 3, 4, 2, 6, 5$

$K(I) = 100, 52, 300, 51, 600$

Select the correct FORTRAN read statement from the following :

(*a*) READ (*I*, *K* (*I*), *L* = 1, 6)

(*b*) READ (*L*, *K* (*I*), *I* = 1, 6)

(*c*) READ (*I*, *K* (*L*), *L* = 1, 6)

(*d*) READ (*L*, *K* (*I*), *L* = 1, 6)

Ans. (*a*)

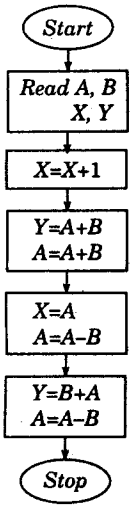
Q. 70. What will be the output values of A and B for the chart given ?

(*a*) (*A* * *B*), *X*

(*b*) *A*, *B*

(*c*) *B*, *A*

(*d*) *X*, *Y*



Ans. (*c*)

Q. 71. Consider the following statements for completely balancing a single rotating mass :

1. Another rotating mass placed diametrically opposite in the same plane balances the unbalanced mass.
2. Another rotating mass placed diametrically opposite in a parallel plane balances the unbalanced mass.
3. Two masses placed in two different parallel planes balance the unbalanced mass.

Which of the above statements is/are correct ?

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

Ans. (*a*)

Q. 72. Consider the following statements in case of reverted gear train :

1. The direction of rotation of the first and the last gear is the same.
2. The direction of rotation of the first and the last gear is opposite.
3. The first and the last gears are on the same shaft.
4. The first and the last gears are on separate but co-axial shafts.

Which of these statements is/are correct ?

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

Ans. (*d*)

Q. 73. The dynamic load on a gear is due to

1. inaccuracies of tooth spacing.
2. irregularities in tooth profile.
3. deflection of the teeth under load.
4. type of service (*i.e.* intermittent, one shift per day, continuous per day).

Which of the above statements are correct ?

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

Ans. (*a*)

Q. 74. Consider the following statements :

A 20° stub tooth system is generally preferred in spur gears as it results in

1. stronger teeth.
2. lesser number of teeth on the pinion.
3. lesser chances of surface fatigue failure.
4. reduction of interference.

Which of the above statements are correct ?

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

Ans. (*a*)

Q. 75. Consider the following statements :
Thermal stress is induced in a component in general, when
1. a temperature gradient exists in the component.
2. the component is free from any restraint.
3. it is restrained to expand or contract freely.
Which of the above statements is/are correct ?
(*a*) 1 and 2 (*b*) 2 and 3 (*c*) 3 alone (*d*) 2 alone

Ans. (*c*)

Q. 76. Consider the following statements in case of beams :
1. Rate of change of shear force is equal to the rate of loading at a particular section.
2. Rate of change of bending moment is equal to the shear force at a particular section.
3. Maximum shear force in a beam occurs at a point where bending moment is either zero or bending moment changes sign.
Which of the above statements is/are correct ?
(*a*) 1 alone (*b*) 2 alone (*c*) 1 and 2 (*d*) 1, 2 and 3

Ans. (*c*)

Q. 77. Which of the following are fabricated using engineering plastics ?
1. Surface plate 2. Gears
3. Guide ways for machine tools 4. Foundry patterns
Select the correct answer using the codes given below :
Codes :
(*a*) 1, 2 and 3 (*b*) 1 (*c*) 2, 3 and 4 (*d*) 1, 2, 3 and 4

Ans. (*c*)

Q. 78. Consider the following statements :
Polytetrafluoroethene is
1. a thermoplastic material. 2. having high friction coefficient.
3. a thermosetting material. 4. having low friction coefficient.
5. an electric insulator. 6. non sticking to surfaces.
Which of the above statements are correct ?
(*a*) 1, 2 and 5 (*b*) 2, 3 and 6 (*c*) 3, 4 and 5 (*d*) 3, 2 and 5

Ans. (*a*)

Q. 79. Which of the following fibre materials are used for reinforcement in composite materials :
1. Glass 2. Boron carbide 3. Graphite
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. (*a*)

Q. 80. Consider the following statements :
The strength of a single point cutting tool depends upon
1. rake angle. 2. clearance angle. 3. lip angle.
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. 81. Which of the following materials are used in Grinding wheel ?
1. Aluminium oxide 2. Cubic boron nitride 3. Silicon carbide
Select the correct answer using the codes given below :
Codes :
(*a*) 1, 2 and 3 (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 1 and 3

Ans. (*a*)

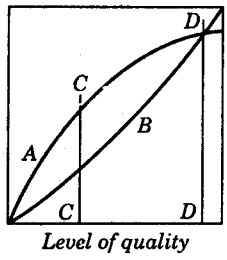
Q. 82. Consider the following statements related to piercing and blanking :
1. Shear on the punch reduces the maximum cutting force.
2. Shear increases the capacity of the press needed.
3. Shear increases the life of the punch.
4. The total energy needed to make the cut remains unaltered due to provision of shear.
Which of the above statements are correct ?
(*a*) 1 and 2 (*b*) 1 and 4 (*c*) 2 and 3 (*d*) 3 and 4

Ans. (*b*)

Q. 83. Consider the following steps involved in hammer forging a connecting rod from bar stock :
1. Blocking 2. Trimming 3. Finishing
4. Fullering 5. Edging
Which of the following is the correct sequence of operations ?
(*a*) 1, 4, 3, 2 and 5 (*b*) 4, 5, 1, 3 and 2
(*c*) 5, 4, 3, 2 and 1 (*d*) 5, 1, 4, 2 and 3

Ans. (*b*)

Q. 84. The graph shows the results of various quality levels for a component.



Consider the following statements :
1. Curve A shows the variation of value of component.
2. Curve B shows the variation of cost of the component.
3. Graph is called as fish bone diagram.
4. The preferred level of quality is given by line CC.
5. The preferred level of quality is given by line DD.
Which of the above statements are correct ?
(*a*) 1, 2 and 5 (*b*) 1, 3 and 4 (*c*) 2, 3 and 4 (*d*) 1, 2 and 4

Ans. (*d*)

Q. 85. The primal of a LP problem is maximization of objective function with 6 variables and 2 constraints.
Which of the following correspond to the dual of the problem stated ?
1. It has 2 variables and 6 constraints.
2. It has 6 variables and 2 constraints.
3. Maximisation of objective function.
4. Minimisation of objective function.
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. 86. Consider the following statements regarding updating of the network :
1. For short duration project, updating is done frequently.
2. For large duration project, frequency of updating is decreased as the project is nearing completion.

3. Updating is caused by overestimated or underestimated times of activities.
4. The outbreak of natural calamity necessitates updating.

Which of the above 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. 87. Match List-I (Kinematic pairs) with List-II (Practical example) and select the correct answer using the codes given below the lists :

List I (Kinematic pairs)	*List II (Practical example)*
A. Sliding pair	1. A road roller rolling over the ground
B. Revolute pair	2. Crank shaft in a journal bearing in an engine
C. Rolling pair	3. Ball and socket joint
D. Spherical pair	4. Piston and cylinder
	5. Nut and screw

Codes :

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

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

Ans. (*d*)

Q. 88. Match List-I (Mechanism) with List-II (Motion) and select the correct answer using the codes given below the lists :

List I (Mechanism)	*List II (Motion)*
A. Hart mechanism	1. Quick return motion
B. Pantograph	2. Copying mechanism
C. Whitworth mechanism	3. Exact straight line motion
D. Scotch yoke	4. Simple harmonic motion
	5. Approximate straight line motion

Codes :

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

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

Ans. (*b*)

Q. 89. Match List-I (Connecting shafts) with List-II (Couplings) and select the correct answer using the codes given below the lists :

List I (Connecting shaft)	*List II (Couplings)*
A. In perfect alignment	1. Oldham coupling
B. With angular misalignment of 10°	2. Rigid coupling
C. Shafts with parallel misalignment	3. Universal joint
D. Where one of the shafts may undergo more deflection with respect to the other	4. Pin type flexible coupling

Codes :

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

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

Ans. (*c*)

Q. 90. Match List-I (Bearings) with List-II (Load type) and select the correct answer using the codes given below the lists :

List I (Bearings)	*List II (Load type)*
A. Hydrodynamic Journal bearing	1. High radial and thrust load combined
B. Rectangular Hydrostatic bearing	2. Radial load only
C. Taper Roller bearing	3. Thrust load only
D. Angular contact ball bearing	4. Medium to low radial and thrust combined

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*)

Q. 91. Match List-I (Loaded cylindrical bar) with List-II (Type of fracture) and select the correct answer using the codes given below the lists :

List I (Loaded cylinder bar)	*List II (Type of fracture)*
A. CI bar subjected to tension	1. Cup and Cone
B. CI bar under torsion	2. Granular helicoidal
C. MS bar under torsion	3. Granular plain perpendicular to axis
D. MS bar under tension	4. Smooth plain perpendicular to axis
	5. Granular plain at 45° to axis

Codes :

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

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

Ans. (*a*)

Q. 92. Match List-I (Phase diagram) with List-II (Characteristic) and select the correct answer using the codes given below the lists :

List I (Phase diagram)	*List II (Characteristic)*
A. Isomorphous system	1. One liquid decomposes into another liquid and solid
B. Eutectic system	2. One liquid and another solid combine to form a new solid
C. Peritectic system	3. Two metals are completely soluble in liquid state and completely insoluble in solid state
D. Monotectic system	4. Two metals, soluble in solid and liquid state

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. (*d*)

Q. 93. March List-I (Material) with List-II (Application) and select the correct answer using the codes given below the lists :

List I (Material)	*List II (Application)*
A. Cermics	1. Construction of chemical plants
B. Refractories	2. Columns and pillars
C. Stones	3. Lining of furnaces
D. High silica glass	4. Tiles

Codes :

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

Ans. (*a*)

Q. 94. Match List-I (Ingredients) with List-II (Welding functions) and select the correct answer using the codes given below the lists :

List I (Ingredients)	*List II (Welding functions)*
A. Silica	1. Arc stabilizer
B. Potassium silicate	2. De-oxidizer
C. Ferro silicon	3. Fluxing agent
D. Cellulose	4. Gas forming material

Codes :

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

Ans. (*c*)

Q. 95. Match List-I (Parts) with List-II (Manufacturing processes) and select the correct answer using the codes given below the lists :

List I (Parts)	*List II (Manufacturing processes)*
A. Seamless tubes	1. Roll forming
B. Accurate and smooth tubes	2. Shot peening
C. Surfaces having higher hardness and fatigue strength	3. Forging
	4. Cold forming

Codes :

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

Ans. (*a*)

Q. 96. Match List-I (Machine tools) with List-II (Machine tool parts) and select the correct answer using the codes given below the lists :

List I (Machine tools)	*List II (Machine tool parts)*
A. Lathe	1. Lead screw
B. Milling machine	2. Rocker arm
C. Shaper	3. Universal indexing
D. Drilling machine	4. Flute

Codes :

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

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

Ans. (*b*)

Q. 97. Match List-I (Machine tool) with List-II (Features) and select the correct answer using the codes given below the lists :

List I (Machine tool)	*List II (Features)*
A. Lathe	1. Push or pull tool
B. Drilling machine	2. Rachet and pawl mechanism
C. Shaper	3. Dividing head
D. Broaching machine	4. Hollow tapered spindle
	5. Face plate

Codes :

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

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

Ans. (*d*)

Q. 98. Match List-I (NC machine tool systems) with List-II (Features) and select the correct answer using the codes given below the lists :

List I (NC machine tool systems)	*List II (Features)*
A. NC system	1. It has an integrated automatic tool changing unit and a component indexing device.
B. CNC system	2. A number of machine tools are controlled by a computer. No tape reader, the part programme is transmitted directly to the machine tool from the computer memory.
C. DNC system	3. The controller consists of soft-wired computer and hard-wired logic system. Graphic display of tool path is also possible.
D. Machining centre	4. The instructions on type is prepared in binary decimal form and operated by a series of coded instructions

Codes :

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

Ans. (*a*)

Q. 99. Match List-I (Wage payment plans) with List-II (Method of payment) and select the correct answer using the codes given below the lists :

List I (Wage payment plans)	*List II (Method of payment)*
A. Time based	1. Stock distribution
B. Price rate	2. 100% bonus
C. Gain sharing	3. Taylor differential piece rate
D. Indirect payments	4. Straight salary

Codes :

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

Ans. (*a*)

Q. 100. Match List-I (Files in MRP) with List-II (Inputs required) and select the correct answer using the codes given below the lists :

List I (Files in MRP)	*List II (Inputs required)*
A. Master production schedule	1. Scheduled receipts
B. Bill of materials	2. Unit costs and discounts
C. Inventory records	3. Production capacity
	4. Product structure

Codes :

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

Ans. (*c*)

Q. 101. Match List-I (Limits in normal distribution) with List-II (Population covered) and select the correct answer using the codes given below the lists :

List I (Limits in normal distribution)	*List II (Population covered)*
A. $\pm 3\sigma$	1. 0.3413
B. $\pm 2\sigma$	2. 0.6826
C. $\pm 1\sigma$	3. 0.9973
	4. 0.9545

Codes :

	A	B	C		A	B	C,
(*a*)	3	4	2	(*b*)	3	2	4,
(*c*)	4	2	3	(*d*)	4	3	2,

Ans. (*a*)

Q. 102. Match List-I (2-D Stress system loading) with List-II (Ratio of principal stresses) and select the correct answer using the codes given below the lists :

List I (2-D Stress system loading)	*List II (Ratio of principal stresses)*
A. Thin cylinder under internal pressure	1. 3.0
B. Thin sphere under internal pressure	2. 1.0
C. Shaft subjected to torsion	3. – 1.0
	4. 2.0

Codes :

	A	B	C
(*a*)	4	2	3
(*c*)	4	3	2

	A	B	C,
(*b*)	1	3	2,
(*d*)	1	2	3,

Ans. (*c*)

Q. 103. Match List-I (Persons with whom the models are associated) with List-II (Models) and select the correct answer using the codes given below the lists :

List I (Persons with whom the models are associated)	*List II (Models)*
A. J. Von Newmann	1. Waiting lines
B. G. Dantzig	2. Simulation
C. A.K. Erlang	3. Dynamic programming
D. Richard Bellman	4. Competitive strategies
	5. Allocation by simplex method

Codes :

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

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

Ans. (*b*)

Q. 104. Match List-I (Computer languages) with List-II (Application) and select the correct answer using the codes given below the lists :

List I (Computer languages)	*List II (Application)*
A. COBOL	1. System software
B. FORTRAN	2. System software and other common applications
C. C	3. Business application
D. Assembler	4. Scientific application

Codes :

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

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

Ans. (*a*)

Directions. *The following 16 (sixteen) 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. 105. *Assertion (A)* : An involute rack with 20° pressure angle meshes with a pinion of 14.5° pressure angle.

Reason (R) : Such a matching is impossible.

Ans. (*d*)

Q. 106. *Assertion (A)* : The precession of the axis of rotation of a shaft causes a gyroscopic reaction couple to act on the frame to which the bearings are fixed.

Reason (R) : The reaction of the shaft on each bearing is equal and opposite to the action of the bearing on the shaft.

Ans. (*c*)

Q. 107. *Assertion (A)* : A dynamically balanced system of multiple rotors on a shaft can rotate smoothly at the critical speeds of the system.

Reason (R) : Dynamic balancing eliminates all the unbalanced forces and couples from the system.

Ans. (*d*)

Q. 108. *Assertion (A)* : When a pair of spur gears of the same material is in mesh, the design is based on pinion.

Reason (R) : For a pair of gears of the same material in mesh, the 'strength factor' of the pinion is less than that of the gear.

Ans. (*a*)

Q. 109. *Assertion (A)* : Tapered roller bearings are sensitive to the tightening between inner and outer races.

Reason (R) : Tapered roller bearings are always provided with adjusting nut for tightening.

Ans. (*a*)

Q. 110. *Assertion (A)* : Mohr's circle of stress can be related to Mohr's circle of strain by some constant of proportionality.

Reason (R) : The relationship is a function of yield stress of the material.

Ans. (*a*)

Q. 111. *Assertion (A)* : If the bending moment diagram is a rectangle, it indicates that the beam is loaded by a uniformly distributed moment all along the length.

Reason (R) : The BMD is a representation of internal forces in the beam and not the moment applied on the beam.

Ans. (*c*)

Q. 112. *Assertion (A)* : The hardness test is a slow, expensive method of assessing the mechanical properties of materials.

Reason (R) : The hardness is a function of yield stress and the work hardening rate of material.

Ans. (*d*)

Q. 113. *Assertion (A)* : Negative rake is usually provided on carbide tipped tools.

Reason (R) : Carbide tools are weaker in compression.

Ans. (*c*)

Q. 114. *Assertion (A)* : Slender shafts are turned with tools having an approach angle of 90°.

Reason (R) : Small approach angle, however, results in increased radial component of force which tends to separate the work from the tool thus promoting chatter.

Ans. (*b*)

Q. 115. *Assertion (A)* : Virtually all modern milling machines are capable of doing down-milling.

Reason (R) : In down-milling the cutter tends to push the work along and lift it upward from the table. This action tends to eliminate any effect in looseness in the feed screw and nut of the milling machine table and results in smooth cut.

Ans. (*a*)

Q. 116. *Assertion (A)* : In ECM, the shape of the cavity is the mirror image of the tool, but unlike EDM, the tool wear in ECM is less.

Reason (R) : The tool in ECM is a cathode.

Ans. (*b*)

Q. 117. *Assertion (A)* : In CO_2 casting process, the mould or core attains maximum strength.

Reason (R) : The optimum gassing time of CO_2 through the mould or core forms Silica Gel which imparts sufficient strength to the mould or core.

Ans. (*a*)

Q. 118. *Assertion (A)* : Job enrichment increases the job satisfaction of the employee.

Reason (R) : The jobs of wireman and lineman doing indoor and outdoor works respectively can be integrated for better results.

Ans. (*c*)

Q. 119. *Assertion (A)* : The change in critical path requires rescheduling in a PERT network.

Reason (R) : Some of the activities cannot be completed in time due to unexpected breakdown of equipments or non-availability of raw materials.

Ans. (*a*)

Q. 120. *Assertion (A)* : Function statement in a FORTRAN program is given in terms of parameters.

Reason (R) : Function statements in a FORTRAN program can be shared by two subroutines in a program.

Ans. (*b*)

MECHANICAL ENGINEERING - 2003
(OBJECTIVE PAPER—I)

Q. 1. Euler equation of turbine giving energy transfer per unit mass E_0 (where U, V_w, V_r and V represents the peripheral, whirl, relative and absolute velocities respectively. Suffix 1 and 2 refer to the turbine inlet and outlet respectively) is given by

(*a*) $E_0 = U_1 V_{w1} - U_2 V_{w2}$ (*b*) $E_0 = U_1 V_{r1} - U_2 V_{r2}$

(*c*) $E_0 = U_1 V_1 - U_2 V_2$ (*d*) $E_0 = U_1 V_{w1} - V_2 V_{w2}$

Ans. (*a*) $E_0 = U_1 V_{w1} - U_2 V_{w2}$

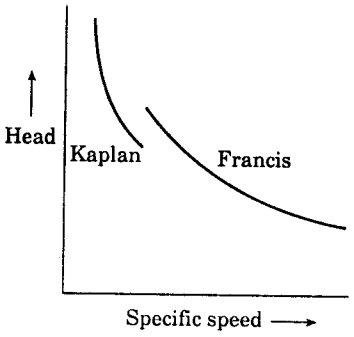
Q. 2. The power ratio of a pump and its 1/4th scale model, if the ratio of the heads of 5 : 1, will be

(*a*) 100 (*b*) 3.2 (*c*) 179 (*d*) 12.8

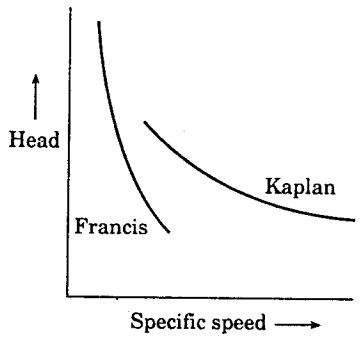
Ans. (*a*) Power ratio of pump $\propto$ head$^2 \times$ Dimension $\propto 5^2 \times 4 = 100$

Q. 3. Which one of the following graphs correctly represents the relations between Head and Specific speed for Kaplan and Francis turbine

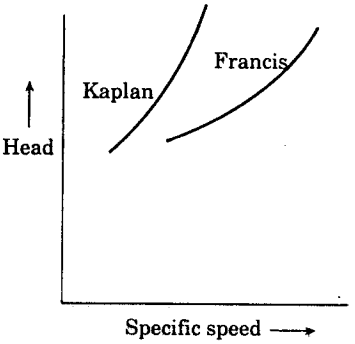
(*a*)



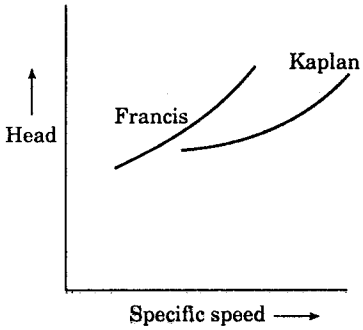
(*b*)



(*c*)



(*d*)



Ans. (*a*) Specific speed of Kaplan turbine is in higher range compared to Francis and specific speed decreases with increase in head.

Q. 4. Consider the following statements regarding air vessels provided in reciprocating pump installations:

1. The air vessels are fitted both on suction and delivery sides.
2. The air vessels are fitted far from the pump cylinder.
3. The air vessels save energy by reducing the friction loss.

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*) (2) is not correct as air vessels are fitted close to pump cylinder.

