Codes :

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

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

Ans. (*a*) Correct matching is A–1, B–3, C–2, D–5.

Q.49. Consider the following statements :

1. Volumetric efficiency of diesel engines is higher than that of SI engines
2. When a SI engine is throttled; its mechanical efficiency decreases.
3. Specific fuel consumption increases as the power capacity of the engine increases.
4. Inspite of higher compression ratios, the exhaust temperature in diesel engines is much lower than that in SI engines.

Of these statements

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

Ans. (*a*) All statements are correct.

Q.50. Consider the following statements about a rocket engine :

1. It is very simple in construction and operation. 2. It can attain very high vehicle velocity.
3. It can operate for very long duration.

Of these statements

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

Ans. (*d*) All statements are correct.

Q.51. Consider the following statements :

CANDU-type nuclear reactor using natural uranium finds extensive use because

1. heavy water is used both as coolant and moderator.
2. cost of fuel used is much lower than that used in pressurised water or boiling water reactor.
3. small leakage of heavy water does not affect the performance of the reactor substantially.
4. fuel consumption is low because of use of heavy water.

Of these statements

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

Ans. (*c*) Statements 1 and 2 are correct.

Q.52. Match List-I with List-II and select the correct answer using the codes given below the Lists :

List-I

A. Prepared fuel
B. Primary fuel
C. Moderator
D. Control rod

List-II

1. Uranium-235
2. Graphite
3. Uranium-233
4. Cadmium

Codes :

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

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

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

Q.53. A solid copper ball of mass 500 grams, when quenched in a water bath at 30°C, cools from 530°C to 430°C in 10 seconds. What will be the temperature of the ball after the next 10 seconds ?

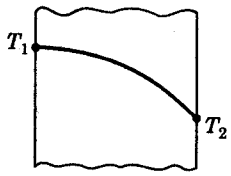
(*a*) 300 °C (*b*) 320 °C (*c*) 350 °C
(*d*) Not determinable for want of sufficient data

Ans. (*c*) In first 10 seconds, temperature is fallen by 100°C. In next 10 seconds fall will be less than 100°C.
$\therefore$ 350°C appears correct solution.

Q.54. A steam pipe is covered with two layers of insulating materials, with the better insulating material forming the outer part. If the two layers are interchanged, the heat conducted
(*a*) will decrease (*b*) will increase (*c*) will remain unaffected
(*d*) may increase or decrease depending upon the thickness of each layer

Ans. (*c*) Heat conducted will remain unaffected irrespective of how insulating materials are placed. However in practice, better material is placed near hot surface.

Q.55. In a large plate, the steady temperature distribution is as shown in the given figure. If no heat is generated in the plate, the thermal conductivity '*k*' will vary as (*T* is temperature and α is a constant)



(*a*) $k_0 (1 + \alpha T)$ (*b*) $k_0 (1 - \alpha T)$
(*c*) $k_0 + \alpha T$ (*d*) $k_0 - \alpha T$

Ans. (*a*) For the shape of temperature profile, $K = K_0 (1 + \alpha T)$.

Q.56. The time constant of a thermocouple is the time taken to attain :
(*a*) the final value to be measured
(*b*) 50% of the value of the initial temperature difference
(*c*) 63.2% of the value of the initial temperature difference
(*d*) 98.8% of the value of the initial temperature difference

Ans. (*c*) Time constant of a thermocouple is the time taken to attain 63.2% of the value of the initial temperature difference.

Q.57. When there is a flow of fluid over a flat plate of length '*L*', the average heat transfer number; (other symbols have the usual meaning).

(*a*) $\int_0^L h_x \, dx$ (*b*) $\frac{d}{dx}(h_x)$ (*c*) $\frac{1}{L}\int_0^L h_x \, dx$ (*d*) $\frac{k}{L}\int_0^L Nu_x \, dx$

Ans. (*c*)

Q.58. When all the conditions are identical, in the case of flow through pipes with heat transfer, the velocity profiles will be identical for :
(*a*) liquid heating and liquid cooling (*b*) gas heating and gas cooling
(*c*) liquid heating and gas cooling (*d*) heating and cooling of any fluid

Ans. (*a*) The velocity profile for flow through pipes with heat transfer is identical for liquid heating and liquid cooling.

Q.59. In the case of turbulent flow through a horizontal isothermal cylinder of diameter '*D*', free convection heat transfer coefficient from the cylinder will
(*a*) be independent of diameter (*b*) vary as $D^{3/4}$
(*c*) vary as $D^{1/4}$ (*d*) vary as $D^{1/2}$

Ans. (*a*) Free convection heat transfer coefficient from the cylinder is independent of its diameter.

Q.60. Sun's surface at 5800 K emits radiation at a wave-length of 0.5 μ. A furnace at 300°C will emit through a small opening, radiation at a wavelength of nearly
(*a*) 10 μ (*b*) 5 μ (*c*) 0.25 μ (*d*) 0.025 μ

Ans. (*b*) As per Wien's law, $\lambda_1 T_1 = \lambda_2 T_2$,
or $5800 \times 0.5 = \lambda_2 \times 573$

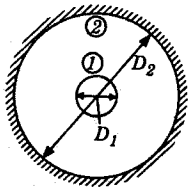
and $$\lambda_2 = \frac{5800 \times 0.5}{573} \approx 5\mu$$

Q.61. Consider the following statements :
If a surface is pock-marked with a number of cavities, then as compared to a smooth surface
1. radiation will increase.
2. nucleate boiling will increase.
3. conduction will increase.
4. convection will increase.

Of these statements
(*a*) 1, 2 and 3 are correct
(*b*) 1, 2 and 4 are correct
(*c*) 1, 3 and 4 are correct
(*d*) 2, 3 and 4 are correct

Ans. (*a*) Convection heat transfer is independent of condition of surface.

Q.62. Consider two infinitely long blackbody concentric cylinders with a diameter ratio $D_2/D_1 = 3$. The shape factor for the outer cylinder with itself will be



(*a*) 0
(*b*) 1/3
(*c*) 2/3
(*d*) 1

Ans. (*d*) Shape factor for two infinitely long concentric cylinders is 1.

Q.63. Consider the following phenomena :
1. Boiling
2. Free convection in air.
3. Forced convection.
4. Conduction in air.

Their correct sequence in increasing order of heat transfer coefficient is :
(*a*) 4, 2, 3, 1 (*b*) 4, 1, 3, 2 (*c*) 4, 3, 2, 1 (*d*) 3, 4, 1, 2

Ans. (*a*) Air being insulator, heat transfer by conduction is least. Next is free convection, followed by forced convection. Boiling has maximum heat transfer.

Q.64. A thermocouple in a thermowell measures the temperature of hot gas flowing through the pipe. For the most accurate measurement of temperature, the thermowell should be made of :
(*a*) steel (*b*) brass (*c*) copper (*d*) aluminium

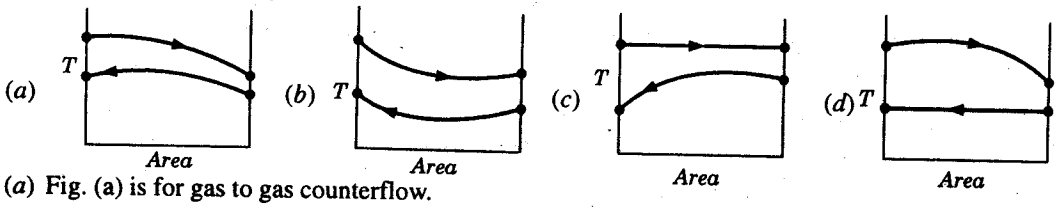
Ans. (*c*) Copper being best conductor compared to other materials, is preferred for accurate measurement.

Q.65. Consider the following statements :
The flow configuration in a heat exchanger, whether counterflow or otherwise, will **NOT** matter if
1. a liquid is evaporating
2. a vapour is condensing
3. mass flow rate of one of the fluids is far greater

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

Ans. (*a*) If liquid is evaporating or a vapour is condensing then whether heat exchanger is counterflow or otherwise is immaterial. Same matters for liquid/gas flows.

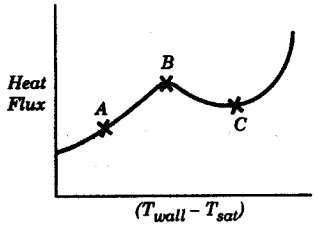
Q.66. Which one of the following diagrams correctly shows the temperature distribution for a gas-to-gas counterflow heat exchanger ?



Ans. (*a*) Fig. (a) is for gas to gas counterflow.

Q.67. Consider the following statements :
The effect of fouling in a water-cooled steam condenser is that it
1. reduces the heat transfer coefficient of water.
2. reduces the overall heat transfer coefficient.
3. reduces the area available for heat transfer.
4. increases the pressure drop of water

Of these statements
(*a*) 1, 2 and 4 are correct (*b*) 2, 3 and 4 are correct
(*c*) 2 and 4 are correct (*d*) 1 and 3 are correct



Ans. (*b*) Heat transfer coefficient of water remains unaffected with fouling.

Q.68. The given figure shows a pool-boiling curve. Consider the following statements in this regard :
1. Onset of nucleation causes a marked change in slope.
2. At the point *B*, heat transfer coefficient is the maximum.
3. In an electrically heated wire submerged in the liquid, film heating is difficult to achieve.
4. Beyond the point *C*, radiation becomes significant.