Q. 5. A pump is installed at a height of 5 m above the water level in the sump. Frictional loss on the suction side is 0.6 m. If the atmospheric pressure is 10.3 m of water and vapour pressure head is 0.4 m (abs), the NPSH (Net Positive Suction Head) will be

(*a*) 3.7 m (*b*) 4 m (*c*) 4.3 m (*d*) 4.6 m

Ans. (*c*) NPSH = 10.3 – 5 – 0.6 – 0.4 = 4.3 m

Q. 6. Priming is necessary in

(*a*) Centrifugal pumps to lift water from a greater depth

(*b*) Centrifugal pumps to remove air in the suction pipe and casing

(*c*) Hydraulic turbine to remove air in the turbine casing

(*d*) Hydraulic turbine to increase the speed of turbine and to generate more power

Ans. (*b*)

Q. 7. An accumulator is a device to store

(*a*) Sufficient quantity of liquid to compensate the change in discharge

(*b*) Sufficient energy to drive the machine when the normal energy source does not function

(*c*) Sufficient energy in case of machines which work intermittently to supplement the discharge from the normal source

(*d*) Liquid which otherwise would have gone to waste

Ans. (*a*)

Q. 8. The draught in locomotive boilers is produced by

(*a*) Chimney (*b*) Centrifugal fan (*c*) Steam jet (*d*) Locomotion

Ans. (*c*) Draught in locomotive boilers is produced by steam jet.

Q. 9. Match *List I (Boilers)* with *List II (Type/Description)* and select the correct answer using the codes given below the Lists :

List I (Boilers)	*List II (Type/Description)*
A. Lancashire	1. Horizontal straight tube, fire-tube boiler
B. Benson	2. Horizontal straight tube, water-tube boiler
C. Babcock and Wilcox	3. Bent tube, water-tube boiler
D. Stirling	4. High pressure boiler

Codes :

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

Ans. (*b*) A-1, B-4, C-2, D-3

Q. 10. Consider the following statements regarding the fluidized bed combustion boilers :

1. The combustion temperatures are low, around 900°C.
2. The formation of oxides of nitrogen is low.
3. It removes sulphur from coal during combustion process.
4. It requires high quality of coal as fuel.

Which of these statements are correct ?

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

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

Ans. (*b*) Fluidised bed combustion boiler can burn any type of fuel.

Q. 11. The correct gas flow path in a typical large modern natural circulation boiler is

(*a*) Combustion chamber - Reheater - Superheater - Economiser - Air Preheater - I.D. fan - Electrostatic precipitator - Stack

(*b*) Combustion chamber - Superheater - Reheater - Economiser - Air Preheater - Electrostatic precipitator - I. D. fan - Stack

(*c*) Combustion chamber - Reheater - Superheater - Air Preheater - Economiser - Electrostatic precipitator - I.D. fan - Stack

(*d*) Combustion chamber - Superheater - Reheater - Economiser - Air Preheater - I.D. fan - Electrostatic precipitator - Stack

Ans. (*b*)

Q. 12. Employing superheater steam in turbines leads to

(*a*) Increase in erosion of blading (*b*) Decrease in erosion of blading

(*c*) No erosion in blading (*d*) No change in erosion of blading

Ans. (*b*)

Q. 13. Steam enters a De laval steam turbine with an inlet velocity of 30 m/s and leaves with an outlet velocity of 10 m/s. The work done by 1 kg of steam is

(*a*) 400 Nm (*b*) 600 Nm (*c*) 800 Nm (*d*) 1200 Nm

Ans. (*b*) Work done $= 1 \times \frac{30}{2} \times (30 + 10) = 600$ Nm

Q. 14. In a 50% reaction stage, absolute velocity angle at inlet is 45°, mean peripheral speed is 75 m/s and the absolute velocity at the exit is axial. The stage specific work is

(*a*) 2500 m^2/s^2 (*b*) 3270 m^2/s^2

(*c*) 4375 m^2/s^2 (*d*) 5625 m^2/s^2

Ans. (*d*) In 50% reaction stage, if absolute velocity at exit is axial, then $V_b = V_w$ and stage specific work is $V_b V_w = 75 \times 75 = 5625$ m^2/s^2

Q. 15. In a reaction turbine stage enthalpy drop in the stator blades is 4.62 kJ/kg and that in the rotor blades is 2.38 kJ/kg. The degree of reaction of the stage is

(*a*) 0.52 (*b*) 0.43 (*c*) 0.34 (*d*) 0.26

Ans. (*c*) Degree of reaction $= \frac{\Delta h_r}{\Delta h_r + \Delta h_s} = \frac{2.38}{2.38 + 4.62} = 0.34$

Q. 16. An emergency governor of a steam turbine trips the turbine when

1. Shaft exceeds 100% of its rated speed

2. Condenser becomes hot due to inadequate cooling water circulation
3. Lubrication system fails
4. Balancing of turbine is not proper

Select the correct answer from the codes given below :

Codes :

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

Ans. (*a*) If balancing of turbine is not proper, it has to be taken care of initially. When turbine is in motion, any balancing problem will result in vibration and action is left to operator, but emergency governor does not trip the turbine.

Q. 17. Roots blower is an example of

(*a*) Reciprocating (positive displacement) compressor
(*b*) Rotary (positive displacement) compressor
(*c*) Centrifugal compressor
(*d*) Axial compressor

Ans. (*b*) Roots blower is a rotary (positive displacement) compressor

Q. 18. Acoustic velocity in an elastic gaseous medium is proportional to

(*a*) Absolute temperature (*b*) Stagnation temperature
(*c*) Square root of absolute temperature (*d*) Square root of stagnation temperature

Ans. (*c*)

Q. 19. In a regenerative feed heating cycle, the economic number of the stages of regeneration

(*a*) increases as the initial pressure and temperature increase
(*b*) decreases as the initial pressure and temperature increase
(*c*) is independent of the initial pressure and temperature
(*d*) depends only on the condenser pressure.

Ans. (*a*)

Q. 20. Match *List I* (*Blades*) with *List II* (*Features*) and select the correct answer using the codes given below the Lists :

List I (*Blades*)	*List II* (*Features*)
A. Ceramic blades	1. High creep strength
B. Steam turbine blades	2. Forged and machined
C. Alloy steel blades	3. Precision cast
D. Compressor blades	4. Thick at mid chord
	5. Thin trailing edge.

Codes :

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

Ans. (*d*) A-3, B-2, C-1, D-5

Directions : The following seventeen (17) items consist of two statements : one labelled as the 'Assertion (A)' and the other as 'Reason (R)'. You are to examine these two statements carefully and select the answers to these items using the codes given below :

Codes :

(*a*) Both A and R are individually true and R is the correct explanation of A

(*b*) Both A and R are individually 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

Ans. (*d*) A-3, B-2, C-1, D-5

Q. 21. *Assertion (A)* : Throttling process for real gases at initial temperature higher than maximum inversion temperature is accompanied by decrease in temperature of the gas.

Reason (R) : Joule - Kelvin coefficient μj is given by $(\partial T/\partial p)_h$ and should have a positive value for decrease in temperature during throttling process.

Ans. (*a*)

Q. 22. *Assertion (A)* : An ideal regenerative Rankine cycle power plant with saturated steam at the inlet to the turbine has same thermal efficiency as Carnot cycle working between the same temperature limits.

Reason (R) : The change in entropy of steam during expansion in the turbine is equal to the change in entropy of the feed water during sensible heating at steam generator pressure.

Ans. (*a*)

Q. 23. *Assertion (A)* : Octane number is used for rating of fuels in spark ignition engine.

Reason (R) : Octane number of a fuel is defined as percentage by volume, of isooctane in a mixture of iso-octane and α-methyl napthalene.

Ans. (*b*)

Q. 24. *Assertion (A)* : Power generated by a four stroke engine working on Otto cycle is higher than the power generated by a two stroke engine for the same swept volume, speed, temperature and pressure conditions.

Reason (R) : In a four stroke engine one cycle is completed in two revolutions.

Ans. (*d*) For same swept volume, speed, temperature and pressure condition, two stroke engine generates more power than four stroke engine.

Q. 25. *Assertion (A)* : A counter flow heat exchanger is thermodynamically more efficient than the parallel flow type.

Reason (R) : A counter flow heat exchanger has a lower LMTD for the same temperature conditions.

Ans. (*c*) For counter flow heat exchanger, LMTD is higher compared to parallel flow for same temperature conditions.

Q. 26. *Assertion (A)* : If the heat flux in pool boiling over a horizontal surface is increased above the critical heat flux, the temperature difference between the surface and liquid decreases sharply.

Reason (R) : With increasing heat flux beyond the value corresponding to the critical heat flux, a state is reached when the rate of formation of bubbles is so high that they start to coalesce and blanket the surface with a vapour film.

Ans. (*a*)

Q. 27. *Assertion (A)* : Decrease of pressure and increase of temperature of the refrigerant in the suction pipeline connecting the evaporator to the reciprocating compressor reduces the refrigerating capacity of the system.

Reason (R) : Decrease of pressure and increase of temperature of the refrigerant in the suction pipeline connecting the evaporator to the compressor reduces the volumetric efficiency of the reciprocating compressor.

Ans. (*c*) Volumetric efficiency of reciprocating compressor is function of clearance volume and volume ratio.

Q. 28. *Assertion (A)* : For a vertically immersed surface, the depth of the centre of pressure is independent of the density of the liquid.
Reason (R) : Centre of pressure lies above the centre of area of the immersed surface.

Ans. (*c*) Centre of pressure lies below the centre of area of immersed body.

Q. 29. *Assertion (A)* : Streamlines can cross one another if the fluid has higher velocity.
Reason (R) : At sufficiently high velocity, the Reynolds number is high and at sufficiently high Reynolds numbers, the structure of the flow is of turbulent type.

Ans. (*a*)

Q. 30. *Assertion (A)* : After the fluid has re-established its flow pattern downstream of an orifice plate, it will return to same pressure that it had upstream of the orifice plate.
Reason (R) : Bernoulli's equation when applied between two points having the same elevation and same velocity gives the same pressure at these points.

Ans. (*a*)

Q. 31. *Assertion (A)* : Aircraft wings are slotted to control separation of boundary layer especially at large angles of attack.
Reason (R) : This helps to increase the lift and the aircraft can take off from, and land on short runways.

Ans. (*a*)

Q. 32. *Assertion (A)* : Reynolds number must be same for the model and prototype immersed in subsonic flows.
Reason (R) : Equality of Reynolds number for the model and prototype satisfies the dynamic similarity criteria.

Ans. (*a*)

Q. 33. *Assertion (A)* : A normal shock always makes a supersonic flow of a compressible fluid subsonic, but an oblique shock may not ensure subsonic flow after the shock.
Reason (R) : A normal shock reduces the stagnation pressure and stagnation enthalpy considerably whereas the loss at oblique shock is minimized.

Ans. (*a*)

Q. 34. *Assertion (A)* : Multi-stage centrifugal pumps are only of the radial flow type.
Reason (R) : In a multi-stage centrifugal pump, two or more impellers are keyed to a single shaft and enclosed in the same casing, the radial inlet to successive impellers being made through guide vanes.

Ans. (*b*)

Q. 35. *Assertion (A)* : Large reaction turbines have higher overall efficiency than the small reaction turbines.
Reason (R) : The mechanical efficiency of small reaction turbines is higher than that of larger ones.

Ans. (*c*)

Q. 36. *Assertion (A)* : Impulse staging is commonly employed in high pressure part and reaction staging in intermediate low pressure parts of the steam turbine.

Reason (R) : The tip leakage across moving blades is less in impulse staging as the pressure drop is small and there can be large pressure drop across fixed blades and nozzles.

Ans. (*a*)

Q. 37. *Assertion (A)* : In constant pressure type gas turbines, large quantity of air is used, in excess of its combustion requirements.

Reason (R) : Excess air is used to compensate for inevitable air-loss due to leakages in the system.

Ans. (*c*)

Q. 38. A heat pump for domestic heating operates between a cold system at 0°C and the hot system at 60°C. What is the minimum electric power consumption if the heat rejected is 80000 kJ/hr ?

(*a*) 2 kW (*b*) 3 kW (*c*) 4 kW (*d*) 5 kW

Ans. (*a*) $\text{COP} = \dfrac{T_1}{T_2 - T_1} = \dfrac{273}{60} = 4.55$

$$\text{COP} = \frac{\text{Refrigeration effect}}{\text{Work input}} = \frac{\text{Heat rejected} - \text{Work input(W)}}{\text{Work input(W)}} = \frac{80000 - w}{w}$$

$$5.55\, w = 80000,\ w = \frac{80000}{5.55 \times 3600} = 2 \text{ kW}.$$

Q. 39. A Carnot refrigerator requires 1.5 kW/ton of refrigeration to maintain a region at a temperature of − 30°C. The C. O. P. of the Carnot refrigerator is

(*a*) 1.42 (*b*) 2.33 (*c*) 2.87 (*d*) 3.26

Ans. (*b*) $T_1 = 273 - 30 = 243°\text{K}$

$$\text{COP} = \frac{\text{Heat absorbed}}{\text{Work done}} = \frac{1 \text{ ton}}{1.5 \text{ kW}} = \frac{210 \text{ kJ/min}}{1.5 \times 60 \text{ kJ/min}} = 2.33$$

Q. 40. In a standard dual air cycle, for a fixed amount of heat supplied and a fixed value of compression ratio, the mean effective pressure

(*a*) Shall increase with increase in r_p (pressure ratio for constant volume heating) and decrease in r_c (constant pressure cut-off ratio)

(*b*) Shall increase with decrease in r_p and increase in r_c

(*c*) Shall remain independent of r_p

(*d*) Shall remain independent of r_c

Ans. (*a*)

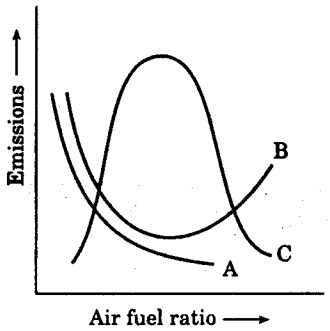
Q. 41. Bomb calorimeter is used to determine the calorific value of

(*a*) Solid fuel only (*b*) Gaseous fuels only

(*c*) Solid as well as gaseous fuels (*d*) Solid as well as liquid fuels

Ans. (*a*)

Q. 42.



Exhaust emissions vs Air fuel ratio curves for a petrol engine are shown in the above figure. The curve *C* represents

(*a*) Hydro carbon (*b*) Carbon dioxide

(*c*) Carbon monoxide (*d*) Oxides of nitrogen

Ans. (*d*) NO_x emission is maximum corresponding to highest temperature which is maximum at optimum fuel air ratio when specific fuel consumption is least.

Q. 43. Orsat apparatus is used to determine products of

(*a*) All constituents of fuel combustion by mass

(*b*) All constituents of fuel combustion by volume

(*c*) Only dry constituents of combustion by mass

(*d*) Only dry constituents of combustion by volume

Ans. (*b*)

Q. 44. Match *List I* (*Measuring Appliances*) with *List II* (*Properties / Composition of Fuel*) and select the correct answer using the codes given below the Lists :

List I (*Measuring Appliances*)	*List II* (*Properties / Composition of Fuel*)
A. Hydrometer	1. Vapour pressure
B. Bomb calorimeter	2. Composition of products of combustion
C. Reid bomb	3. Specific gravity
D. Orsat apparatus	4. Heating value

Codes :

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

Ans. (*b*) A-3, B-4, C-1, D-2

Q. 45. For a simple closed system of constant composition, the difference between the net heat and work interactions is identifiable as the change in

(*a*) Enthalpy (*b*) Entropy

(*c*) Flow energy (*d*) Internal energy

Ans. (*d*)

Q. 46. If the performance of diesel engines of different sizes, cylinder dimensions and power ratings are to be compared, which of the following parameters can be used for such comparison ?

(*a*) Swept volume (*b*) Air fuel ratio

(*c*) Specific brake fuel consumption (*d*) Volumetric efficiency

Ans. (*c*)

Q. 47. The propulsive efficiency of a turbojet aircraft approaches 100% when the thrust approaches

(*a*) Maximum (*b*) 50% of the maximum

(*c*) 25% of the maximum (*d*) Zero

Ans. (*d*)

Q. 48. Identify the process for which the two intergrals $\int pdv$ and $-\int vdp$, evaluated between any two given states give the same value

(*a*) Isenthalpic (*b*) Isothermal (*c*) Isentropic (*d*) Polytropic

Ans. (*b*)

Q. 49. Which one of the following phenomena occurs when gas in a piston-in-cylinder assembly expands reversibly at constant pressure ?

(*a*) Heat is added to the gas (*b*) Heat is removed from the gas

(*c*) Gas does work from its own stored energy (*d*) Gas undergoes adiabatic expansion

Ans. (*b*)

Q. 50. During steady flow compression process of a gas with mass flow rate of 2 kg / s, increase in specific enthalpy is 15 kJ/kg and decrease in kinetic energy is 2 kJ/kg. The rate of heat rejection to the environment is 3 kW. The power needed to drive the compressor is

(*a*) 23 kW (*b*) 26 kW (*c*) 29 kW (*d*) 37 kW

Ans. (*c*) Power needed = $15 \times 2 - 2 \times 2 + 3 = 29$ kW

Q. 51. Consider the following statements :

1. Zeroth law of thermodynamics is related to temperature.
2. Entropy is related to first law of thermodynamics.
3. Internal energy of an ideal gas is a function of temperature and pressure.
4. Van der Waal's equation is related to an ideal gas.

Which of the above statements is/are correct ?

(*a*) 1 only (*b*) 2, 3 and 4

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

Ans. (*c*)

Q. 52. Gas contained in a closed system consisting of piston cylinder arrangement is expanded. Work done by the gas during expansion is 50 kJ. Decrease in internal energy of the gas during expansion is 30 kJ. Heat transfer during the process is equal to

(*a*) – 20 kJ (*b*) + 20 kJ

(*c*) – 80 kJ (*d*) + 80 kJ

Ans. (*a*) $\delta Q = du + \delta W = -30 + 50 = -20$ kJ

Q. 53. Van der Wall's equation of state is given by $(p + a/v^2)(v - b) = RT$. The constant b in the equation in terms of specific volume at critical point v_c is equal to

(*a*) $v_c/3$ (*b*) $2v_c$

(*c*) $3v_c$ (*d*) $8a/(27v_cR)$

Ans. (*a*)

Q. 54. Saturated liquid at a high pressure p_1 having enthalpy of saturated liquid 1000 kJ/kg is throttled to a lower pressure p_2. At pressure p_2, enthalpy of saturated liquid and that of the saturated vapour are 800 and 2800 kJ / kg respectively. The dryness fraction of vapour after throttling process is

(*a*) 0.1 (*b*) 0.5

(*c*) 18 / 28 (*d*) 0.8

Ans. (*a*) $1000 = 800 + q\,(2800 - 800)$; $q = \dfrac{200}{2000} = 0.1$

Q. 55. Match *List I (Terms)* with *List II (Relations)* and select the correct answer using the codes given below the Lists :

List I (Terms)	*List II (Relations)*
A. Specific heat at constant volume C_v	1. $\frac{1}{v}\left(\frac{\partial v}{\partial T}\right)_p$
B. Isothermal compressibility k_T	2. $T\left(\frac{\partial p}{\partial T}\right)_v\left(\frac{\partial v}{\partial T}\right)_p$
C. Volume expansivity β	3. $-T\left(\frac{\partial s}{\partial T}\right)_v$
D. Difference between specific heats at constant pressure and at constant volume, $C_p - C_v$	4. $-\frac{1}{v}\left(\frac{\partial v}{\partial T}\right)_T$

Codes :

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

Ans. (*c*) A-3, B-4, C-1, D-2

Q. 56. Consider the following statement pertaining to the features of a regenerative steam cycle plant as compared to a non-regenerative plant :

1. It increases the cycle efficiency.
2. It requires a bigger boiler.
3. It requires a small condenser.

Which of the above statements are correct ?

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

(*c*) 2 and 3 (*d*) 1 and 3

Ans. (*d*) For regenerative steam cycle plant, boiler size need not be bigger.

Q. 57. For a steady flow process from state 1 to 2, enthalpy changes from $h_1 = 400$ kJ/kg to $h_2 = 100$ kJ/kg and entropy changes from $s_1 = 1.1$ kJ/kg - k to $s_2 = 0.7$ kJ/kg-K. Surrounding environmental temperature is 300 K. Neglect changes in kinetic and potential energy. The change in availability of the system is

(*a*) 420 kJ/kg (*b*) 300 kJ/kg

(*c*) 180 kJ/kg (*d*) 90 kJ/kg

Ans. (*a*) Change in availability $= (4 - 40) - T_o (S - S_o) = (400 - 100) + 300 (1.1 - 0.7) = 420$ kJ/kg

Q. 58. For a heat engine operating on the Carnot cycle, the work output is 1/4th of the heat transferred to the sink. The efficiency of the engine is

(*a*) 20% (*b*) 33.3% (*c*) 40% (*d*) 50%

Ans. (*a*) $\eta = \frac{Q_1 - Q_2}{Q_1} = \frac{1/4\, Q_2}{Q_1} = \frac{1/4 Q_2}{0.25 Q_2 + Q_2} = \frac{0.25}{1.25} = 20\%$

Q. 59. Consider the following statements about modification in a gas turbine power plant working on a simple Brayton cycle :

1. Incorporation of regeneration process increases specific work output as well as thermal efficiency.
2. Incorporation of regeneration process increases thermal efficiency but specific work output remains unchanged.
3. Incorporation of intercooling process increases in a multistage compression increases specific work output but the heat input also increases.
4. Incorporation of intercooling process in a multi-stage compression system increases specific work output, the heat addition remains unchanged.

Which of the above statements are correct ?