Of these statements
(*a*) 1, 2 and 4 are correct (*b*) 1, 3 and 4 are correct
(*c*) 2, 3 and 4 are correct (*d*) 1, 2 and 3 are correct

Ans. (*a*) Statements 1, 2 and 4 are correct.

Q.69. A composite wall consists of two layers of different materials having conductivities k_1 and k_2. For equal thickness of the two layers, the equivalent thermal conductivity of the slab will be

(*a*) $k_1 + k_2$ (*b*) $k_1 k_2$ (*c*) $\dfrac{2k_1k_2}{k_1 + k_2}$ (*d*) $\dfrac{k_1 + k_2}{k_1 k_2}$

Ans. (*c*) Equivalent thermal conductivity of two layers is equal to $\dfrac{2k_1k_2}{k_1 + k_2}$

Q.70. Consider the following statements :
In the case of a vapour compression machine, if the condensing temperature of the refrigerant is closer to the critical temperature, then there will be
1. excessive power consumption 2. high compression 3. large volume flow.

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

Ans. (*c*) If the condensing temperature of the refrigerant is closer to the critical temperature, compression will be high and large volume flow will take place.

Q.71. Hydrogen is essential in an Electrolux refrigeration system, because
(*a*) it acts as a catalyst in the evaporator
(*b*) the reaction between hydrogen and ammonia is endothermic in evaporator and exothermic in absorber
(*c*) the cooled hydrogen leaving the heat exchanger cools the refrigerant entering the evaporator
(*d*) it helps in maintaining a low partial pressure for the evaporating ammonia

Ans. (*d*) Hydrogen gas in Electrolux refrigerator helps in maintaining a low partial pressure for the evaporating ammonia.

Q.72. In an ideal refrigeration (reversed Carnot) cycle, the condenser and evaporator temperatures are 27°C and –13°C respectively. The COP of this cycle would be
(*a*) 6.5 (*b*) 7.5 (*c*) 10.5 (*d*) 15.0

Ans. (*a*) $\text{COP} = \frac{T_1}{T_2 - T_1} = \frac{273-13}{(273+27)-(260)} = \frac{260}{300-260} = \frac{260}{40} = 6.5$

Q.73. A single-stage vapour compression refrigeration system cannot be used to produce ultralow temperatures because
(*a*) refrigerants for ultra-low temperatures are not available
(*b*) lubricants for ultra-low temperatures are not available
(*c*) volumetric efficiency will decrease considerably
(*d*) heat leakage into the system will be excessive

Ans. (*a*) Refrigerants for ultra-low temperatures are not available.

Q.74. Vapour absorption refrigeration system works using the
(*a*) ability of a substance to get easily condensed or evaporated
(*b*) ability of a vapour to get compressed or expanded
(*c*) affinity of a substance for another substance
(*d*) absorptivity of a substance

Ans. (*c*) Vapour absorption refrigeration system works using the affinity of a substance for another substance.

Q.75. Which one of the following statements regarding ammonia absorption system is correct ?
The solubility of ammonia in water is
(*a*) a function of the temperature and pressure of the solution
(*b*) a function of the pressure of the solution irrespective of the temperature
(*c*) a function of the temperature of the solution alone
(*d*) independent of the temperature and pressure of the solution

Ans. (*a*) The solubility of ammonia in water is a function of temperature and pressure of the solution.

Q.76. Consider the following statements :
In thermoelectric refrigeration, the coefficient of performance is a function of :
1. electrical conductivity of materials.
2. Peltier coefficient
3. Seebeck coefficient
4. temperature at cold and hot junctions.
5. thermal conductivity of materials.

Of these statements
(*a*) 1, 3, 4 and 5 are correct
(*b*) 1, 2, 3 and 5 are correct
(*c*) 1, 2, 4 and 5 are correct
(*d*) 2, 3, 4 and 5 are correct

Ans. (*b*) In thermoelectric refrigeration, there are no hot and cold junctions.

Q.77. Air cooling is used for freon compressors whereas water jacketing is adopted for cooling ammonia compressors. This is because
(*a*) latent heat of ammonia is higher than that of freon
(*b*) thermal conductivity of water is higher than that of air
(*c*) specific heat of water is higher than that of air
(*d*) of the larger superheat horn of ammonia compression cycle.

Ans. (*a*) Because of high latent heat of ammonia water cooling is required to remove large heat.

Q. 78. Consider the following statements :
A psychrometer measures
1. wet bulb temperature.
2. dew point temperature.
3. dry bulb temperature.

On these statements
(*a*) 1 alone is correct
(*b*) 2 and 3 are correct
(*c*) 1 and 3 are correct
(*d*) 1, 2 and 3 are correct

Ans. (*c*) A psychrometer measures wet bulb temperature and dry bulb temperature.