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

(*c*) 2 and 3 (*d*) 2 and 4

Ans. (*d*)

Q. 60. Match *List I* (*Cycles*) with *List II* (*Processes*) and select the correct answer using the codes given below the Lists :

List I (*Cycles*)	*List II* (*Processes*)
A. Bell Coleman cycle	1. One constant pressure, one constant volume and two isentropic
B. Stirling cycle	2. Two constant pressure and two isentropic
C. Ericsson cycle	3. Two constant pressure and two isothermal
D. Diesel cycle	4. Two constant volume and two isothermal

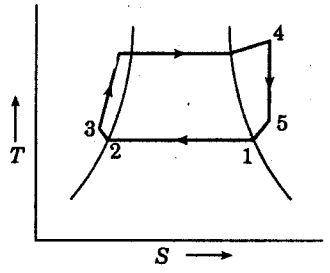
Codes :

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

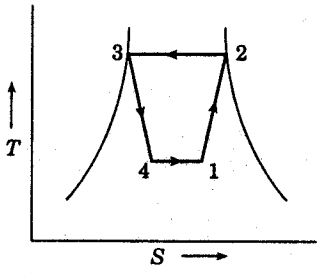
Ans. (*c*) A-2, B-4, C-3, D-1

Q. 61.

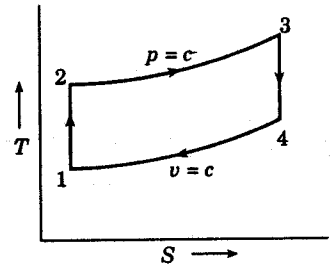
(*a*)



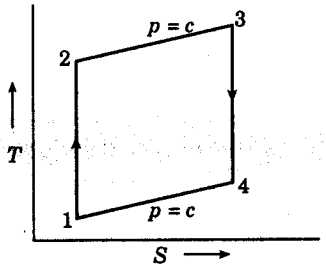
(*b*)



(*c*)



(*d*)



The correct sequence of the cycles given in the above T - S diagrams is

(*a*) Vapour compression refrigeration, Rankine, Diesel, Otto

(*b*) Rankine, Vapour compression refrigeration, Diesel, Brayton

(*c*) Rankine, Carnot, Otto, Brayton

(*d*) Vapour compression refrigeration, Carnot, Diesel, Otto

Ans. (*b*)

Q. 62. The absolute jet exit velocity from a jet engine is 2800 m/s and the forward flight is 1400 m/s. The propulsive efficiency is

(*a*) 33.33% (*b*) 40% (*c*) 66.67% (*d*) 90%

Ans. (*c*) $\eta_p = \frac{2\,Va}{Vj + Va} = \frac{2 \times 1400}{1400 + 2800} = 66.67\%$

Q. 63. The efficiency of jet engine is

(*a*) higher at high speeds (*b*) lower at low speeds

(*c*) higher at high altitudes (*d*) same at all altitudes

Ans. (*a*)

Q. 64. A metal rod of 2 cm diameter has a conductivity of 40 W/m K, which is to be insulated with an insulating material of conductivity of 0.1 W/m K. If the convective heat transfer coefficient with the ambient atmosphere is 5 W/m^2K, the critical thickness of insulation will be

(*a*) 1 cm (*b*) 2 cm (*c*) 7 cm (*d*) 8 cm

Ans. (*b*) Critical thickness of insulation $= \frac{k}{h} = \frac{0.1}{5}$ m = 2 cm

Q. 65. Match *List I* (*Process*) with *List II* (*Pre-dominant parameter Associated with the Process*) and select the correct answer using the codes given below the Lists:

List I (*Process*)	*List II* (*Pre-dominant Parameter Associated with the Process*)
A. Mass transfer	1. Reynolds Number
B. Forced convection	2. Sherwood Number
C. Free convection	3. Mach Number
D. Transient conduction	4. Biot Number
	5. Grashoff Number

Codes :

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

Ans. (*b*) A-2, B-1, C-5, D-4

Q. 66. The velocity and temperature distribution in a pipe flow are given by $u(r)$ and $T(r)$. If u_m is the mean velocity at any section of the pipe, the bulk mean temperature at that section is

(*a*) $\int_0^{r_0} u(r)T(r)r^2 dr$ (*b*) $\int_0^{r_0} \frac{u(r)}{3r} \frac{T(r)}{2r} dr$

(*c*) $\int_0^{r_0} \frac{u(r)\, T(r).\, dr}{2\pi r_0^3}$ (*d*) $\frac{2}{u_m r_0^2}\int_0^{r_0} u(r)(T_r) r\, dr$

Ans. (*a*)

Q. 67. For fully-developed turbulent flow in a pipe with heating, the Nusselt number Nu, varies with Reynolds number Re and Prandtl number Pr as

(*a*) $R_e^{0.5} P_r^{1/3}$ (*b*) $R_e^{0.8} P_r^{0.2}$ (*c*) $R_e^{0.8} P_r^{0.4}$ (*d*) $R_e^{0.8} P_r^{0.3}$

Ans. (*d*)

Q. 68. Consider the following statements in respect of automobile engine with thermosyphon cooling :

1. Heat transfer from gases to cylinder walls takes place by convection and radiation.
2. Most of the heat transfer from radiator to atmosphere takes place by radiation.
3. Most amount of heat transfer from radiator to atmosphere takes place by convection.
4. Heat transfer from cylinder walls takes place by conduction and convection.

Which of the above statements are correct ?

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

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

Ans. (*b*)

Q. 69. A body at 500 K cools by radiating heat to ambient atmosphere maintained at 300 K. When the body has cooled to 400 K, the cooling rate as a percentage of original cooling rate is about

(*a*) 31.1 (*b*) 41.5 (*c*) 50.3 (*d*) 80.4

Ans. (*b*)

Q. 70. Fraction of radiative energy leaving one surface that strikes the other surface is called

(*a*) Radiative flux (*b*) Emissive power of the first surface

(*c*) View factor (*d*) Re-radiation flux

Ans. (*b*)

Q. 71. A finned surface consists of root or base area of 1 m^2 and fin surface area of 2 m^2. The average heat transfer coefficient for finned surface is 20 W/m^2 K. Effectiveness of fins provided is 0.75. If finned surface with root or base temperature of 50°C is transferring heat to a fluid at 30°C, then rate of heat transfer is

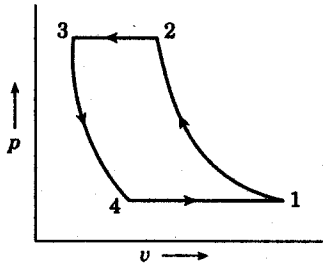
(*a*) 400 W (*b*) 800 W

(*c*) 1000 W (*d*) 1200 W

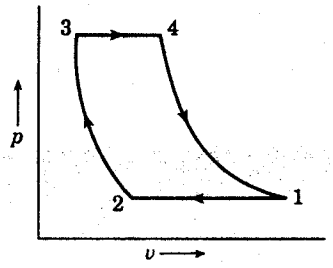
Ans. (*c*)

Q. 72. Which one of the following is the p-v diagram for air refrigeration cycle ?

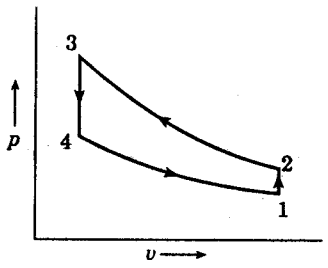
(*a*)



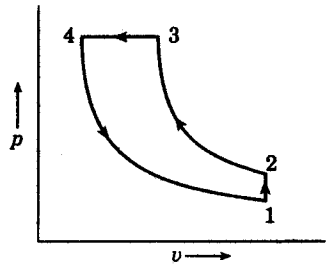
(*b*)



(c)



(d)



Ans. (*a*)

Q. 73. Match *List I* (*Process*) with *List II* (*Type*) for Bell Coleman or Joule or Reverse Brayton cycle for gas cycle refrigeration and select the correct answer using the codes given below the Lists :

List I (*Process*)	*List II* (*Type*)
A. Compression	1. Isobaric
B. Heat rejection	2. Isothermal
C. Expansion	3. Isentropic
D. Heat absorption	4. Isenthalpic

Codes :

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

Ans. (*a*)

Q. 74. Consider the following statements in respect of absorption refrigeration and vapour compression refrigeration systems :

1. The former runs on low grade energy.
2. The pumping work in the former is negligible since specific volume of strong liquid solution is small.
3. The latter uses an absorber while former uses a generator.
4. The liquid pump alone replaces compressor of the latter.

Which of these statements are correct ?

(*a*) 1 and 2 (*b*) 1 and 3

(*c*) 1 and 4 (*d*) 2 and 4

Ans. (*a*)

Q. 75. In a two-stage compressor with ideal intercooling, for the work requirement to be minimum, the intermediate pressure p_i in terms of condenser and evaporator pressure p_c and p_e respectively is

(*a*) $p_i = p_c p_e$ (*b*) $p_i = \sqrt{p_c p_e}$

(*c*) $p_i = \sqrt{p_c / p_e}$ (*d*) $p_i = p_c / p_e$

Ans. (*b*)

Q. 76. In a one ton capacity water cooler, water enters at 30°C at the rate of 200 litres per hour. The outlet temperature of water will be (sp. heat of water = 4.18 kJ/kg K)

(*a*) 3.5°C (*b*) 6.3°C (*c*) 23.7°C (*d*) 15°C

Ans. (*d*) 1 Ton of refrigeration $= 210$ kJ/min $= \frac{200}{60} \times (30 - t) \times 4.18$; $30 - t = 15, t = 15°C$

Q. 77. A refrigerator working on a reversed Carnot cycle has a C.O.P. of 4. If it works as a heat pump and consumes 1 kW, the heating effect will be

(*a*) 1 kW (*b*) 4 kW

(*c*) 5 kW (*d*) 6 kW

Ans. (*b*) $COP = \frac{\text{heat rejected}}{\text{work done}}$, $4 = \frac{\text{heat}}{1}$, heating effect = 4 kW

Q. 78. Theoretical maximum C.O.P. of a vapour absorption system (where T_G = generator temp. T_E = evaporator temp, T_O = environmental temp.) is

(*a*) $\frac{T_E}{T_G}\left(\frac{T_G - T_O}{T_O - T_E}\right)$ (*b*) $\frac{T_E}{T_G}\left(\frac{T_O - T_E}{T_G - T_O}\right)$

(*c*) $\frac{T_G}{T_E}\left(\frac{T_G - T_O}{T_O - T_E}\right)$ (*d*) $\frac{T_G}{T_E}\left(\frac{T_O - T_E}{T_G - T_O}\right)$

Ans. (*a*)

Q. 79. When a refrigerator system is started from ambient conditions, the evaporator temperature decreases from ambient temperature to design value. This period is known as a pull-down period. The power requirement of compressor during pull-down.

(*a*) decreases continuously (*b*) increases continuously

(*c*) remains constant (*d*) increases and then decreases

Ans. (*c*) Compressor does same work and cooling effect goes produced goes on lowering temperature

Q. 80. Oil separator is NOT required in refrigeration system if

(*a*) refrigerant and oil are immiscible at all pressures and temperatures

(*b*) refrigerant and oil are immiscible at condensation pressure and temperature

(*c*) refrigerant and oil are miscible at all pressures and temperatures

(*d*) refrigerant and oil are miscible at condensation pressures and temperature

Ans. (*d*)

Q. 81. For a circular channel, the wetted parameter (where R = radius of circular channel, θ = half the angle substended by the water surface at the centre) is given by

(*a*) $R\,\theta/2$ (*b*) $3R\,\theta$

(*c*) $2R\,\theta$ (*d*) $R\,\theta$

Ans. (*c*)

Q. 82. Consider the following statements : A hydraulic jump occurs in an open channel,

1. when the Froude number is equal to or less than one.
2. at the toe of a spillway.
3. downstream of a sluice gate in a canal.
4. when the bed slope suddenly changes.

Which of these are correct ?

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

Ans. (*c*)

Q. 83. An orifice meter with $C_d = 0.61$ is substituted by venturimeter with $C_d = 0.98$ in a pipeline carrying crude oil, having the same throat diameter as that of the orifice. For the same flow rate, the ratio of the pressure drops for the venturimeter and the orifice meter is

(*a*) 0.61/0.98 (*b*) $(0.61)^2/(0.98)^2$

(*c*) 0.98/0.61 (*d*) $(0.98)^2/(0.61)^2$

Ans. (*d*)

Q. 84. The instrument preferred in the measurement of highly fluctuating velocities in air flows is

(*a*) Pitot-static tube

(*b*) Propeller type anemometer

(*c*) Three cum anemometer

(*d*) Hot wire anemometer

Ans. (*d*) For measurement of highly fluctuating parameter, there should be no moving parts in measuring instrument.

Q. 85. The friction factor for fully developed turbulent flow through a rough circular pipe depends on

(*a*) Reynolds number (*b*) Relative roughness

(*c*) Reynolds number and relative roughness

(*d*) Reynolds number, relative roughness and diameter to length ratio

Ans. (*d*)

Q. 86. In a steady flow of an oil in a pipe in the fully developed laminar regime, the shear stress is

(*a*) Constant across the pipe

(*b*) Maximum at the centre and decreases parabolically towards the pipe wall boundary

(*c*) Zero at the boundary and increases linearly towards the centre

(*d*) Zero at the centre and increases towards the pipe wall

Ans. (*b*)

Q. 87. Velocity of pressure waves due to pressure disturbances imposed in a liquid is equal to

(*a*) $\left(\frac{E}{\rho}\right)^{1/2}$ (*b*) $(E\rho)^{1/2}$ (*c*) $\left(\frac{\rho}{E}\right)^{1/2}$ (*d*) $\left(\frac{1}{\rho E}\right)^{1/2}$

Ans. (*a*)

Q. 88. Consider the following statements pertaining to boundary layer :

1. Boundary layer is a thin layer adjacent to the boundary where maximum viscous energy dissipation takes lace.
2. Boundary layer thickness is a thickness by which the ideal flow is shifted.
3. Separation of boundary layer is caused by presence of adverse pressure gradient.

Which of these statements are correct ?

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

Ans. (*a*)

Q. 89. The velocity profile for turbulent layer over a flat plate is

(*a*) $\frac{u}{U} = \sin\left(\frac{\pi}{2} - \frac{y}{\delta}\right)$ (*b*) $\frac{u}{U} = \left(\frac{y}{\delta}\right)^{1/7}$

(*c*) $\frac{u}{U}=2\left(\frac{y}{\delta}\right)-\left(\frac{y}{\delta}\right)^2$ (*d*) $\frac{u}{U}=\frac{3}{2}\left(\frac{y}{\delta}\right)-\frac{1}{2}\left(\frac{y}{\delta}\right)^3$

Ans. (*b*)

Q. 90. Match *List I* (*Flows Over or Inside the systems*) with *List II* (*Type of Flow*) and select the correct answer using the codes given below the Lists :

List I (*Flows Over or Inside the systems*)	*List II* (*Type of Flow*)
A. Flow over a sphere	1. Two dimensional flow
B. Flow over a long circular cylinder	2. One dimensional flow
C. Flow in a pipe bend	3. Axisymmetric flow
D. Fully developed flow in a pipe at constant flow rate	4. Three dimensional flow

Codes :

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

Ans. (*c*) A-1, B-4, C-2, D-3

Q. 91. Consider the following statements :

1. Dimensional analysis is used to determine the number of variables involved in a certain phenomenon.
2. The group of repeating variables in dimensional analysis should include all the fundamental units.
3. Buckingham's π theorem stipulates the number of dimensionless groups for a given phenomenon.
4. The coefficient in Cheyzy's equation has no dimension.

Which of these are correct ?

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

(*c*) 1 and 4 (*d*) 2 and 4

Ans. (*a*)

Q. 92. Match *List I* (*Flow / Wave*) with *List II* (*Dimensionless Number*) and select the correct answer using the codes given below the Lists :

List I (*Flow / Wave*)	*List II* (*Dimensionless Number*)
A. Capillary waves in channel	1. Reynolds number
B. Testing of aerofoils	2. Froud number
C. Flow around bridge piers	3. Weber number
D. Turbulent flow through pipes	4. Euler number
	5. Mach Number

Codes :

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

Ans. (*d*)

Q. 93. Consider the following statements :

1. Complete similarity between model and prototype envisages geometric and dynamic similarities only.
2. Distorted models are necessary where geometric similarity is not possible due to practical reasons.
3. In testing of model of a ship, the surface tension forces are generally neglected.
4. The scale effect takes care of the effect of dissimilarity between model and prototype.

Which of these statements are correct ?

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

(*c*) 2 and 3 (*d*) 2 and 4

Ans. (*a*)

Q. 94. The fluid property that remains unchanged across a normal shock wave is

(*a*) Stagnation enthalpy (*b*) Stagnation pressure

(*c*) Static pressure (*d*) Mass density

Ans. (*d*)

Q. 95. Match *List I* (*Phenomena*) with *List II* (*Causes*) and select the correct answer using the codes given below the Lists :

List I (*Phenomena*)	*List II* (*Causes*)
A. Shock wave	1. Surface tension
B. Flow separation	2. Vapour pressure
C. Capillary rise	3. Compressibility
D. Cavitation	4. Adverse pressure gradient

Codes :

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

Ans. (*c*) A-3, B-4, C-1, D-2

Q. 96. Consider the following statements pertaining to one-dimensional isentropic flow in a convergent divergent passage :

1. A convergent - divergent passage may function as a supersonic nozzle or a venturi depending on the back pressure.
2. At the throat, sonic conditions exist for subsonic or super-sonic flow at the outlet.
3. A supersonic nozzle discharges fluid at constant rate even if the exit pressure is lower than the design pressure.
4. A normal shock appears in the diverging section of the nozzle if the back pressure is above the design pressure but below a certain minimum pressure for venturi operation.

Which of these statements are correct ?

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

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

Ans. (*b*) At throat sonic condition does not exist for all subsonic flows.

Q. 97. Two pelton wheels A and B have the same specific speed and are working under the same head. Wheel A produces 400 kW at 1000 rpm. If B produces 100 kW, then its rpm is

(*a*) 4000 (*b*) 2000 (*c*) 1500 (*d*) 1250

Ans. (*b*)

Q. 98. On the assumption that a double suction impeller is the equivalent of two single suction impellers placed back to back, it is customary to base the specific speed of the double suction pump on

(*a*) One half of the total capacity (*b*) Three fourth of the total capacity

(*c*) Full total capacity (*d*) Double the total capacity

Ans. (*c*)

Q. 99. Consider the following types of water turbines :

1. Bulb 2. Francis 3. Kaplan 4. Pelton

The correct sequence of order in which the operating head decreases while developing the same power is

(*a*) 4 - 2 - 3 - 1 (*b*) 3 - 4 - 1 - 2

(*c*) 2 - 1 - 4 - 3 (*d*) 1 - 3 - 2 - 4

Ans. (*a*)

Q. 100. Match *List I* (*Type of Pumps*) with *List II* (*Associated Features*) and select the correct answer using the codes given below the Lists :

List I (*Type of Pumps*)	*List II* (*Associated Features*)
A. Centrifugal pump	1. Air vessel
B. Gear pump	2. Draft tube
C. Reciprocating pump	3. Guide vanes
D. Turbine pump	4. Rotary pump
	5. Rotor having blades

Codes :

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

Ans. (*b*)

Q. 101. Match *List I* (*Industrial Needs*) with *List II* (*Type of Pump*) and select the correct answer using the codes given below the Lists :

List I (*Industrial Needs*)	*List II* (*Type of Pump*)
A. Combustible fluid to be pumped	1. Single stage centrifugal
B. High head but small discharge needed	2. Multi-stage centrifugal
C. Low head but large discharge needed	3. Positive displacement
D. High head and high discharge needed	4. Jet pump

Codes :

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

Ans. (*b*)

Q. 102. Consider the following energies associated with a Pelton turbine :

1. Mechanical energy
2. Kinetic energy
3. Potential energy

The correct sequence of energy conversion starting from the entry of fluid is

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

Ans. (*c*)

Q. 103. If the volume of moist air with 50% relative humidity is isothermally reduced to half its original volume, then relative humidity of moist air becomes

(*a*) 25% (*b*) 60% (*c*) 75% (*d*) 100%

Ans. (*d*) With volume being halved, moisture content is same. Therefore relative humidity will be 100%.

Q. 104. When the wet and dry bulb temperatures are identical, which of the following statements is/are true ?

1. Air is fully saturated
2. Dew point temperature is reached
3. Humidity ratio is unity
4. Partial pressure of vapour equals total pressure

Select the correct answer from the codes given below :

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

Ans. (*b*)

Q. 105. In a cooling tower the sum of range and approach is equal to twice the wet bulb depression. Then

(*a*) Dry bulb temperature is mean of water inlet tempreature and wet bulb temperature

(*b*) Dry bulb temperature is mean of water outlet temperature and wet bulb temperature

(*c*) Water inlet temperature is mean of dry bulb temperature and wet bulb temperature

(*d*) Water inlet temperature is mean of water outlet temperature and wet bulb temperature

Ans. (*a*) (hot water in – cold water out) + (cold water out – wet bulb temp.) = 2 (dry air temp. – wet bulb temp); dry air temp = $\frac{\text{hot water in + wet bulb temp}}{2}$

Q. 106. Which of the following properties increase(s) during sensible heating of air-water vapour mixture?

1. Relative humidity
2. Humidity ratio
3. Wet bulb temperature
4. Specific enthalpy of air - vapour mixture

Select the correct answer from the codes given below :

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

Ans. (*d*)

Q. 107. Upon which of the following factors does the effective temperature for human comfort depend ?

1. Dry bulb temperature
2. Humidity ratio
3. Air velocity
4. Mean radiation temperature

Select the correct answer from the codes given below :

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

Ans. (*a*)

Q. 108. Moist air enters the cooling coil with mass flow rate of 10 kgda/s at dry bulb temperature of 30°C and humidity ratio of 0.017 kgw/kgda. It leaves the cooling coil at dry bulb temperature of 16°C and humidity ratio of 0.008 kgw/kgda. If specific heat of humid air is 1.02 kJ/kgda-K and latent heat of water vapour is 2500 kJ/kgw. The sensible and latent heat transfer of cooling coil are, respectively

(*a*) 140 kW and 25000 kW (*b*) 142.8 kW and 2.25 kW

(*c*) 142.8 kW and 225 kW (*d*) 225 kW and 142.8 kW

Ans. (*c*) Sensible heat transfer $= 10 \times 1.02 \times (30 - 16) = 142.8$ kW

Latent heat transfer $= 10 \times (0.017 - 0.008) \times 2500 = 225$ kW.

Q. 109. An air-conditioned room has length, width and height of 20 m, 30 m and 4 m respectively. The infiltration is assumed to be one air change. The outdoor and indoor dry bulb temperatures are 40°C and 25°C respectively. The sensible heat load due to infiltration is

(*a*) 734 kW (*b*) 12.24 kW (*c*) 0.204 kW (*d*) 10 kW

Ans. (*b*) SHL due to infiltration $=20 \times 30 \times 4 \times$ density of air $\times$ Specific heat $\times (t_{d1} - t_{d2}) \times 1$

$$= \frac{2400 \times 1.2 \times 1 \times 15}{3600} \text{ kW} = 12.24 \text{ kW}$$

Q. 110. Consider the following statements in respect of the contraction and expansion in air conditioning ducts :

1. Pressure drop is more in contraction than in expansion.
2. Pressure drop is more in expansion than in contraction.
3. Static pressure increases (regain) in expansion.
4. Static pressure increases (regain) in contraction.

Which of these statements are correct ?

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

Ans. (*c*)

Q. 111. On which of the following factors does sol-air temperature depend ?

1. Outdoor air temperature
2. Intensity of solar radiation.
3. Absorptivity of wall
4. Convective heat transfer coefficient at outer surface of wall
5. Indoor design temperature

Choose the correct answer from the codes given below :

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

Ans. (*b*)

Q. 112. Instantaneous cooling loads are NOT equal to instantaneous heat gains because

(*a*) Heat gains are offset by cooling provided by the AC system

(*b*) Indoor temperatures are lower

(*c*) Comfort conditions are maintained in the space

(*d*) Of the storage effect in the construction material of wall and roof.

Ans. (*a*)

Q.113. Consider the following statements about hydrostatic force on a submerged surface :

1. It remains the same even when the surface is turned.

2. It acts vertically even when the surface is turned.

Which of these is / are correct ?

(*a*) Only 1 (*b*) Only 2 (*c*) Both 1 and 2 (*d*) Neither 1 nor 2

Ans. (*b*)

Q. 114. The depth of centre of pressure for rectangular lamina immersed vertically in water up to height '*h*' is given by

(*a*) *h*/2 (*b*) *h*/4 (*c*) 2*h*/3 (*d*) 3*h*/2

Ans. (*c*)

Q. 115. The vertical component of force on a curved surface submerged in a static liquid is equal to the

(*a*) Weight of liquid column above the C.G. of the curved surface

(*b*) Weight of liquid above the curved surface

(*c*) Product of pressure at C.G., multiplied by the area of the curved surface

(*d*) Product of pressure at C.G., multiplied by the projected area of the curved surface.

Ans. (*b*)

Q. 116. The point of application of a horizontal force on a curved surface submerged in liquid is

(*a*) $\frac{I_G}{A\bar{h}} - \bar{h}$ (*b*) $\frac{I_G + A\bar{h}^2}{A\bar{h}}$ (*c*) $\frac{A\bar{h}}{I_G} + \bar{h}$ (*d*) $\frac{I_G}{\bar{h}} + A\bar{h}$

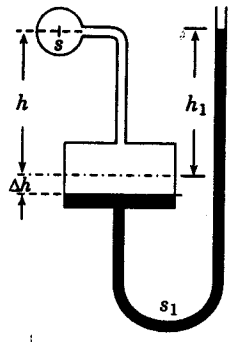
where A = area of the immersed surface

$\bar{h}$ = depth of centre of surface immersed

I_G = moment of inertia about centre of gravity

Ans. (*b*)

Q. 117. To measure the pressure head of the fluid of specific gravity S flowing through a pipeline, a simple micro-manometer containing a fluid of specific gravity S_1 is connected to it. The readings are as indicated in the diagram. The pressure head in the pipeline is



(*a*) $h_1S_1 - hS - \Delta h(S_1 - S)$ (*b*) $h_1S_1 - hS_1 - \Delta h(S_1 - S)$

(*c*) $hS - h_1S_1 - \Delta h(S_1 - S)$ (*d*) $hS - h_1S_1 - \Delta h(S_1 - S)$

Ans. (*a*)

Q. 118. Match *List I* (*Rheological Equation*) with *List II* (*Types of Fluids*) and select the correct answer using the codes given below the Lists :

List I (*Rheological Equation*)	*List II* (*Types of Fluids*)
A. $\tau = \mu\left(\frac{du}{dy}\right)^n, n = 1$	1. Bingham plastic
B. $\tau = \mu\left(\frac{du}{dy}\right)^n, n < 1$	2. Dilatant fluid
C. $\tau = \mu\left(\frac{du}{dy}\right)^n, n > 1$	3. Newtonian fluid
D. $\tau = \tau_0 + \mu\left(\frac{du}{dy}\right)^n, n = 1$	4. Pseudoplastic fluid

Codes :

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

Ans. (*a*)

Q. 119. Which one of the following stream function is a possible irrotational flow field ?

(*a*) $\psi = x^3y$ (*b*) $\psi = 2xy$ (*c*) $\psi = Ax^2y^2$ (*d*) $\psi = Ax + By^2$

Ans. (*b*)

Q. 120. The expression $\frac{\partial \phi}{\partial t} + \int \frac{\partial p}{\rho} + \frac{1}{2}|\nabla \phi|^2 + gz =$ constant represents

(*a*) Steady flow energy equation (*b*) Unsteady irrotational Bernoulli's equation

(*c*) Steady rotational Bernoulli's equation (*d*) Unsteady rotational Bernoulli's equation

Ans. (*a*)

MECHANICAL ENGINEERING—2003 (PAPER—II)

Q. 1. Under axial load, each section of a close-coiled helical spring is subjected to

(*a*) Tensile stress and shear stress due to load

(*b*) Compressive stress and shear due to torque

(*c*) Tensile stress and shear stress due to torque

(*d*) Torsional and direct shear stresses

Ans. (*d*)

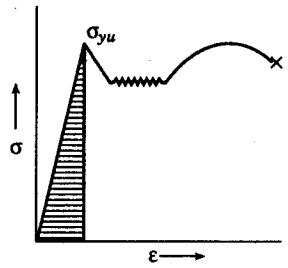
Q. 2. A bar having length L and uniform cross-section with area A is subject to both tensile force P and torque T. If G is the shear modulus and E is the Young's modulus, the internal strain energy stored in the bar is

(*a*) $\frac{T^2L}{2GJ}+\frac{P^2L}{AE}$ (*b*) $\frac{T^2L}{GJ}+\frac{P^2L}{2AE}$ (*c*) $\frac{T^2L}{2GJ}+\frac{P^2L}{2AE}$ (*d*) $\frac{T^2L}{GJ}+\frac{P^2L}{AE}$

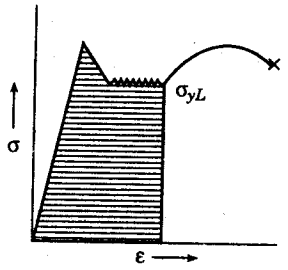
Ans. (*c*)

Q. 3. Toughness for mild steel under uniaxial tensile loading is given by the shaded portion of the stress-strain diagram as shown in

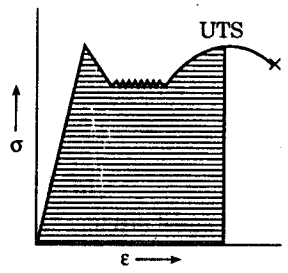
(*a*)



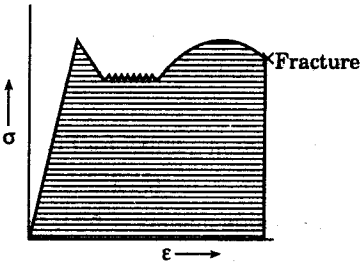
(*b*)



(*c*)



(*d*)



Ans. (*c*)

Q. 4. Monel metal is an alloy of

(*a*) Iron and carbon (*b*) Copper and zinc

(*c*) Aluminium and copper (*d*) Copper and nickel

Ans. (*d*)

Q. 5. Primary object of full annealing is to

(*a*) Increase toughness and yield point

(*b*) Reduce ductility and resilience

(*c*) Remove foreign impurities and improve surface finish

(*d*) Increase ductility and machinability

Ans. (*d*)

Q. 6. Globular form of cementite in the structure of steel is obtained through

(*a*) Normalising (*b*) Malleabilising (*c*) Spheroidising (*d*) Carbonising

Ans. (*c*)

Q. 7. Gunmetal, which is used in journal bearings, contains

(*a*) 88% Cu, 10% Sn, 2% Zn (*b*) 80% Cu, 10% Zn, 10% Al

(*c*) 85% Cu, 5% Mg, 10% Al (*d*) 85% Cu, 5% Sn, 10% Pb

Ans. (*d*)

Q. 8. The correct sequence of elements of 18 - 4 - 1 HSS tool is

(*a*) W, Cr, V (*b*) Mo, Cr, V (*c*) Cr, Ni, C (*d*) Cu, Zn, Sn

Ans. (*a*)

Q. 9. Teflon is a

(*a*) Thermosetting fluorocarbon polymer

(*b*) Thermo-plastic fluorocarbon polymer

(*c*) Inorganic compound of fluorine and carbon

(*d*) Laminated phenolic material

Ans. (*b*)

Q. 10. In the case of rubber, vulcanization refers to the process of producing a

(*a*) Linear polymer (*b*) Branched polymer

(*c*) Cross-linked polymer (*d*) Net-work polymer

Ans. (*c*)

Q. 11. Polyesters can be defined as the condensation products of

(*a*) Dicarboxylic acids with dihydroxy alcohols

(*b*) Bisphenol - A and epichloro - hydrin

(*c*) Phenol and formaldehyde

(*d*) Benzene and toluene

Ans. (*a*)

Q. 12. The coordination number for FCC crystal structure is

(*a*) 4 (*b*) 8 (*c*) 12 (*d*) 16

Ans. (*c*) Coordination number (CN) is no. of atoms which are at equal distance from an atom in a space lattice. For BCC, CN is 8 and for FCC & HCP it is 12.

Q. 13. Match *List I* (*Crystal structure*) *with List II* (*Example*) and select the correct answer using the codes given below the Lists :

List I (*Crystal Structure*)	*List II* (*Example*)
A. Simple Cubic	1. Zinc
B. Body-centred Cubic	2. Copper
C. Face-centered Cubic	3. Alpha iron at room temperature
D. Hexagonal Close Packed	4. Manganese

Codes :

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

Ans. (*b*)

Q. 14. Which one of the following pairs is ***not*** correctly matched ?

(*a*) Point defect in crystal lattice : Self interstitials

(*b*) Linear defect in crystal lattice : Grain boundary

(*c*) Planar defect in crystal lattice : External surface

(*d*) Volume defect in crystal lattice : Other phases

Ans. (*c*)

Q. 15. A screw dislocation

1. Lies parallel to its Burger's vector
2. Lies perpendicular to its Burger's vector
3. Moves in a perpendicular direction to the Burger's vector
4. Moves in an inclined direction to the Burger's vector

Select the correct answer using the codes given below :

Codes :

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

Ans. (*a*)

Q. 16. According to Gibs' phase rule, the number of degrees of freedom of an eutectic point in a binary system is

(*a*) 1 (*b*) 2 (*c*) 0 (*d*) 3

Ans. (*a*) $f = 3 - 2 = 1$

Q. 17. An orthogonal cutting operation is being carried out under the following conditions : cutting speed = 2 m/s, depth of cut = 0.5 mm, chip thickness = 0.6 mm. Then the chip velocity is

(*a*) 2.0 m/s (*b*) 2.4 m/s (*c*) 1. 0 m/s (*d*) 1.66 m/s

Ans. (*d*) Chip velocity $= (0.5/0.6) \times 2 = 1.66$ m/s

Q. 18. The angle of inclination of the rake face with respect to the tool base measured in a plane perpendicular to the base and parallel to the width of the tool is called

(*a*) Back rake angle (*b*) Side rake angle (*c*) Side cutting edge angle (*d*) End cutting edge angle

Ans. (*b*)

Q. 19. The correct sequence of cutting tools in the ascending order of their wear resistance is

(*a*) HSS - Cast non-ferrous alloy (Stellite) - Carbide - Nitride

(*b*) Cast non-ferrous alloy (Stellite) - HSS - Carbide - Nitride

(*c*) HSS - Cast non-ferrous alloy (Stellite) - Nitride - Carbide

(*d*) Cast non-ferrous alloy (Stellite) - Carbide - Nirtide - HSS

Ans. (*a*)

Q. 20. In orthogonal cutting test, the cutting force = 900 N, the thrust force = 600 N and chip shear angle is 30°C. Then the chip shear force is

(*a*) 1079.4 N (*b*) 969.6 N (*c*) 479.4 N (*d*) 69.6 N

Ans. (*d*) $F_s = (F_H \cos \phi - Fv \sin \phi) = (600 \cos 30 - 900 \sin 30) = 69.6N$

Q. 21. The time taken to face a workpiece of 72 mm diameter, if the spindle speed is 80 r.p.m. and cross-feed is 0.3 mm / rev, is

(*a*) 1.5 minutes (*b*) 3.0 minutes (*c*) 5.4 minutes (*d*) 8.5 minutes

Ans. (*a*) $t = \frac{72/2}{80 \times 0.3} = 1.5$ min.

Q. 22. The purpose of helical grooves in a twist drill is to

1. Improve the stiffness
2. Save a tool material
3. Provide space for chip removal
4. Provide rake angle for the cutting edge

Select the correct answer using the codes given below :

Codes :

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

Ans. (*c*)

Q. 23. Which one of the following is ***not*** a synthetic abrasive material ?

(*a*) Silicon Carbide (*b*) Aluminium Oxide (*c*) Titanium Nitride (*d*) Cubic Boron Nitride

Ans. (*d*)

Q. 24. The span of control refers to the

(*a*) Total amount of control which can be exercised by the supervisor

(*b*) Total number of persons which report to any one supervisor

(*c*) Delegation of authority by the supervisor to his subordinates

(*d*) Delegation of responsibility by the supervisor to his subordinates

Ans. (*a*)

Q. 25. Match *List I* (*Trend/Defect*) with *List II* (*Chart*) and select the correct answer using the codes given below the Lists :

List I (*Trend/Defect*)	*List II* (*Chart*)
A. Trend	1. R - Chart
B. Dispersion	2. C - Chart
C. Number of defects	3. $\overline{X}$ - Chart
D. Number of defectives	4. np - Chart
	5. u-Chart

Codes :

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

Ans. (*c*)

Q. 26. Which one of the following statements is correct ?

(*a*) Time series analysis technique of forecasting is used for very long range forecasting

(*b*) Qualitative techniques are used for long range forecasting and quantitative techniques for short and medium range forecasting

(*c*) Coefficient of correlation is calculated in case of time series technique

(*d*) Market survey and Delphi techniques are used for short range forecasting

Ans. (*b*)

Q. 27. In the solution of linear programming problems by Simplex method, for deciding the leaving variable

(*a*) The maximum negative coefficient in the objective function row is selected

(*b*) The minimum positive ratio of the right-hand side to the first decision variable is selected

(*c*) The maximum positive ratio of the right-hand side to the coefficients in the key column is selected

(*d*) The minimum positive ratio of the right-hand side to the coefficient in the key column is selected

Ans. (*a*)

Q. 28. Consider the following statements on transportation problem :

1. In Vogel's approximation method, priority allotment is made in the cell with lowest cost in the column or row with least penalty
2. The North-West corner method ensures faster optimal solution
3. If the total demand is higher than the supply, transportation problem cannot be solved
4. A feasible solution may not be an optimal solution

Which of these statements are correct ?

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

Ans. (*a*)

Q. 29. At a self-service store, a cashier can serve 10 customers in 5 minutes. On an average 15 customers arrive every 10 minutes. If the arrivals are as per Poisson distribution and services as per exponential distribution, the probability that the cashier would be idle is

(*a*) 0.5 (*b*) 0.75 (*c*) 0.25 (*d*) 0

Ans. (*c*)

Q. 30. ABC analysis in materials management is a method of classifying the inventories based on

(*a*) The value of annual usage of the items (*b*) Economic order quantity

(*c*) Volume of material consumption (*d*) Quantity of materials used

Ans. (*a*)

Q. 31. Consider the following steps which are involved in constructing a function analysis system technique of value engineering :

1. Find the critical path
2. Prepare a function worksheet
3. Listing of functions
4. Diagram layout

Which of the following gives the correct sequence of steps ?

(*a*) 1 - 3 - 2 - 4 (*b*) 2 - 1 - 3 - 4

(*c*) 4 - 2 - 3 - 1 (*d*) 3 - 2 - 4 - 1

Ans. (*d*)

Q. 32. Consider the following statements in respect of double sampling plan :

1. Average number of pieces inspected is double that of single sampling
2. Average number of pieces inspected is less than that for single sampling
3. Decision to accept or reject the lot is taken only after the inspection of both samples
4. Decision to accept or reject the lot is reached sometimes after one sample and sometimes after two samples

Which of these statements are correct ?

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

Ans. (*b*)

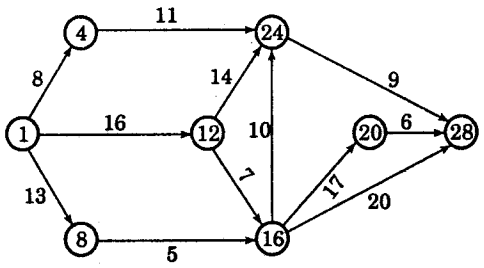
Q. 33. The variance of the completion time for a project is the sum of variances of

(*a*) All activity times (*b*) Non-critical activity times

(*c*) Critical activity times (*d*) Activity times of first and last activities of the project

Ans. (*c*)

Q. 34.



The earliest time of the completion of the last event in the above network in week is

(*a*) 41 (*b*) 42 (*c*) 43 (*d*) 46

Ans. (*d*)

Q. 35. The indirect cost of a plant is Rs. 4,00,000 per year. The direct cost is Rs. 20 per product. If the average revenue per product is Rs. 60, the break-even point is

(*a*) 10000 products (*b*) 20000 products

(*c*) 40000 products (*d*) 60000 products

Ans. (*a*)

Q. 36. Which one of the following statements correctly defines the term 'despatching' ?

(*a*) Maintaining the record of time of starting and completion of each operation

(*b*) The appraisal and evaluation of human work in terms of time

(*c*) Taking all such steps which are meant to affect and implement the programmes of production according to plans

(*d*) Moving the work after completion to the next process or machine on the route

Ans. (*c*)

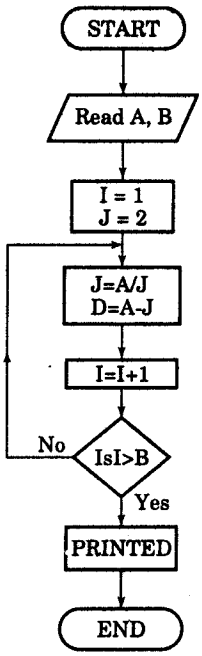
Q. 37. In computer application, if a direct dialogue is carried on between computer and user, it is referred to as

(*a*) Real-time application (*b*) Decision application

(*c*) Batch processing application (*d*) Interfacing

Ans. (*a*)

Q. 38. In the given flow chart, if the values of inputs are, A = 64 and B = 3, the value of D is



(*a*) 2 (*b*) 30

(*c*) 32 (*d*) 60

Ans. (*c*)

Q. 39. Which one of the following statements is ***not*** correct ?

(*a*) Every C - language programme contains a function 'main'

(*b*) \n symbol in C - language tells the computer programme to print a new line

(*c*) In a C - language programme, there is no need to declare the variable types

(*d*) In C - language the text enclosed in /* and */ is a comment

Ans. (*c*)

Q. 40. For deleting a record from a dBase III plus file, the command(s) given is/are

(*a*) delete

(*b*) delete followed by pack

(*c*) delete followed by done

(*d*) delete followed by modify

Ans. (*b*)

Q. 41. Consider the following statements related to computer applications in mechanical engineering :

1. Computer can solve any problem that is impossible to be solved by conventional calculation methods.
2. The optimization techniques involving numerical calculations can be easily employed using computers
3. The speed of calculations in computers depends on speed of input-output devices
4. The central processor unit mainly co-ordinates the functions of various parts of the computer system

Which of these statements is/are correct

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

(*c*) 3 only (*d*) 2 only

Ans. (*d*)

Directions : *The following Eleven (11) items consist of two statements : one labelled as the 'Assertion (A)' and the other as 'Reason (R)'. You are to examine these two statements carefully and select the answers to these items using the codes given below :*

Codes :

(*a*) Both A and R are individually true and R is the correct explanation of A

(*b*) Both A and R are individually 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. 42. *Assertion (A) :* Slider-crank chain is an inversion of the four-bar mechanism.
Reason (R) : Slider-crank chain often finds applications in most of the reciprocating machinery.

Ans. (*b*)

Q. 43. *Assertion (A)* : The maximum efficiency $\left(\eta = \frac{1 - \sin\theta}{1 + \sin\theta}\right)$ of a screw jack is same, where ϕ is the friction angle, for both motion up and motion down the plane.
Reason (R) : The condition for the maximum efficiency for motion up and motion down the plane is same, given by $\alpha = \frac{\pi}{4} - \frac{\theta}{2}$, where α = helix angle.

Ans. (*a*)

Q. 44. *Assertion (A) :* A Woodruff key is an easily adjustable key.
Reason (R) : The Woodruff key accommodates itself to any taper in the hub or boss of the mating piece.

Ans. (*c*)

Q. 45. *Assertion (A) :* In case of friction clutches, uniform wear theory should be considered for power transmission calculation rather than the uniform pressure theory.
Reason (R) : The uniform pressure theory gives a higher friction torque than the uniform wear theory.

Ans. (*c*)

Q. 46. *Assertion (A) :* In a simply supported beam subjected to a concentrated load P at mid-span, the elastic curve slope becomes zero under the load.
Reason (R) : The deflection of the beam is maximum at midspan.

Ans. (*b*)

Q. 47. *Assertion (A) :* Unlike in the case of ionic bonds, the co-ordination numbers for covalently bonded atoms are ***not*** controlled by the radii ratio.
Reason (R) : A covalent bond has a specific direction of bonding in space.

Ans. (*d*)

Q. 48. *Assertion (A) :* The machinability of steels improves by adding sulphur to obtain so called 'Free Machining Steels'.

Reason (R) : Sulphur in steel forms manganese sulphide inclusion which helps to produce thin ribbon like continuous chip.

Ans. (*a*)

Q. 49. *Assertion (A) :* Water jet machining uses high pressure and high velocity water stream which acts like a saw and cuts a narrow groove in the material.
Reason (R) : The force required for cutting is generated from sudden change in the momentum of the water stream.

Ans. (*c*)

Q. 50. *Assertion (A) :* While rolling metal sheet in rolling mill, the edges are sometimes not straight and flat but are wavy.
Reason (R) : Non-uniform mechanical properties of the flat material rolled out result in waviness of the edges.

Ans. (*a*)

Q. 51. *Assertion (A) :* In case of control charts for variables, the average of readings of a sub-group of four and more is plotted rather than the individual readings.

Reason (R) : Plotting of individual readings needs a lot of time and effort.

Ans. (*c*)

Q. 52. *Assertion (A)* : In the solution of transportion problem, for application of optimality test, the number of allocations required is m + n – 1 and these should be in independent positions.
Reason (R) : If the number of allocations is not m + n – 1, values of all oddments, i.e., u_i and v_j cannot be found.

Ans. (*a*)

Q. 53.

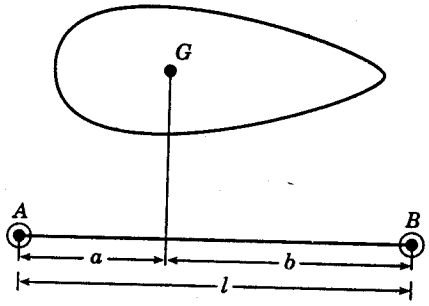


Figure shows a rigid body of mass *m* having radius of gyration *k* about its centre of gravity. It is to be replaced by an equivalent dynamical system of two masses placed at A and B. The mass at A should be

(*a*) $\frac{a \times m}{a+b}$ (*b*) $\frac{b \times m}{a+b}$ (*c*) $\frac{m}{3} \times \frac{a}{b}$ (*d*) $\frac{m}{2} \times \frac{b}{a}$

Ans. (*b*)

Q. 54. $f = 3(n-1) - 2j$. In the Gruebler's equation for planar machanisms given, *j* is the

(*a*) Number of mobile links (*b*) Number of links
(*c*) Number of lower pairs (*d*) Length of the longest link

Ans. (*c*)

Q. 55. Which of the following are examples of forced closed kinematic pairs ?

1. Cam and roller mechanism 2. Door closing mechanism
3. Slider-crank mechanism 4. Automotive clutch operating machanism

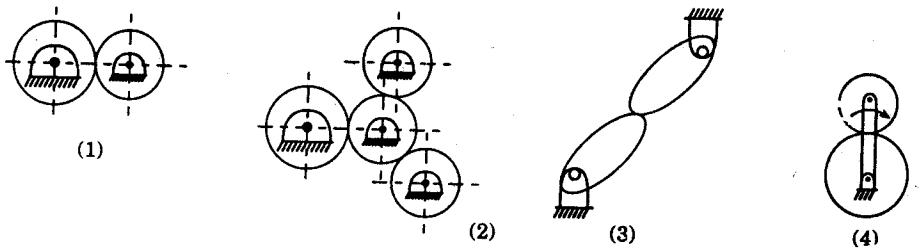
Select the correct answer using the codes given below :

Codes :

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

Ans. (*c*)

Q. 56.

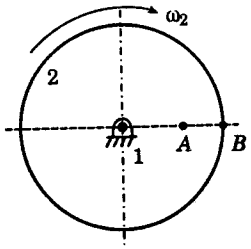


Which of the mechanisms shown above do / does ***not*** have single degree of freedom ?

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

Ans. (*d*)

Q. 57.



Two points, A and B located along the radius of a wheel, as shown in the figure above, have velocities of 80 and 140 m/s, respectively. The distance between points A and B is 300 mm. The radius of wheel is

(*a*) 400 mm (*b*) 500 mm

(*c*) 600 mm (*d*) 700 mm

Ans. (*d*)

Q. 58. In a slider-Crank mechanism, the velocity of piston becomes maximum when

(*a*) Crank and connecting rod are in line with each other

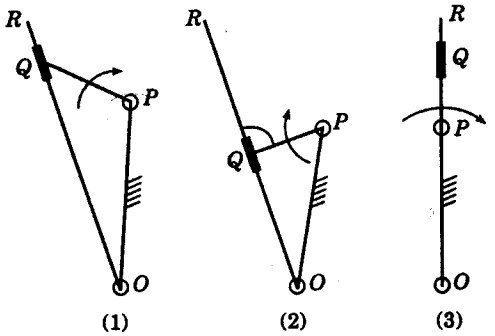
(*b*) Crank is perpendicular to the line of stroke of the piston

(*c*) Crank and connecting rod are mutually perpendicular

(*d*) Crank is 120° with the line of stroke

Ans. (*b*)

Q. 59.



(1) (2) (3)

Three positions of the quick - return mechanisms are shown above. In which of the cases does the Coriolis component of acceleration exist ? Select the correct using the codes given below :

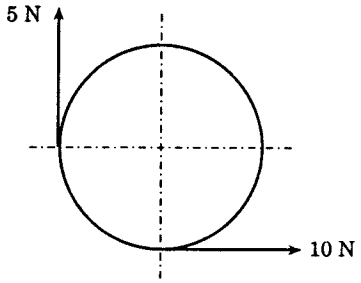
Codes :

(*a*) 1 only (*b*) 1 and 2

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

Ans. (*b*)

Q. 60.



The above figure shows a circular disc of 1 kg mass and 0.2 m radius undergoing unconstrained plannar motion under the action of two forces as shown. The magnitude of angular acceleration α of the disc is

(*a*) 50 rad/s^2 (*b*) 100 rad/s^2 (*c*) 25 rad/s^2 (*d*) 20 rad/s^2

Ans. (*c*)

Q. 61. For a slider-crank mechanism with radius of crank r, length of connecting rod l, obliquity ratio n, crank rotating at an angular velocity ω, for any angle θ of the crank, match *List I* (*Kinematic Variable*) with *List II* (*Equation*) and select the correct answer using the codes given below the Lists :

List I (*Kinematic Variable*)	*List II* (*Equation*)
A. Velocity of piston	1. $\frac{\omega}{n}.\cos\theta$
B. Acceleration of piston	2. $\omega^2 r.\left(\cos\theta+\frac{\cos 2\theta}{n}\right)$
C. Angular velocity of connecting rod	3. $-\frac{\omega^2}{n}.\sin\theta$
D. Angular acceleration of connecting rod	4. $\omega r\left(\sin\theta+\frac{\sin 2\theta}{2n}\right)$

Codes :

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

Ans. (*c*)

Q. 62.

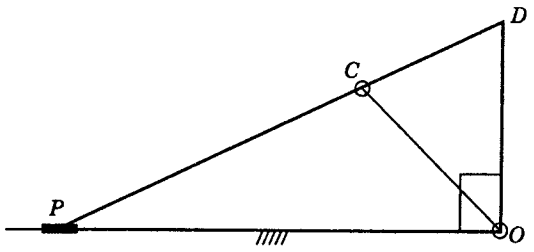


Figure shows Klen's construction for slider-crank mechanism OCP drawn to full scale. What velocity does CD represent ?

(*a*) Velocity of the crank pin (*b*) Velocity of the piston

(*c*) Velocity of the piston with respect to crank pin

(*d*) Angular velocity of the connecting rod

Ans. (*c*)

Q. 63. The maximum fluctuation of energy E_f, during a cycle for a flywheel is

(*a*) $I(\omega_{max}^2 - \omega_{min}^2)$ (*b*) $1/2.I.\omega_{av}.(\omega_{max} - \omega_{min})$

(*c*) $1/2.I.K_{es}.\omega_{av}$ (*d*) $I.\omega_{av}^2.K_{es}$

(where I = Mass moment of inertia of the flywheel, ω_{av} = Average rotational speed

K_{es} = Coefficient of fluctuation of speed)

Ans. (*d*)

Q. 64. For minimising speed fluctuations of an engine as a prime mover, it must have

(*a*) Only a flywheel fitted to the crankshaft

(*b*) A governor provided in the system

(*c*) Both a flywheel and a governor provided in the system

(*d*) Neither a flywheel nor a governor

Ans. (*c*)

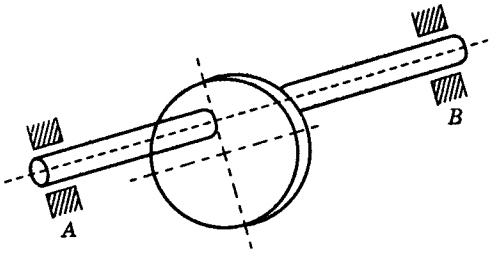
Q. 65. Effect of friction at the sleeve of a centrifugal governor is to make it

(*a*) More sensitive (*b*) More stable

(*c*) Insensitive over a small range of speed (*d*) Unstable

Ans. (*c*)

Q. 66. A circular disc having a mass of 30 kg is mounted symmetrically between two bearings A and B as shown in the figure. It is used as an eccentric cam with an eccentricity of 0.01 m. If the shaking force on each of the bearings is not to exceed 1500 N, the speed of rotation of the cam should not exceed

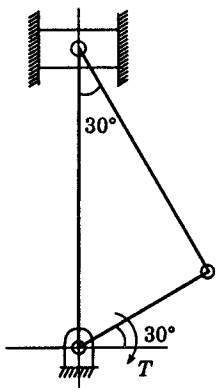


(*a*) 10 rad/s (*b*) 100 rad/s

(*c*) 70.7 rad/s (*d*) 140 rad/s

Ans. (*c*)

Q. 67. The figure shows the schematic diagram of an IC engine producing a torque T = 40 N-m at the given instant. The Coulomb friction coefficient between the cylinder and the piston is 0.08. If the mass of the piston is 0.5 kg and the crank radius is 0.1 m, the Coulomb friction force occurring at the piston cylinder interface is



(*a*) 16 N (*b*) 0.4 N

(*c*) 4 N (*d*) 16.4 N

Ans. (*a*)

Q. 68. Consider the following modifications regarding avoiding the interference between gears :

1. The centre distance between meshing gears be increased.
2. Addendum of the gear be modified
3. Teeth should be undercut slightly at the root
4. Pressure angle should be increased
5. Circular pitch be increased

Which of these are effective in avoiding interference ?

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

Ans. (*a*)

Q. 69. In a reverted gear train, two gears P and Q are meshing, Q-R is a compound gear, and R and S are meshing. The modules of P and R are 4 mm and 5 mm respectively. The numbers of teeth in P, Q and R are 20, 40 and 25 respectively. The number of teeth is S is

(*a*) 23 (*b*) 35 (*c*) 50 (*d*) 53

Ans. (*a*)

Q. 70. When two spur gears having involute profiles on their teeth engage, the line of action is tangential to the

(*a*) Pitch circles (*b*) Dedendum circles (*c*) Addendum circles (*d*) Base circles

Ans. (*a*)

Q. 71. If the annular wheel of an epicyclic gear train has 100 teeth and the planet wheel has 20 teeth, the number of teeth on the sun wheel is

(*a*) 80 (*b*) 60 (*c*) 40 (*d*) 20

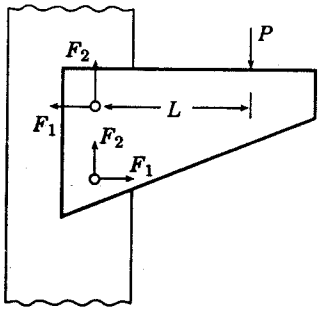
Ans. (*c*)

Q. 72. The piston rod and the crosshead in a steam engine are usually connected by means of

(*a*) Cotter joint (*b*) Knuckle joint (*c*) Ball joint (*d*) Universal joint

Ans. (*a*)

Q. 73.



A riveted joint has been designed to support an eccentric load P. The load generates value of F_1 equal to 3 kN and F_2 equal to 4 kN. The cross-sectional area of each rivet is 500 mm^2. Consider the following statements :

1. The stress in the rivet is 10 N/mm^2
2. The value of eccentricity L is 100 mm

3. The value of load P is 6 kN
4. The resultant force in each rivet is 6 kN

Which of these statements are correct ?

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

Ans. (*a*)

Q. 74. Match *List I (Phenomenon)* with *List II (Significant Parameters/Phenomenon)* and select the correct answer using the codes given below the Lists :

List I (*Phenomenon*)	*List II* (*Significant Parameters/Phenomenon*)
A. Interference fit	1. Viscosity index
B. Cyclic loading	2. Interference
C. Gear meshing	3. Notch sensitivity
D. Lubricating of bearings	4. Induced compressive stress

Codes :

	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. 75. The hemispherical end of a pressure vessel is fastened to the cylindrical portion of the pressure vessel with the help of gasket, bolts and lock nuts. The bolts are subjected to

(*a*) Tensile stress (*b*) Compressive stress

(*c*) Shear stress (*d*) Bearing stress

Ans. (*a*)

Q. 76. For bolts of uniform strength, the shank diameter is made equal to

(*a*) Major diameter of threads (*b*) Pitch diameter of threads

(*c*) Minor diameter of threads (*d*) Nomical diameter of threads

Ans. (*c*)

Q. 77. Match *List I (Device)* with *List II (Component/Accessory)* and select the correct answer using the codes given below the Lists :

List I (Device)	*List II (Component/Accessory)*
A. Lifting machine	1. Idler of jockey pulley
B. Fibre rope drive	2. Sun wheel
C. Differential gear	3. Sheave
D. Belt drive	4. Power screw

Codes :

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

Ans. (*c*)

Q. 78. A pulley is connected to a power transmission shaft of diameter d by means of a rectangular sunk key of width w and length l. The width of the key is taken as $d/4$. For full power transmission, the shearing strength of the key is equal to the torsional shearing strength of the shaft. The ratio of the length of the key to the diameter of the shaft (l/d) is

(*a*) $\frac{\pi}{4}$ (*b*) $\frac{\pi}{\sqrt{2}}$ (*c*) $\frac{\pi}{2}$ (*d*) π

Ans. (*c*) $\frac{\pi}{16} \times s_s \times d^3 = l \times \frac{d}{4} \times s_s \times \frac{d}{2}$ and $\frac{l}{d} = \frac{\pi}{2}$

Q. 79. A circular solid rod of diameter d welded to a rigid flat plate by a circular fillet weld of throat thickness t is subjected to a twisting moment T. The maximum shear stress induced in the weld is

(*a*) $\frac{T}{\pi t d^2}$ (*b*) $\frac{2T}{\pi t d^2}$ (*c*) $\frac{4T}{\pi t d^2}$ (*d*) $\frac{2T}{\pi t d^3}$

Ans. (*c*)

Q. 80. A 6 × 19 rope implies that there are

(*a*) 6 wires in each strand and 19 strands in the rope

(*b*) 6 strands and 19 wires in each strand

(*c*) 6 large diameter wires and 19 small diameter wires

(*d*) 19 large diameter wires and 6 small diameter wires

Ans. (*a*)

Q. 81. Consider the following statements :

1. Flywheel and governor of an engine are the examples of an open loop control system
2. Governor is the example of closed loop control system
3. The thermostat of a refrigerator and relief valve of a boiler are the examples of closed loop control system

Which of these statements is/are correct ?

(*a*) 1 only (*b*) 2 and 3

(*c*) 3 only (*d*) 2 only

Ans. (*b*)

Q. 82. In a multiple disc clutch if n_1 and n_2 are the number of discs on the driving and driven shafts, respectively, the number of pairs of contact surfaces will be

(*a*) $n_1 + n_2$ (*b*) $n_1 + n_2 - 1$ (*c*) $n_1 + n_2 + 1$ (*d*) $\frac{n_1 + n_2}{2}$

Ans. (*b*)

Q. 83. Match *List I (Gears)* with *List II (Configurations)* and select the correct answer using the codes given below the Lists :

List I (*Gears*)	*List II* (*Configurations*)
A. Spur	1. Connecting two non-parallel or intersecting but coplanar shafts
B. Bevel	2. Connecting two parallel and coplanar shafts with teeth parallel to the axis of the gear wheel
C. Helical	3. Connecting two parallel and coplanar shafts with teeth inclined to the axis of the gear
D. Mitre	4. Connecting two shafts whose axes are mutually perpendicular to each other

Codes :

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

Ans. (*c*)

Q. 84. Two shafts A and B in the same straight line are geared together through an intermediate parallel shaft. The parameters relating to the gears and pinions are given in the table :

Item	*Speed*	*Teeth*	*PCD*	*Module*
Driving wheel A	N_A	T_A	D_A	m
Driven wheel B	N_B	T_B	D_B	m
Driven wheel C on the intermediate shaft	N_C	T_C	D_C	m
Driving wheel D on the intermediate shaft, in mesh with B	N_D	T_D	D_D	m

Which of the following relations is **not** valid for kinematic design considerations ?

(*a*) $\frac{N_A}{N_B} = \frac{T_C}{T_A} \times \frac{T_B}{T_D}$ (*b*) $\frac{N_A}{N_B} = \frac{T_A}{T_C} \times \frac{T_D}{T_B}$

(*c*) $D_A + D_C = D_B + D_D$ (*d*) $T_A + T_C = T_B + T_D$

Ans. (*b*)

Q. 85. The gears employed for connecting two non-intersecting and non-parallel, *i.e.*, non-coplanar shafts are

(*a*) Bevel gears (*b*) Spiral gears (*c*) Helical gears (*d*) Mitre gears

Ans. (*b*)

Q. 86. The rolling element bearings are

(*a*) Hydrostatic bearings (*b*) Squeeze film bearings

(*c*) Antifriction bearings (*d*) Grease lubrication bearings

Ans. (*c*)

Q. 87. On the motors with the low starting torque, the type of the clutch to be used is

(*a*) Multiple-plate clutch (*b*) Cone clutch

(*c*) Centrifugal clutch

(*d*) Single-plate clutch with both sides effective

Ans. (*d*)

Q. 88. Which one of the following is **not** a friction clutch ?

(*a*) Disc or plate clutch (*b*) Cone clutch (*c*) Centrifugal clutch (*d*) Jaw clutch

Ans. (*d*)

Q. 89. Two dimensional state of stress at a point in a plane stressed element is represented by a Mohr circle of zero radius. Then both principal stresses

(*a*) are equal to zero

(*b*) are equal to zero and shear stress is also equal to zero

(*c*) are of equal magnitude but of opposite sign

(*d*) are of equal magnitude and of same sign

Ans. (*d*)

Q. 90. Which of the following materials generally exhibits a yield point ?

(*a*) Cast iron (*b*) Annealed and hot-rolled mild steel

(*c*) Soft brass (*d*) Cold-rolled steel

Ans. (*b*)

Q. 91. A cube having each side of length a, is constrained in all directions and is heated uniformly so that the temperature is raised to $T°C$. If α is the thermal coefficient of expansion of the cube material and E the modulus of elasticity, the stress developed in the cube is

(*a*) $\frac{\alpha TE}{\gamma}$ (*b*) $\frac{\alpha TE}{(1-2\gamma)}$ (*c*) $\frac{\alpha TE}{2\gamma}$ (*d*) $\frac{\alpha TE}{(1+2\gamma)}$

Ans. (*b*)

Q. 92. A simply supported beam has equal over-hanging lengths and carries equal concentrated loads P at ends. Bending moment over the length between the supports

(*a*) is zero (*b*) is a non-zero constant

(*c*) varies uniformly from one support to the other

(*d*) is maximum at mid-span

Ans. (*b*)

Q. 93. Consider the following statements : In a cantilever subjected to a concentrated load at the free end

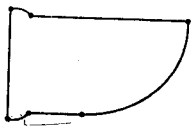
1. The bending stress is maximum at the free end
2. The maximum shear stress is constant along the length of the beam
3. The slope of the elastic curve is zero at the fixed end

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. 94.



The shear stress distribution over a beam cross-section is shown in the figure above. The beam is of

(*a*) Equal flange I-section (*b*) Unequal flange I-section

(*c*) Circular cross-section (*d*) T-section

Ans. (*b*)

Q. 95. Slenderness ratio of a column is defined as the ratio of its length to its

(*a*) Least radius of gyration (*b*) Least lateral dimension

(*c*) Maximum lateral dimension (*d*) Maximum radius of gyration

Ans. (*a*)

Q. 96. A circular shaft subjected to twisting moment result in maximum shear stress of 60 MPa. The maximum compressive stress in the material is

(*a*) 30 MPa (*b*) 60 MPa (*c*) 90 MPa (*d*) 120 MPa

Ans. (*b*)

Q. 97. One-half length of 50 mm diameter steel rod is solid while the remaining half is hollow having a bore of 25 mm. The rod is subjected to equal and opposite torque at its ends. If the maximum shear stress in solid portion is τ, the maximum shear stress in the hollow portion is

(*a*) $\frac{15}{16}\tau$ (*b*) τ (*c*) $\frac{4}{3}\tau$ (*d*) $\frac{16}{15}\tau$

Ans. (*a*)

Q. 98. A thick cylinder with internal diameter d and outside diameter $2d$ is subjected to internal pressure p. The maximum hoop stress developed in the cylinder is

(*a*) p (*b*) $\frac{2}{3}p$ (*c*) $\frac{5}{3}p$ (*d*) $2p$

Ans. (*a*)

Q. 99. The volumetric strain in case of a thin cylindrical shell of diameter d, thickness t, subjected to internal pressure p is

(*a*) $\frac{pd}{2tE}.(3 - 2\mu)$ (*b*) $\frac{pd}{3tE}.(4 - 3\mu)$

(*c*) $\frac{pd}{4tE}.(5 - 4\mu)$ (*d*) $\frac{pd}{4tE}.(4 - 5\mu)$

(where E = Modulus of elasticity, μ = Poisson's ratio for the shell material)

Ans. (*c*)

Q. 100. The commonly used technique of strengthening thin pressure vessel is

(*a*) Wire winding (*b*) Shrink fitting (*c*) Auto-frettage (*d*) Multi-layered construction

Ans. (*a*)

Q. 101. In milling machine, the cutting tool is held in position by

(*a*) Chuck (*b*) Spindle (*c*) Arbor (*d*) Tool holder

Ans. (*c*)

Q. 102. A spur gear of 40 teeth is machined in a gear hobbing machine using a double start hob cutter. The speed ratio between the hob and the blank is

(*a*) 1 : 20 (*b*) 1 : 40 (*c*) 40 : 1 (*d*) 20 : 1

Ans. (*d*)

Q. 103. Match *List I (Materials)* with *List II (Machining)* and select the correct answer using the codes given below the Lists :

List I (Materials)	*List II (Machining)*
A. Machining of conducting materials	1. ECM
B. Ruby rod	2. EDM
C. Electrolyte	3. USM
D. Abrasive slurry	4. LBM

Codes :

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

Ans. (*d*)

Q. 104. Cold working produces the following effects :

1. Stresses are set up in the metal
2. Grain structure gets distorted
3. Strength and hardness of the metal are decreased
4. Surface finish is reduced

Which of these statements are correct ?

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

Ans. (*a*)

Q. 105. A gating ratio of 1 : 2 : 4 is used to design the gating system for magnesium alloy casting. This gating ratio refers to the cross-section areas of the various gating elements as given below :

1. Down sprue
2. Runner bar
3. Ingates

The correct sequence of the above elements in the ratio 1 : 2 : 4 is

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

Ans. (*a*)

Q. 106. Match *List I (Products)* with *List II (Casting Process)* and select the correct answer using the codes given below the Lists :

List I (Products)	*List II (Casting Process)*
A. Hollow statues	1. Centrifugal Casting
B. Dentures	2. Investment Casting
C. Aluminium alloy pistons	3. Slush Casting

D. Rocker arms

4. Shell Moulding

5. Gravity Die Casting

Codes :

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

Ans. (*a*)

Q. 107. Match *List I (Welding Defects)* with *List II (Causes)* and select the correct answer using the codes given below the Lists :

List I (*Welding Defects*)	*List II* (*Causes*)
A. Spatter	1. Damp electrodes
B. Distortion	2. Arc blow
C. Slag inclusion	3. Improper cleaning in multipass welding
D. Porosity	4. Poor joint selection

Codes :

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

Ans. (*d*)

Q. 108. High speed electron beam of electron beam welding is focused on the weld spot using

(*a*) Vacuum lens (*b*) Inert gas lens

(*c*) Optical lens (*d*) Magnetic lens

Ans. (*d*)

Q. 109. In resistance welding, heat is generated due to the resistance between

(*a*) Electrode and workpiece (*b*) Asperities between touching plates

(*c*) Two dissimilar metals being in contact

(*d*) Interatomic forces

Ans. (*b*)

Q. 110. A forging method for reducing the diameter of a bar and in the process making it longer it termed as

(*a*) Fullering (*b*) Punching (*c*) Upsetting (*d*) Extruding

Ans. (*a*)

Q. 111. Consider the following steps in forging a connecting rod from the bar stock :

1. Blocking 2. Trimming 3. Finishing 4. Edging

Select the correct sequence of these operations using the codes given below :

Codes : 1. 1—2—3—4 2. 2—3—4—1 3. 3—4—1—2 4. 4—1—3—2

Ans. (*a*)

Q. 112. The extrusion process(es) used for the production of toothpaste tube is/are

1. Tube extrusion 2. Forward extrusion 3. Impact extrusion

Select the correct answer using the codes given below :

Codes : (*a*) 1 only (*b*) 1 and 2 (*c*) 2 and 3 (*d*) 3 only

Ans. (*d*)

Q. 113. Machine tool manufacturers prefer grey cast-iron grade 40 for producing machine columns and tables because grey cast-iron is

1. Heavy
2. Easily castable
3. Easily weldable
4. Having good damping capacity

Select the correct answer using the codes given below :

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

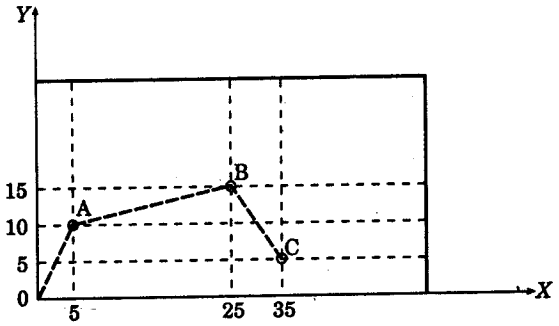
Ans. (*b*)

Q. 114. Which one of the following mechanisms is employed for indexing of turret in an automatic lathe?

(*a*) Whitworth (*b*) Rack and pinion (*c*) Ratchet and pawl (*d*) Geneva wheel

Ans. (*d*)

Q. 115. While part programming in CNC machines, the input of dimensional information for the tool path can be given in the absolute co-ordinate system or in incremental co-ordinate system. The figure shows the route to be followed by the tool from C, *i.e.*, 0-A-B-C. If incremental co-ordinate system is used, the co-ordinates of each point A, B and C are



(*a*) A : X 5.0, Y 10.0
B : X 20.0, Y 5.0
C : X 10.0, Y –10.0

(*b*) A : X 5.0, Y 10.0
B : X 25.0, Y 15.0
C : X 35, Y – 5.0

(*c*) A : X 10.0, Y 5.0
B : X 15.0, Y 25.0
C : X 5.0, Y – 35.0

(*d*) A : X 10.0, Y 5.0
B : X 5.0, Y 20.0
C : X 10.0, Y – 10.0

Ans. (*a*)

Q. 116. Standard time is

(*a*) Normal time + Allowances (*b*) (Normal time × Rating) + Allowances

(*c*) $\left(\frac{\text{Normal time}}{\text{Rating}}\right)$ + Allowances (*d*) Normal time + (Allowances × Rating)

Ans. (*a*)

Q. 117. Which one of the following is *not* a technique of Pre-determined Motion Time Systems ?

(*a*) Work factor system (*b*) MTM

(*c*) Synthetic data (*d*) Stopwatch time study

Ans. (*c*)

Q. 118. An operation consultant for an automatic car wash wishes to plan for enough capacity of stalls to handle 60 cars per hour. Each car will have a wash time of 3 minutes, but there is to be a 20% allowance for set-up time, delays and payment transactions. How many car wash stalls should be installed ?

(*a*) 3 (*b*) 4

(*c*) 5 (*d*) 6

Ans. (*b*)

Q. 119. Which one of the following types of layout is used for the manufacture of huge aircrafts ?

(*a*) Product layout (*b*) Process layout

(*c*) Fixed position layout (*d*) Combination layout

Ans. (*d*)

Q. 120. A furniture company is maintaining a constant work force which can produce 3000 tables per quarter. The annual demand is 12000 units and is distributed seasonally in accordance with the quarterly indexes $Q_1 = 0.80$, $Q_2 = 1.40$, $Q_3 = 1.00$ and $Q_4 = 0.80$. Inventories are accumulated when demand is less than the capacity and are used up during periods of strong demand to supply the total demand. To take into account any seasonal demand the inventories on hand at the beginning of the first quarter should be at least

(*a*) 0 (*b*) 600 (*c*) 1200 (*d*) 2400

Ans. (*c*)

MECHANICAL ENGINEERING — 2004
(PAPER — I)

Q. 1. A small sphere of outer area 0.6 m^2 is totally enclosed by a large cubical hall. The shape factor of hall with respect to sphere is 0.004. What is the measure of the internal side of the cubical hall ?

(*a*) 4 m (*b*) 5 m (*c*) 6 m (*d*) 10 m

Ans. (*b*) $0.004 = 4\pi r^2/6a^2 = 0.6/6a^2$; $a^2 = 0.1/0.004$; $a = 5$

Q. 2. In a vapour compressor refrigeration system, the compressor capacity is 2100 kJ/minute and heat rejection factor is 1.2. What will, respectively be the heat rejected from the condenser and C.O.P.?

(*a*) 5040 kJ/minute and 5 (*b*) 2520 kJ/minute and 5

(*c*) 2520 kJ/minute and 4 (*d*) 5040 kJ/minute and 4

Ans. (*b*)

Q. 3. Which one of the following statements is correct ?
In a domestic refrigerator periodic defrosting is required because frosting

(*a*) causes corrosion of materials (*b*) reduces heat extraction

(*c*) overcools food stuff (*d*) partially blocks refrigerant flow

Ans. (*b*)

Q. 4. Air at 35°C DBT and 25°C dew point temperature passes through the water shower whose temperature is maintained at 20°C. What is the process involved ?

(*a*) Cooling and humidification (*b*) Sensible cooling

(*c*) Cooling and dehumidification (*d*) Heating and humidification

Ans. (*c*)

Q. 5. Consider the following statements :

1. The specific humidity is the ratio of the mass of water vapour to the mass of dry air in a given volume of the mixture.
2. The relative humidity of the atmosphere air is the ratio of the actual mass of the water vapour in a given volume to that which it would have if it were saturated at the same temperature.
3. The degree of saturation is defined as the ratio of the specific humidity of a mixture to the specific humidity of the mixture when saturated at the same temperature.

Which of the statements given above are correct ?

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

Ans. (*d*)

Q. 6. Atmospheric air at dry bulb temperature of 15°C enters a heating coil whose surface temperature is maintained at 40°C. The air leaves the heating coil at 25°C. What will be the by-pass factor of the heating coil ?

(*a*) 0.376 (*b*) 0.4

(*c*) 0.6 (*d*) 0.67

Ans. (*c*) Bypass factor $= \frac{t_o - t_c}{t_i - t_c} = \frac{15}{25} = 0.6$

Q. 7. Velocity of air passing through a rectangular duct and a circular duct is same. Which one of the following is the correct expression for the equivalent diameter of the circular duct in respect of a rectangular duct for the same pressure loss per unit length ? (a and b are the length and breadth of the rectangular duct cross-section)

(a) $\frac{a+b}{ab}$ (b) $\frac{2ab}{a+b}$ (c) $\frac{2a}{a-b}$ (d) $\frac{2b}{a+b}$

Ans. (b)

Q. 8. Which one of the following statements is correct ?

(a) Effective temperature is the index which correlates the combined effects of air dry bulb temperature, air humidity and air movement upon human comfort

(b) The value of effective temperature in winter and summer should be same for human comfort

(c) Effective temperature and wet bulb temperature are one and the same

(d) The value of effective temperature should be higher in winter than in summer for comfort

Ans. (a)

Q. 9. Which of the following are normally desired comfort conditions in an air-conditioning system ?

(a) 25°C DBT and 50% RH (b) 22°C DBT and 90% RH

(c) 15°C DBT and 75% RH (d) 15°C DBT and 40% RH

Ans. (a)

Q. 10. In an air-conditioning plant the refrigeration load on the coil is 100 TR. The mass and enthalpy of air leaving the coil are 420 kg/minute and 40 kJ/kg respectively. What will be the enthalpy of the air at the inlet to the coil under these conditions ?

(a) 80 kJ/kg (b) 90 kJ/kg (c) 100 kJ/kg (d) 102.5 kJ/kg

Ans. (b) $210 \times 100\ TR = 420\ (h_i - 40)$; $h_i = 9$ kJ/kg.

Q. 11. If coefficient of contraction at the vena contracta is equal to 0.62, then what will be the dynamic loss coefficient in sudden contraction in air-conditioning duct ?

(a) 0.25 (b) 0.375 (c) 0.55 (d) 0.65

Ans. (b) $\left(\frac{1}{C_c} - 1\right)^2 = \left(\frac{1}{0.62} - 1\right)^2 = 0.375$

Q. 12. An oil of specific gravity 0.9 has viscosity of 0.28 Stokes at 38°C. What will be its viscosity in Ns/m^2 ?

(a) 0.2520 (b) 0.0311 (c) 0.0252 (d) 0.0206

Ans. (a) $\left(\frac{0.28}{10^4}\right)\frac{m^2}{s} \times 0.9 \times 10^4 = 0.252$

Q. 13. Which one of the following is the correct expression for the critical pressure ratio of a nozzle ?

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

Ans. (c)

Q. 14. What is the critical pressure ratio for isentropic nozzle flow with ratio of specific heats as 1.5 ?

(a) $(0.8)^3$ (b) $(0.)^{0.6}$ (c) $(1.25)^{0.33}$ (d) $(1.25)^3$

Ans. (a)

Q. 15. Consider the following statements :

1. The speed of rotation of the moving elements of gas turbines as much higher than those of steam turbines.
2. Gas turbine plants are heavier and larger in size than steam turbine plants.
3. Gas turbines require cooling water for its operations
4. Almost any kind of fuel can be used with gas turbines.

Which of the statements given above are correct ?

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

Ans. (*c*)

Q. 16. Which one of the following is the feature of pressure-compounding (Rateau staging) ?

(*a*) Low efficiency at low rotational speeds

(*b*) High efficiency with low fluid velocities

(*c*) High efficiency with high fluid velocities

(*d*) Low efficiency at high rotational speeds

Ans. (*d*)

Q. 17. In Parson's reaction turbines, the velocity diagram triangles at the inlet and outlet are which of the following ?

(*a*) Asymmetrical (*b*) Isosceles (*c*) Right-angled (*d*) Congruent

Ans. (*d*)

Q. 18. Which one of the following statements is correct ?
In reciprocating compressors, one should aim at compressing air.

(*a*) adiabatically (*b*) isentropically (*c*) isothermally (*d*) polytropically

Ans. (*c*)

Q. 19. In Parson's turbine if (α) is nozzle angle, then what is the maximum efficiency of the turbine ?

(*a*) $\frac{2\cos\alpha}{(1+\cos\alpha)}$ (*b*) $\frac{2\cos^2\alpha}{(1+\cos^2\alpha)}$ (*c*) $\frac{2\cos^2\alpha}{(1-\cos\alpha)}$ (*d*) $\frac{\cos^2\alpha}{(1+\cos^2\alpha)}$

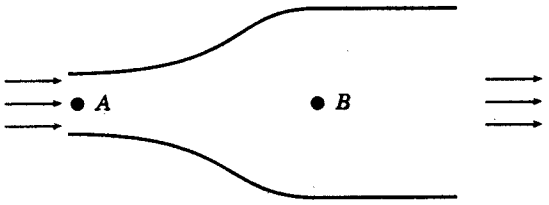
Ans. (*b*)

Q. 20. What is the value of the reheat factor in multi-stage turbine ?

(*a*) 1.03 to 1.04 (*b*) 1.10 to 1.20 (*c*) 0.90 to 1.00 (*d*) 1.20 to 1.25

Ans. (*a*)

Q. 21.



A compressible fluid flows through a passage as shown in the above diagram. The velocity of the fluid at the point A is 400 m/s.

Which one of the following is correct ?

At the point B, the fluid experiences

(*a*) an increase in velocity and decrease in pressure

(*b*) a decrease in velocity and increase in pressure

(*c*) an increase in velocity and pressure

(*d*) a decrease in velocity and pressure

Ans. (*b*)

Q. 22. In which one of the following steam turbines, steam is taken from various points along the turbine, solely for feed-water heating ?

(*a*) Extraction turbine (*b*) Bleeder turbine

(*c*) Regenerative turbine (*d*) Reheat turbine

Ans. (*a*)

Q. 23. Which one of the following is the correct expression for the degree of reaction for an axial-flow air compressor ?

(*a*) $\frac{\text{Work input to the rotor}}{\text{Work input to the stage}}$ (*b*) $\frac{\text{Change of enthalpy in the rotor}}{\text{Change of enthalpy in the stage}}$

(*c*) $\frac{\text{Pressure rise in the rotor}}{\text{Pressure rise in the stage}}$ (*d*) $\frac{\text{Isentropic work}}{\text{Actual work}}$

Ans. (*b*)

Directions : *The following 8 (Eight) items consist of two statements; one labelled as the 'Assertion (A)' and the other as 'Reason (R)'. You are to examine these two statements carefully and select the answers to these items using the codes given below :*

Codes :

(*a*) Both A and R are individually true and R is the correct explanation of A

(*b*) Both A and R are individually 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. 24. *Assertion (A) :* A simple or elementary carburettor provides progressively rich mixture with increasing air flow.
Reason (R) : The density of the air tends to increase as the rate of air flow increases.

Ans. (*c*)

Q. 25. *Assertion (A) :* In lumped heat capacity systems the temperature gradient within the system is negligible.
Reason (R) : In analysis of lumped capacity systems, the thermal conductivity of the system material is considered very high irrespective of the size of the system

Ans. (*a*)

Q. 26. *Assertion (A) :* Subcooling of refrigerant liquid increases the coefficient of performance of a refrigeration cycle.
Reason (R) : Subcooling reduces the work requirements of a refrigeration cycle.

Ans. (*c*) Subcooling increases the refrigeration effect but work requirement remains same.

Q. 27. *Assertion (A) :* A circular plate is immersed in a liquid with its periphery touching the free surface and the plane makes an angle θ with the free surface. With different values of θ, the position of centre of pressure will be different.
Reason (R) : Since the centre of pressure is dependent on second moment of area, with different values of θ, second moment of area for the circular plate will change.

Ans. (*c*) Centre of pressure is $\alpha \sin^2 \theta$ but second moment of area remains same for all angular positions.

Q. 28. *Assertion (A) :* In a supersonic nozzle, with sonic condition at the throat, any reduction of downstream pressure will not be felt at the inlet of the nozzle.
Reason (R) : The disturbance caused downstream of supersonic flow travels at sonic velocity which cannot propagate upstream by Mach cone.

Ans. (*a*)

Q. 29. *Assertion (A) :* For the same power, the rotor of an impulse turbine need not be as large as that of a reaction turbine.
Reason (R) : In the case of a reaction turbine, water has to be admitted to the runner around its entire circumference.

Ans. (*b*)

Q. 30. *Assertion (A) :* For higher specific speeds, radial flow pumps have the greatest efficiency.
Reason (R) : Pumps having larger discharge under smaller heads have higher specific speeds.

Ans. (*b*)

Q. 31. *Assertion (A) :* The volute casing of a centrifugal pump helps in creating the high velocity head necessary for enabling water flow upwards to a higher level.
Reason (R) : The water flows through a diverging passage in the volume chamber.

Ans. (*d*) Volute casing converts high velocity into pressure head.

Q. 32. Which one of the following correctly defines 1 K, as per the internationally accepted definition of temperature scale ?

(*a*) 1/100th of the difference between normal boiling point and normal freezing point of water

(*b*) 1/273.15th of the normal freezing point of water

(*c*) 100 times the difference between the triple point of water and the normal freezing point of water.

(*d*) 1/273.15th of the triple point of water

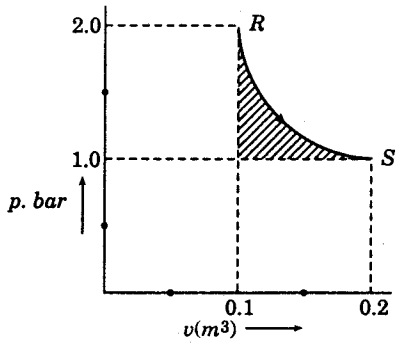
Ans. (*b*)

Q. 33. In a steady-flow adiabatic turbine, the changes in the internal energy, enthalpy, kinetic energy and potential energy of the working fluid, from inlet to exit, are – 100 kJ/kg, – 140 kJ/kg, – 10 kJ/kg and 0 kJ/kg respectively. Which one of the following gives the amount of work developed by the turbine ?

(*a*) 100 kJ/kg (*b*) 110 kJ/kg (*c*) 140 kJ/kg (*d*) 150 kJ/kg

Ans. (*d*) Work = 140 + 10 kJ/kg ; For steady flow, $h = u + pv$; Thus u (internal energy) is part of h.

Q. 34. An ideal gas undergoes an isothermal expansion from state R to state S in a turbine as shown in the diagram given below :



The area of shaded region is 1000 Nm. What is the amount of turbine work done during the process?

(*a*) 14,000 Nm (*b*) 12,000 Nm (*c*) 11,000 Nm (*d*) 10,000 Nm

Ans. (*c*) Work = Projection of RS on Y-axis = $(2.0 - 1.0) \times 10^5 \times 0.1 + 1000 = 11000$ Nm

Q. 35. 170 kJ of heat is supplied to a system at constant volume. Then the system rejects 180 kJ of heat at constant pressure and 150 kJ of work is done on it. The system is finally brought to its original state by adiabatic process. If the initial value of internal energy is 100 kJ, then which one of the following statements is correct ?

(*a*) The highest value of internal energy occurs at the end of the constant volume process

(*b*) The highest value of internal energy occurs at the end of constant pressure process

(*c*) The highest value of internal energy occurs after adiabatic expansion

(*d*) Internal energy is equal at all points

Ans. (*a*)

Q. 36. An insulated box containing 0.5 kg of a gas having $C_v = 0.98$ kJ/kg. It falls from a balloon 4 km above the earth's surface. What will be the temperature rise of the gas when the box hits the ground?

(*a*) 0 K (*b*) 20 K (*c*) 40 K (*d*) 60 K

Ans. (*a*) Since box is insulated, no temperature rise will be transferred to the gas inside the box.

Q. 37. In a heat engine operating in a cycle between a source temperature at 606°C and a sink temperature 20°C, what will be the least rate of heat rejection per kW net output of the engine ?

(*a*) 0.50 kW (*b*) 0.667 kW (*c*) 1.5 kW (*d*) 0.0341 kW

Ans. (*a*) $\frac{879 - 279}{879} = \frac{1\ kW}{1 + H_R}$, $H_R = 0.5\ kW$

Q. 38. Two reversible engines operate between thermal reservoirs at 1200 K, T_2 K and 300 K such that 1st engine receives heat from 1200 K reservoir and rejects heat to thermal reservoir at T_2 K, while the 2nd engine receives heat from thermal reservoir at T_2 K and rejects heat to the thermal reservoir at 300 K. The efficiency of both the engines is equal. What is the value of temperature T_2 ?

(*a*) 400 K (*b*) 500 K (*c*) 600 K (*d*) 700 K

Ans. (*c*) $\frac{1200 - T_2}{1200} = \frac{T_2 - 300}{T_2}$, $T_2 = \sqrt{360000} = 600°K$

Q. 39. A perfect gas at 27°C was heated until its volume was doubled using the following three different processes separately :

1. Constant pressure process 2. Isothermal process 3. Isentropic process

Which one of the following is the correct sequence in the order of increasing value of the final temperature of the gas reached by using the above three different processes ?

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

Ans. (*d*)

Q. 40. A system undergoes a process during which the heat transfer to the system per degree increase in temperature is given by the equation : $\frac{dQ}{dT} = 2.0$ kJ/°C. The work done by the system per degree increase in temperature is given by the equation $\frac{dW}{dT} = 2 - 0.1$ T, where T is in °C. If during the process, the temperature of water varies from 100°C to 150°C, what will be the change in internal energy ?

(*a*) 125 kJ (*b*) – 250 kJ (*c*) 625 kJ (*d*) – 1250 kJ

Ans. (*a*) $dQ = 2 \times (100 - 50) = 100$, $dw = 2 \times (100 - 50) - 0.1 \dfrac{(100 - 50)^2}{2} = -25$

$dQ = du + dw$, $du = 100 - (-25) = 125$ kJ

Q. 41. One kg of air is subjected to the following processes :

1. Air expands isothermally from 6 bar to 3 bar.
2. Air is compressed to half the volume at constant pressure.
3. Heat is supplied to air at constant volume till the pressure becomes three fold.

In which of the above processes, the change in entropy will be positive ?

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

Ans. (*d*) Change of entropy is positive for all these three processes. It would be negative for isothermal compression.

Q. 42. What will be the loss of available energy associated with the transfer of 1000 kJ of heat from constant temperature system at 600 K to another at 400 K when the environmental temperature is 300 K ?

(*a*) 150 kJ (*b*) 250 kJ (*c*) 500 kJ (*d*) 700 kJ

Ans. (*c*) 1000 [(600 – 300)/(600 – 400)] = 500 kJ

Q. 43. The variation of saturation pressure with saturation temperature of a liquid is 0.1 bar/K at 400 K. The specific volume of saturated liquid and dry saturated vapour at 400 K are 0.251 and 0.001 m^3/kg. What will the value of latent heat of vaporization using Clausius Clayperon equation?

(*a*) 16000 kJ/kg (*b*) 1600 kJ/kg (*c*) 1000 kJ/kg (*d*) 160 kJ/kg

Ans. (*c*) $\dfrac{dp}{dT_{sat}} = \dfrac{hg - hf}{T_{sat}(v_g - v_f)}$; 0.1 bar (or 10^4 N/m^2) $= \dfrac{LH}{400\ (0.250)}$; $LH = 10^6$J/kg = 1000 kJkg

Q. 44. Which one of the following represents the condensation of a mixture of saturated liquid and saturated vapour on the enthalpy-entropy diagram ?

(*a*) a horizontal line (*b*) An inclined line of constant slope

(*c*) A vertical line (*d*) A curved line

Ans. (*b*)

Q. 45. For a two-stage reciprocating air compressor, the suction pressure is 1.5 bar and the delivery pressure is 54 bar. What is the value of the ideal intercooler pressure ?

(*a*) 6 bar (*b*) 9 bar (*c*) 27.75 bar (*d*) $9/\sqrt{2}$ bar

Ans. (*b*)

Q. 46. Which of the following action(s) increase(s) the knocking tendency in the S.I. engine ?

(*a*) Increasing mixture strength beyond equivalence ratio (ϕ) = 1.4

(*b*) Retarding the spark and increasing the compression ratio

(*c*) Increasing the compression ratio and reducing engine speed

(*d*) Increasing both mixture strength beyond equivalence ratio (ϕ) = 1.4 and the compression ratio

Ans. (*d*)

Q. 47. Which of the following feature (s) is/are used in the combustion chamber design to reduce S.I. engine knock ?

(*a*) Spark plug located away from exhaust valve, wedge shaped combustion chamber and short flame travel distance

(*b*) Wedge shaped combustion chamber

(*c*) Wedge shaped combustion chamber and short flame travel distance

(*d*) Spark plug located away from exhaust valve, short flame travel distance and side valve design

Ans. (*a*)

Q. 48. Which of the following factor (s) increase (s) the tendency for knocking in the C.I. engine ?

(*a*) Increasing both the compression ratio and the coolant temperature

(*b*) Increasing both the speed and the injection advance

(*c*) Increasing the speed, injection advance and coolant temperature

(*d*) Increasing the compression ratio

Ans. (*c*)

Q. 49. Match List I (*S.I. Engine Operational Mode*) with List II (*Air Fuel Ratio by Mass*) and select the correct answer using the codes given below the Lists :

List I (*S.I. Engine Operational Mode*)	*List II* (*Air Fuel Ratio by Mass*)
A. Idling	1. 4 : 1
B. Cruising	2. 10 : 1
C. Maximum power	3. 12.5 : 1
D. Cold starting	4. 16 : 1
	5. 14.8 : 1

Codes :

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

Ans. (*a*)

Q. 50. Consider the following statements for a multi-jet carburettor :

1. Acceleration jet is located just behind the throttle valve.
2. Idle jet is located close to the choke.
3. Main jet alone supplies petrol at normal engine speeds.

Which of the statements given above are correct ?

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

Ans. (*a*)

Q. 51. The stoichiometric air/fuel ratio for petrol is 15 : 1. What is the air/fuel ratio required for maximum power ?

(*a*) 16 : 1 — 18 : 1 (*b*) 15 : 1

(*c*) 12 : 1 — 14 : 1 (*d*) 9 : 1 — 11 : 1

Ans. (*c*)

Q. 52. Consider the following statements with reference to supercharging of I.C. engines :

1. Reciprocating compressors are invariably used for high degree of supercharging
2. Rotary compressors like roots blowers are quite suitable for low degree of supercharging

3. Axial flow compressors are most commonly employed for supercharging diesel engines used in heavy duty transport vehicles
4. Centrifugal compressors are used for turbo-charging.

Which of the statements given above are correct ?

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

Ans. (*a*)

Q. 53. The relative jet exit velocity from a rocket is 2700 m/s. The forward flight velocity is 1350 m/s. What is the propulsive efficiency of the unit ?

(*a*) 90% (*b*) 66.66% (*c*) 50% (*d*) 33.33%

Ans. (*d*) $\eta_p = \frac{2 \times 1350}{2750 + 1350} = 66.66\%$

Q. 54. What is the ratio of displacement thickness to momentum thickness for linear velocity distribution over a flat plate ?

(*a*) 1.5 (*b*) 2.0 (*c*) 2.5 (*d*) 3.0

Ans. (*d*)

Q. 55. Consider the following statements regarding laminar sublayer of boundary layer flow :

1. The laminar sublayer exists only in a region that occurs before the formation of laminar boundary layer.
2. The laminar sublayer is a region next to the wall where the viscous force is predominant while the rest of the flow is turbulent.
3. The laminar sublayer occurs only in turbulent flow past a smooth plate.

Which of the statements given above is/are correct ?

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

Ans. (*d*)

Q. 56. Match List I (*Flow Depth*) with List II (*Basic Hydraulic Condition Associated therewith*) and select the correct answer using the codes given below the Lists :

List I (*Flow Depth*)	*List II* (*Basic Hydraulic Condition Associated therewith*)
A. Conjugate depth	1. Uniform flow
B. Critical depth	2. Same specific energy
C. Alternate depth	3. Minimum specific energy
D. Normal depth	4. Same specific force
	5. Same bed slope

Codes :

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

Ans. (*c*)

Q. 57. A 40 mm diameter 2 m long straight uniform pipe carries a steady flow of water (viscosity 1.02 centipoise) at the rate of 3.0 litres per minute. What is the approximate value of the shear stress on the internal wall of the pipe ?

(*a*) 0.0166 dyne/cm^2 (*b*) 0.0812 dyne/cm^2

(*c*) 8.12 dyne/cm^2 (*d*) 0.9932 dyne/cm^2

Ans. (*c*)

Q. 58. Which of the following is the correct expression for the area of flow for a circular channel ? (Where θ = half the angle subtended by water surface at the centre and R = radius of the circular channel)

(*a*) $R^2\left(2\theta - \frac{\sin 2\theta}{2}\right)$ (*b*) $R^2\left(\theta - \frac{\sin 2\theta}{2}\right)$ (*c*) $R^2(2\theta - \sin 2\theta)$ (*d*) $2R^2(\theta - \sin 2\theta)$

Ans. (*b*)

Q. 59. A 1.0 m long model of a ship is towed at a speed of 81 cm/s in a towing tank. To what speed of the ship, 64 m long does this correspond to ?

(*a*) 7.20 m/s (*b*) 6.48 m/s (*c*) 5.76 m/s (*d*) 3.60 m/s

Ans. (*b*) $V_p = V_m\sqrt{\frac{L_P}{L_m}} = 0.81 \times \sqrt{\frac{64}{1}} = 6.48$ m/s

Q. 60. In a flow condition where both viscous and gravity forces dominate and both the Froude number and the Reynolds number are the same in model and prototype; and the ratio of kinematic viscosity of model to that of the prototype is 0.0894. What is the model scale ?

(*a*) 1 : 3.3 (*b*) 3.3 : 1 (*c*) 5 : 1 (*d*) 1 : 5

Ans. (*d*) $L_m/L_p = (\nu_m/\nu_p)^{2/3} = (0.0894)^{2/3} = 1/5$

Q. 61. A ship whose full length is 100 m is to travel at 10 m/s. For dynamic similarity, with what velocity should a 1 : 25 model of the ship be towed ?

(*a*) 2 m/s (*b*) 10 m/s (*c*) 25 m/s (*d*) 250 m/s

Ans. (*a*) $V_m = V_p\sqrt{\frac{L_m}{Lp}} = 10\sqrt{\frac{1}{25}} = 2$ m/s

Q. 62. Match List I (*Type of Model*) with List II (*Transference Ratio for Velocity*) and select the correct answer using the codes given below the Lists :

List I (Type of Model)	*List II (Transference Ratio for Velocity)*
A. Reynolds model	1. $\sqrt{K_r/\rho_r}$
B. Froude model	2. $\sqrt{\sigma_r/(\rho_r l_r)}$
C. Weber model	3. $\mu_r/(\rho_r l_r)$
D. Mach model	4. $\sqrt{g_r l_r}$

(Where symbols g, μ, ρ, σ and K have their usual meanings and subscript r refers to the ratio)

Codes :

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

Ans. (*b*) A-3, B-4, C-2, D-1

Q. 63. An aircraft is flying at a speed of 800 km/h at an altitude, where the atmospheric temperature is – 20°C. What is the approximate value of the Mach number of the aircraft ?

(*a*) 0.653 (*b*) 0.697 (*c*) 0.240 (*d*) 0.231

Ans. (*b*) Sonic velocity $= \sqrt{1.4 \times 287 \times 253} = 318.8$;

$$\text{Mach number} = 800 \times 1000/3600 \times \frac{1}{318.8} = 0.697$$

Q. 64. In a perfect gas having ratio of specific heats as 1.4, what is the strength of a normal shock with upstream Mach number equal to 5.0 ?

(*a*) 27 (*b*) 28 (*c*) 29 (*d*) 24

Ans. (*a*) Strength of natural shock $= \frac{p_2 - p_1}{p_1} = \frac{2\nu}{\nu + 1}(M_1^2 - 1) = \frac{2 \times 1.4}{1.4 + 1}(5^2 - 1) = 28$

$$\text{and } \frac{p_2}{p_1} = 28 - 1 = 27$$

Q. 65. Which one of the following statements is relevant to the specific speed of a centrifugal pump ?

(*a*) Head developed is unity and discharge is unity

(*b*) Head developed is unity and power absorbed is unity

(*c*) Discharge is unity and power absorbed is unity

(*d*) Each of head developed, power absorbed and discharge is equal unity

Ans. (*a*)

Q. 66. A centrifugal pump needs 1000 W of power when operating at 1500 rpm. What is the power requirement if the speed of the pump is increased to 3000 rpm ?

(*a*) 2000 W (*b*) 4000 W (*c*) 6500 W (*d*) 8000 W

Ans. (*d*) Power $\propto$ speed^3

Q. 67. Two centrifugal pumps have impellers with outer dimensions of each equal to twice the inner dimensions. The inner diameter of the second impeller is three times the inner diameter of the first one. What is the speed ratio N_2/N_1 of pumps, if the pumps are required to develop the same manometric head to start delivery of water ?

(*a*) 9 (*b*) 4 (*c*) 1/2 (*d*) 1/3

Ans. (*d*) For same head, $D^2 N^2$ is constant, $\therefore$ Speed ratio is 1 : 3

Q. 68. Water is required to be lifted by a 10 kW pump from a depth of 100 m. If the pump is unable to lift the water, then which one of the following is correct ?

(*a*) A greater capacity pump has to be used

(*b*) A larger diameter delivery pipe has to be used

(*c*) A larger diameter suction pipe has to be used

(*d*) A multistage pump has to be used

Ans. (*d*) To lift water from higher depth, higher head is required for which multistage pump must be used.

Q. 69. Which one of the following is correct ?

In positive displacement pumps, the slip can sometimes be negative when the actual discharge is greater than the theoretical discharge. This happens in

(*a*) small suction pipes coupled with a low delivery head

(*b*) small suction pipes coupled with a medium delivery head

(*c*) long suction pipes coupled with a low delivery head

(*d*) long suction pipes coupled with medium delivery head

Ans. (*a*)

Q. 70. A centrifugal pump operating at 1000 rpm develops a head of 30 m. If the speed is increased to 2000 rpm and the pump operates with the same efficiency, what is the head developed by the pump ?

(*a*) 60 m (*b*) 90 m (*c*) 120 m (*d*) 150 m

Ans. (*c*) $H \propto N^2$, $\therefore$ New head $= 2^2 \times 30$

Q. 71. What is the range of the speed ratio ϕ for Kaplan turbine for its most efficient operation ?

(*a*) 0.10 to 0.30 (*b*) 0.43 to 0.65 (*c*) 0.85 to 1.20 (*d*) 1.40 to 2.00

Ans. (*d*)

Q. 72. Match List I (*Type of Pump*) with List II (*Liquid Handled*) and select the correct answer using the codes given below the Lists :

List I (*Type of Pump*)	*List II* (*Liquid Handled*)
A. Closed impeller pump	1. Sandy water
B. Semi-open impeller pump	2. Acids
C. Open impeller pump	3. Sewage water

Codes :

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

Ans. (*c*)

Q. 73. An impulse turbine operating with a single nozzle has a specific speed of 5. What will be the approximate specific speed of the turbine if the turbine is operated with one more additional nozzle of the same size ?

(*a*) 4 (*b*) 6 (*c*) 7 (*d*) 10

Ans. (*d*)

Q. 74. Two centrifugal pumps 'A' and 'B' operate at their maximum efficiencies at 1000 rpm and 500 rpm respectively. Against the same delivery head, pump 'A' discharges 1 m^3/s and pump B discharges 4 m^3/s respectively. What is the ratio of specific speeds $(N_s)_A : (N_s)_B$?

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

Ans. (*b*) $\frac{1000\sqrt{1}}{1^{3/4}} : \frac{500\sqrt{4}}{1^{3/4}}$, 1 : 1

Q. 75. Match List I (*Specific Speed*) with List II (*Expression/Magnitude*) and select the correct answer using the codes given below the Lists :

List I (*Specific Speed*)	*List II* (*Expression/Magnitude*)
A. Specific speed of turbine	1. $N\sqrt{Q}/H^{\frac{3}{4}}$
B. Specific speed of pump	2. $N\sqrt{P}/H^{\frac{5}{4}}$
C. Specific speed of pelton wheel	3. 50 – 250
D. Specific speed of Francis turbine	4. 10 – 50

Codes :

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

Ans.(*c*) A-2, B-1, C-4, D-3

Q. 76. Which one of the following pairs is ***not*** correctly matched ?

(*a*) Centrifugal pump : Rotating blades in the motor create centrifugal head

(*b*) Reciprocating pump : Positive displacement pump

(*c*) Turbine pump : Centrifugal pump with guide vanes

(*d*) Gear pump : Gear teeth work like rotating blades to create centrifugal head

Ans. (*a*)

Q. 77. Match List I (*Flow Parameter*) with List II (*Type of Turbine*) and select the correct answer using the codes given below the Lists :

List I (*Flow Parameter*)	*List II* (*Type of Turbine*)
A. High head	1. Francis turbine
B. Axial flow	2. Pelton wheel
C. Mixed flow	3. Kaplan turbine
D. High specific speed	

Codes :

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

Ans. (*c*)

Q. 78. Which one of the following statements is correct ?
When a fluid passes from the inlet to exit of the rotor in a centrifugal pump, tangential momentum

(*a*) increases and energy increases

(*b*) decreases and energy increases

(*c*) remains unchanged and energy decreases

(*d*) increases and energy remains unchanged

Ans. (*a*)

Q. 79. A Francis turbine is coupled to an alternator to generating electricity with a frequency of 50 Hz. If the alternator has 12 poles, then the turbine should be regulated to run at which one of the following constant speeds ?

(*a*) 250 rpm (*b*) 500 rpm (*c*) 600 rpm (*d*) 1000 rpm

Ans. (*b*)

Q. 80. Consider the following statements regarding waste-heat boilers :

1. Waste-heat boilers are placed in the path of exhaust gases.
2. These are fire tube boilers
3. The greater portion of the heat transfer in such boilers is due to convection.

Which of the statements given above are correct ?

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

Ans. (*d*)

Q. 81. Consider the following statements regarding performance of turbojet engines :

1. The thrust decreases at higher altitudes due to reduced density of air and consequently lower mass flow of air.
2. At subonic speeds, the effect of increased velocity is to increase the air flow and the thrust increases.
3. The relative velocity of jet with respect to the medium decreases at higher speeds which tends to reduce the thrust.
4. For turbojet engine the thrust of jet at subsonic speeds remains relatively constant.

Which of the statements given above are correct ?

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

Ans. (*b*)

Q. 82. Consider the following statements for NO_x emissions from I.C. engines :

1. Formation of NO_x depends upon combustion temperature.
2. Formation of NO_x depends upon type of coolant used.
3. Exhaust gas recirculation is an effective means for control of NO_x.
4. Activated Platinum is used for reduction of NO_x.

Which of the statements given above are correct ?

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

Ans. (*a*)

Q. 83. Consider the following statements :

Exhaust emissions of carbon monoxide from spark ignition engine is

1. mainly fuel-air mixture strength dependent.
2. in the range of zero to 10%.
3. measured with the help of an instrument working on the principle of non-dispersive infra-red analysis.
4. controlled by the use of a two way catalytic convertor.

Which of the statements given above are correct ?

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

Ans. (*d*)

Q. 84. Which one of the following orders is the correct order of passing the flue gases through the different absorbents (in the flasks) during analysis in Orsat apparatus ?

(*a*) Potassium hydroxide solution—alkaline solution of pyrogallic acid—cuprous chloride solution

(*b*) Potassium hydroxide solution—cuprous chloride solution—alkaline solution of pyrogallic acid

(*c*) Alkaline solution of pyrogallic acid—cuprous chloride solution—Potassium hydroxide solution

(*d*) Cuprous chloride solution—Potassium hydroxide solution—alkaline solution of pyrogallic acid

Ans. (*a*)

Q. 85. An engine using octane-air mixture has N_2, O_2, CO_2, CO and H_2O as constituents in the exhaust gas. Which one of the following can be concluded ?

(*a*) Supply mixture is stoichiometric (*b*) Supply mixture has incomplete combustion

(*c*) Supply mixture is rich (*d*) Supply mixture is lean

Ans. (*b*) Since exhaust gas has CO and O_2, it suggests that combustion is incomplete.

Q. 86. Which one of the following statements is correct ? In CANDU type nuclear reactor

(*a*) natural uranium is used as fuel and water as moderator

(*b*) natural uranium is used as fuel and heavy water as moderator

(*c*) enriched uranium is used as fuel and water as moderator

(*d*) enriched uranium is used as fuel and heavy water as moderator

Ans. (*d*)

Q. 87. Match List I (*Material*) with List II (*Application*) and select the correct answer using the codes given below the Lists :

List I (Material)	*List II (Application)*
A. Plutonium-239	1. Fertile material
B. Thorium-232	2. Control rods
C. Cadmium	3. Moderator
D. Graphite	4. Fissile material

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. 88. Which one of the following statement is correct ?

The curve for unsteady state cooling or heating of bodies is

(*a*) parabolic curve asymptotic to time axis (*b*) exponential curve asymptotic to time axis

(*c*) exponential curve asymptotic both to time and temperature axes

(*d*) hyperbolic curve asymptotic both to time and temperature axes

Ans. (*b*) $\frac{t - t_a}{t_1 - t_a} = e^{-\left(\frac{hA_1}{\rho CV}\right)\tau}$

Q. 89. What will be the geometric mean radius of heat transfer for a hollow sphere of inner and outer radii r_1 and r_2 ?

(*a*) $\sqrt{r_1 r_2}$ (*b*) $r_2 r_1$ (*c*) r_2/r_1 (*d*) $(r_2 - r_1)$

Ans. (*a*)

Q. 90. A composite wall is made of two layers of thickness δ_1 and δ_2 having thermal conductivities K and 2K and equal surface areas normal to the direction of heat flow. The outer surfaces of the composite wall are at 100°C and 200°C respectively. The heat transfer takes place only by conduction and the required surface temperature at the junction is 150°C. What will be the ratio of their thicknesses, $\delta_1 : \delta_2$?

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

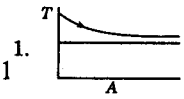
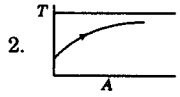
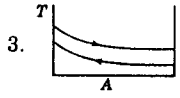
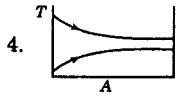
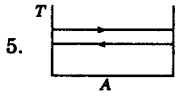
Ans. (*b*)

Q. 91. A hollow pipe of 1 cm outer diameter is to be insulated by thick cylindrical insulation having thermal conductivity 1 W/mK. The surface heat transfer coefficient on the insulation surface is 10 W/m^2K. What is the minimum effective thickness of insulation for causing the reduction in heat leakage from the insulated pipe ?

(*a*) 10 cm (*b*) 15 cm (*c*) 19.5 cm (*d*) 20 cm

Ans. (*a*) Critical thickness $= \frac{k}{h} = \frac{1}{10}$ m = 10 cm

Q. 92. Match List I (*Heat Exchanger Process*) with List II (*Temperature Area Diagram*) and select the correct answer using the codes given below the Lists :

List I (*Heat Exchanger Process*)	*List II* (*Temperature Area Diagram*)
A. Counter flow sensible heating	1. 
B. Parallel flow sensible heating	2. 
C. Evaporating	3. 
D. Condensing	4. 
	5. 

Codes :

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

Ans. (*a*)

Q. 93. Nusset number for a pipe flow heat transfer coefficient is given by the equation $Nu_D = 4.36$. Which one of the following combinations of conditions do exactly apply for use of this equation ?

(*a*) Laminar flow and constant wall temperature

(*b*) Turbulent flow and constant wall heat flux

(*c*) Turbulent flow and constant wall temperature

(*d*) Laminar flow and constant wall heat flux

Ans. (*d*) For fully developed flow, Nu = 4.36 for constant wall heat flux and 3.65 for constant wall temperature

Q. 94. Match List I (*Process*) with List II (*Predominant Parameter Associated with the Flow*) and select the correct answer using the codes given below the Lists :

List I (*Process*)	*List II* (*Predominant Parameter Associated with the flow*)
A. Transient conduction	1. Shearwood Number
B. Mass transfer	2. Mach number
C. Forced convection	3. Biot Number
D. Free convection	4. Grashof Number
	5. Reynolds Number

Codes :

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

Ans. (*c*)

Q. 95. Which one of the following statements is correct ?
The non-dimensional parameter known as Stanton number (St) is used in

(*a*) forced convection heat transfer in flow over flat plate

(*b*) condensation heat transfer with laminar film layer

(*c*) natural convection heat transfer over flat plate

(*d*) unsteady heat transfer from bodies in which internal temperature gradients cannot be neglected

Ans. (*a*)

Q. 96. In a convective heat transfer situation Reynold number is very large but the Prandtl number is so small that the product Re × Pr is less than one. In such a condition which one of the following is correct ?

(*a*) Thermal boundary layer does not exist

(*b*) Viscous boundary layer thickness is less than the thermal boundary layer thickness

(*c*) Viscous boundary layer thickness is equal to the thermal boundary layer thickness

(*d*) Viscous boundary layer thickness is greater than the thermal boundary layer thickness

Ans. (*b*)

Q. 97. Match List I (*Surfaces with Orientations*) with List II (*Equivalent Emissivity*) and select the correct answer using the codes given below the Lists :

List I (*Surfaces with Orientations*)	*List II* (*Equivalent Emissivity*)
A. Infinite parallel planes	1. ε_1
B. Body I completely enclosed by body 2 but body 1 is very small	2. $\dfrac{1}{\frac{1}{\varepsilon_1}+\frac{1}{\varepsilon_2}-1}$
C. Radiation exchange between two small gray bodies	3. $\dfrac{1}{\frac{1}{\varepsilon_1}+\left(\frac{A_1}{A_2}\right)\left(\frac{1}{\varepsilon_2}-1\right)}$
D. Two concentric cylinders with large lengths	4. $\varepsilon_1 \cdot \varepsilon_2$

Codes :

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

Ans. (*c*)

Q. 98. Two spheres A and B of same material have radii 1 m and 4 m and temperature 4000 K and 2000 K respectively. Which one of the following statements is correct ?

The energy radiated by sphere A is

(*a*) greater than that of sphere B (*b*) less than that of sphere B

(*c*) equal to that of sphere B (*d*) equal to double that of sphere B

Ans. (*a*)

Q. 99. For an opaque plane surface the irradiation, radiosity and emissive power are respectively 20, 12 and 10 W/m^2. What is the emissivity of the surface ?

(*a*) 0.2 (*b*) 0.4 (*c*) 0.8 (*d*) 1.0

Ans. (*d*) $G = 20, J = 12, E = 12$; $J = \varepsilon E_b + (1 - \varepsilon) G$;

$\varepsilon = E/E_b$; $\therefore$ $J = E + (1 + \varepsilon) G$; $12 = 12 + (1 - \varepsilon)\, 20, \varepsilon = 1$

Q. 100. Two long parallel surfaces, each of emissivity 0.7 are maintained at different temperatures and accordingly have radiation exchange between them. It is desired to reduce 75% of this radiant heat transfer by inserting thin parallel shields of equal emissivity (0.7) on both sides. What would be the number of shields ?

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

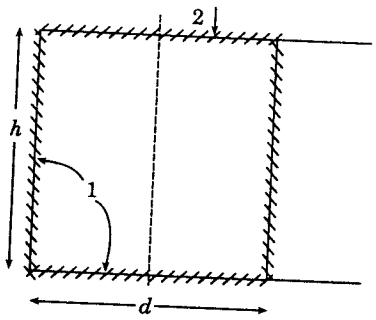
Ans. (c) $q_r/A = \dfrac{1}{n+1}\left(\dfrac{q0}{A}\right)$ To reduce 75% heat, reduced heat rate is 25%, $\therefore$ $1/4 = 1/n + 1$; $n = 3$

Q. 101. The earth receives at its surface radiation from the sun at the rate of 1400 W/m^2. The distance of centre of sun from the surface of earth is 1.5×10^{11} m and the radius of sun is 7.0×10^8 m. What is approximately the surface temperature of the sun treating the sun as a black body ?

(*a*) 3650 K (*b*) 4500 K (*c*) 5800 K (*d*) 6150 K

Ans. (*c*)

Q. 102.



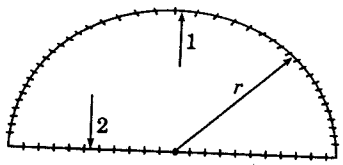
What is the value of the shape factor F_{12} in a cylindrical cavity of diameter d and height h between bottom face known as surface 1 and top flat surface known as surface 2 ?

(*a*) $\frac{2h}{2h+d}$ (*b*) $\frac{d}{d+4h}$

(*c*) $\frac{4d}{4d+h}$ (*d*) $\frac{2d}{2d+h}$

Ans. (*b*)

Q. 103.



A hemispherical surface 1 lies over a horizontal plane surface 2 such that convex portion of the hemisphere is facing sky. What is the value of the geometrical shape factor F_{12} ?

(*a*) 1/4 (*b*) 1/2

(*c*) 3/4 (*d*) 1/8

Ans. (*b*)

Q. 104. A heat engine with 30 % efficiency drives a refrigerator of C.O.P. 5.0. What would be the net heat input to the engine for each MW of heat removed in the refrigerator ?

(*a*) 66.67 kJ (*b*) 600 kJ

(*c*) 666.67 kJ (*d*) 6600 kJ

Ans. (*c*) COP = Refrigeration effect/work done, $5 = 1 \times 10^3/v$

or W = 200 kW and network done = 200/0.3 = 666.66 kW

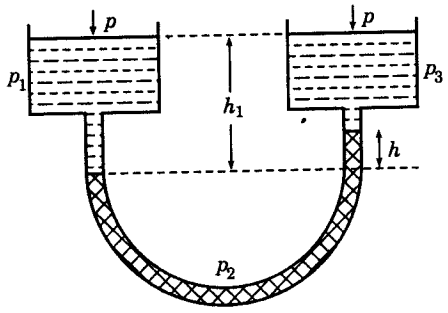
Q. 105. A mercury-water manometer has a gauge difference of 500 mm (difference in elevation of meniscii). What will be the difference in pressure ?

(*a*) 0.5 m (*b*) 6.3 m

(*c*) 6.8 m (*d*) 7.3 m

Ans. (*c*)

Q. 106.



The balancing column shown in the above diagram contains 3 liquids of different densities ρ_1, ρ_2 and ρ_3. The liquid level of one limb is h_1 below the top level and there is a difference of h relative to that in the other limb.

What will be the expression for h ?

(*a*) $\frac{\rho_1 - \rho_2}{\rho_1 - \rho_3} h_1$ (*b*) $\frac{\rho_2 - \rho_3}{\rho_1 - \rho_3} h_1$ (*c*) $\frac{\rho_1 - \rho_3}{\rho_2 - \rho_3} h_1$ (*d*) $\frac{\rho_1 - \rho_2}{\rho_2 - \rho_3} h_1$

Ans. (*c*) $\rho_1 h_1 = \rho_2 h + \rho_3 (h_1 - h)$; $h = \frac{h_1 (\rho_1 - \rho_3)}{\rho_2 - \rho_3}$

Q. 107. A circular annular plate bounded by two concentric circle of dimeter 1.2 m and 0.8 m is immersed in water with its plane making an angle of 45° with the horizontal. The centre of the circles is 1.625 m below the free surface. What will be the total pressure force on the face of the plate ?

(*a*) 7.07 kN (*b*) 10.00 kN (*c*) 14.14 kN (*d*) 18.00 kN

Ans. Total Pressure $= \rho g A \bar{x} = 10^3 \times 9.81 \times \frac{\pi}{4} (1.2^2 - 0.8^2) \times 1.625 = 10.00$ kN

Q. 108. A plate of rectangular shape having the dimensions of 0.4 m × 0.6 m is immersed in water with its longer side vertical. The total hydrostatic thrust on one side of the plate is estimated as 18.3 kN. All other conditions remaining the same, the plate is turned through 90° such that its longer side remains vertical. What would be the total force on one face of the plate ?

(*a*) 9.15 kN (*b*) 18.3 kN (*c*) 36.6 kN (*d*) 12.2 kN

Ans. (*b*)

Q. 109. An open rectangular box of base $2m \times 2m$ contains a liquid of specific gravity 0.80 up to a height of 2.5 m. If the box is imparted a vertically upward acceleration of $4.9 m/s^2$, what will be the pressure on the base of the tank ?

(*a*) 9.81 kPa (*b*) 19.62 kPa (*c*) 36.80 kPa (*d*) 29.40 kPa

Ans. (*a*)

Q. 110. A constant-head water tank has, on one of its vertical sides two identical small orifices issuing two horizontal jets in the same vertical plane. The vertical distance between the centres of orifices is 1.5 m and the jet trajectories interest at a point 0.5 m below the lower orifice. What is the approximate height of water level in the tank above the point of intersection trajectories ?

(*a*) 1.0 m (*b*) 2.5 m

(*c*) 0.5 m (*d*) 2.0 m

Ans. (*b*) $\sqrt{H - 0.5} = \sqrt{\frac{g x^2}{2 \times 0.5}}$; $\sqrt{H - 2} = \sqrt{\frac{g x^2}{2 \times 2}}$; $H = 2.5$ m

Q. 111. The components of velocity in a two-dimensional frictionless incompressible flow are $u = t^2 + 3y$ and $v = 3t + 3x$. What is the approximate resultant total accelaration at the point (3, 2) and t = 2 ?

(*a*) 5 (*b*) 49 (*c*) 59 (*d*) 54

Ans. (*d*)

Q. 112. The stream function $\psi = x^3 - y^3$ is observed for a two dimensional flow field. What is the magnitude of the velocity at point (1, – 1) ?

(*a*) 4.24 (*b*) 2.83 (*c*) 0 (*d*) – 2.83

Ans. (*a*)

Q. 113. Which one of the following statements is correct ?
Irrotational flow is characterized as the one in which

(*a*) the fluid flow along a straight line

(*b*) the fluid does not rotate as it moves along

(*c*) the net rotation of fluid particles about their mass centres remains zero

(*d*) the streamlines of flow are curved and closely spaced

Ans. (*c*)

Q. 114. A 20 cm diameter 500 m long water pipe with friction factor $u_f = 0.025$, leads from a constant-head reservoir and terminates at the delivery end into a nozzle discharging into air. (Neglect all energy losses other than those due to pipe friction). What is the approximate diameter of the jet for maximum power ?

(*a*) 6.67 mm (*b*) 5.98 mm (*c*) 66.7 mm (*d*) 59.8 mm

Ans. (*d*)

Q. 115. Which of the following functions represent the velocity potential in a two - dimensional flow of an ideal fluid ?

1. $2x + 3y$
2. $4x^2 - 3y^2$
3. $\cos(x - y)$
4. $\tan^{-1}(x/y)$

Select the correct answer using the codes given below :

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

Ans. (*d*)

Q. 116. The pressure drop for a relatively low Reynolds number flow in a 600 mm, 30 m long pipeline is 70 kPa. What is the wall shear stress ?

(*a*) 0 Pa (*b*) 350 Pa (*c*) 700 Pa (*d*) 1400 Pa

Ans. (*b*) Shear stress $= -\mu \frac{dv}{dr} = \frac{(p_1 - p_2)\,\pi\gamma^2}{2\pi\gamma l}$

$$= \frac{(p_1 - p_2)e}{2l} = 350 \text{ Pa}$$

Q. 117. A pitot-static tube (C = 1) is used to measure air flow. With water in the differential manometer and a gauge difference of 75 mm, what is the value of air speed if $\rho = 1.16$ kg/m^3 ?

(*a*) 1.21 m/s (*b*) 16.2 m/s (*c*) 35.6 m/s (*d*) 71.2 m/s

Ans. (*c*)

Q. 118. Match List I (*Measuring Devices*) with List II (*Measured Parameter*) and select the correct answer using the codes given below the Lists :

List I (Measuring Devices)	*List II (Measured Parameter)*
A. Pitot tube	1. Flow static pressure
B. Micro-manometer	2. Rate of flow (indirect)
C. Pipe bend meter	3. Differential pressure
D. Wall pressure tap	4. Flow stagnation pressure

Codes :

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

Ans. (*c*)

Q. 119. Match List I (*Variables in Laminar Boundary Layer Flow over a Flat Plate Set Parallel to the Stream*) with List II (*Related Expression with usual notations*) and select the correct answer using the codes given below the Lists :

List I (Variables in Laminar Boundary Layer Flow over a Flat Plate Set Parallel to the Stream)	*List II (Related Expression with usual notations)*
A. Boundary layer thickness	1. $1.729\sqrt{Ux/v}$
B. Average skin friction coefficient	2. $0.332\rho U^2/\sqrt{Ux/v}$
C. Shear stress at boundary	3. $5\sqrt{vx/U}$
D. Displacement thickness	4. $0.664\sqrt{v/Ux}$
	5. $1.328/\sqrt{UL/v}$

Codes :

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

Ans. (*c*)

Q. 120. A flate plate, 2 m × 0.4 is set parallel to a uniform stream of air (density 1.2 kg/m^3 and viscosity 16 centistokes) with shorter edges along the flow. The air velocity is 30 km / h. What is the approximate estimated thickness of boundary layer at the downstream end of the plate ?

(*a*) 1.96 mm (*b*) 4.38 mm (*c*) 13.12 mm (*d*) 9.51 mm

Ans. (*b*) $\delta = \dfrac{0.374 \times L}{(R_e)^{1/5}} = \dfrac{0.374 \times 2}{(0.4 \times 10^5)^{1/5}} = 4.38$ mm

I.E.S. (OBJECTIVE)
MECHANICAL ENGINEERING—2004 (PAPER—II)

Q. 1. Which one of the following statements is correct ? Queuing theory is applied best in situations where
(*a*) arrival rate of costomers equal to service rate
(*b*) average service time is greater than average arrival time
(*c*) there is only one channel of arrival at random and the service time is constant
(*d*) the arrival and service rate connot be analysed through any standard statistical distribution

Ans. (*b*)

Q. 2. Match List I (*Symbols in Flowcharts*) with List II (*Actions*) and select the correct answer using the codes given below the Lists :

List I (Symbols in Flowcharts)	*List II (Actions)*
A. Parallelogram	1. Decision
B. Diamond shaped box	2. Stop
C. Ellipse	3. Processing
D. Rectangle	4. Input/output

Codes :

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

Ans. (*c*)

Q. 3. Which one of the following statements is correct ?
If the size of a flywheel in a punching machine is increased
(*a*) then the fluctuation of speed and fluctuation of energy will both decrease
(*b*) then the functuation of speed will decrease and the fluctuation of energy will increase
(*c*) then the fluctuation of speed will increase and the fluctuation of energy will decrease
(*d*) then the fluctuation of speed and fluctuation of energy both will increase

Ans. (*a*) With bigger flywheel, both fluctuation of speed & fluctuation of energy will decrease

Q. 4. Which one of the following drives is used for a constant velocity ratio, positive drive with large centre distance between the driver and driven shafts ?
(*a*) Gear drive (*b*) Flat belt drive (*c*) Chain drive (*d*) V-belt drive

Ans. (*c*)

Q. 5. What is the value of the radius of gyration of disc type flywheel as compared to rim type flywheel for the same diameter ?
(*a*) $\sqrt{2}$ times (*b*) $1/\sqrt{2}$ times (*c*) 2 times (*d*) 1/2 times

Ans. (*b*) Radius of gyration of solid disc flywheel is $\frac{D}{2\sqrt{2}}$ & that of rim type is $\frac{D}{2}$.

Q. 6. Consider the following statements :

1. RAM is the place in a computer where the operating system, application programs, and data in current use are kept.
2. Data in RAM stays there only as long as the computer is running.

Which of the statements given above is/are correct ?

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

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

Ans. (*c*)

Q. 7. A circular rod of diameter d is welded to a flat plate along its circumference by fillet weld of thickness t. Assuming τ_ω as the allowable shear stress for the weld material, what is the value of the safe torque that can be transmitted ?

(*a*) $\pi d^2 . t . \tau_\omega$ (*b*) $\frac{\pi d^2}{2} t \tau_\omega$ (*c*) $\frac{\pi d^2}{2\sqrt{2}} t \tau_\omega$ (*d*) $\frac{\pi d^2}{\sqrt{2}} t \tau_\omega$

Ans. (*b*) $T = \pi \times d \times t \times \frac{d}{2} \times \tau_\omega$

Q. 8. The rated life of a ball bearing varies inversely as which one of the following ?

(*a*) load (*b*) $(\text{load})^2$ (*c*) $(\text{load})^3$ (*d*) $(\text{load})^{3.33}$

Ans. (*c*) For ball bearings, rated life is $\propto \frac{1}{\text{Load}^3}$ and for roller bearings, it is $\propto \frac{1}{\text{load}^{3.3}}$

Q. 9. Assuming atoms to be perfect spheres, what is the value of the highest possible atomic packing factor (APF) in metals ?

(*a*) 0.95 (*b*) 0.74 (*c*) 0.66 (*d*) 0.5

Ans. (*b*) Face centered cubic structure has 4 atoms in a unit cell and its atomic packing factor

$$= 4 \times \frac{\pi a^3 \sqrt{2}}{24} \div 6/a^3 = 0.74$$

Q. 10. For improving the strength of steel at elevated temperatures, which one of the following alloying element is used ?

(*a*) Copper (*b*) Tungsten (*c*) Aluminium (*d*) Zinc

Ans. (*b*)

Q. 11. Consider the following statements :

1. The operating system must be designed to work with the particular processor's set of instructions.
2. The term processor has generally replaced the term CPU.

Which of the statements given is/are correct ?

(*a*) 1 only (*b*) 2 only (*c*) Both 1 and 2 (*d*) Neither 1 nor 2

Ans. (*c*)

Q. 12. Consider the following statements :

1. The data in ROM is lost when the computer power is turned off.
2. ROM contains the programming that allows the computer to be booted up each time it is turned on.

Which of the statements given above is/are correct ?