Q.79. Hot coffee in a cup is allowed to cool. Its cooling rate is measured and found to be greater than the value calculated by conduction, convection and radiation measurements. The difference is due to
(*a*) properties of coffee changing with temperature
(*b*) currents of air flow in the room (*c*) underestimation of the emissivity of coffee
(*d*) evaporation

Ans. (*d*) The difference is due to evaporation.

Q.80. For an airconditioning plant above 300 ton, which one of the following systems would normally be preferred ?
(*a*) Ammonia reciprocating compressor (*b*) Centrifugal chiller
(*c*) Absorption refrigeration system (*d*) Hermetic compressor

Ans. (*a*) Ammonia reciprocating compressor is preferred.

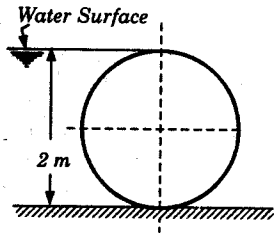
Q.81. Fresh air intake (air change per hour) recommended for ventilation purposes in the airconditioning system of an office building is
(*a*) 1/2 (*b*) 3/2 (*c*) 9/2 (*d*) 25/2

Ans. (*c*) 9/2

Q.82. Given that
Nu = Nusselt number, Re = Reynolds number, Pr = Prandtl number,
Sh = Sherwood number, Sc = Schmidt number and Gr = Grashoff number,
the functional relationship for free convective mass transfer is given as :
(*a*) $Nu = f(Gr, Pr)$ (*b*) $Sh = f(Sc, Gr)$ (*c*) $Nu = f(Re, Pr)$ (*d*) $Sh = f(Re, Sc)$

Ans. (*a*) $\text{Nu} = f(\text{Gr}, \text{Pr})$

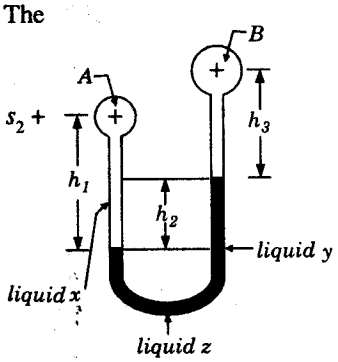
Q.83. A cylindrical gate is holding water on one side as shown in the given figure. The resultant vertical component of force of water per meter width of gate will be
(*a*) zero
(*b*) 7700.8 N/m
(*c*) 15401.7 N/m
(*d*) 30803.4 N/m



Ans. (*d*) Resultant vertical component of force of water per meter width of

$$\text{gate} = \rho\, g\, A\bar{x} = 1000 \times 9.81 \times \frac{\pi}{4} \times 4 \times 1 = 30803.4 \text{ N/m}.$$

Q.84. A differential manometer is used to measure the difference in pressure at points A and B in terms of specific weight of water, W. The specific gravities of the liquids X, Y and Z are respectively s_1, s_2 and s_3. The correct difference $\left(\frac{P_A}{W} - \frac{P_B}{W}\right)$ is given by :
(*a*) $h_3 s_2 - h_1 s_1 + h_2 s_3$ (*b*) $h_1 s_1 + h_2 s_3 - h_3 s_2$ (*c*) $h_3 s_1 - h_1 s_2 + h_2 s_3$ (*d*) $h_1 s_1 + h_2 s_2 - h_3 s_3$



Ans. (*a*) Considering equal pressure plane at h_1 below chamber A,

$$\frac{P_A}{w} + h_1 s_1 = \frac{P_B}{w} + h_3 s_3 + h_2 s_2,$$

$$\therefore \quad \frac{P_A}{w} - \frac{P_B}{w} = h_3 s_3 - h_1 s_1 + h_2 s_2$$

Q.85. A large metacentric height in a vessel
(*a*) improves stability and makes periodic time to oscillation longer

(*b*) impairs stability and makes periodic time of oscillation shorter
(*c*) has no effect on stability or the periodic time of oscillation
(*d*) improves stability and makes the periodic time of oscillation shorter

Ans. (*d*) Large metacentric height improves stability and decreases periodic time of oscillation.

Q.86. The parameters for ideal fluid flow around a rotating circular cylinder can be obtained by superposition of some elementary flows. Which one of the following sets would describe the flow around a rotating circular cylinder ?

(*a*) Doublet, vortex and uniform flow
(*b*) Source, vortex and uniform flow
(*c*) Sink, vortex and uniform flow
(*d*) Vortex and uniform flow

Ans. (*d*) In source flow, all the streamlines are straight lines emanating from an origin. In sink flow all streamlines are directed towards the origin. A doublet flow is obtained by bringing a source and a sink of equal strength.

Q.87. For an irrotational flow, the velocity potential lines and the streamlines are always

(*a*) parallel to each other
(*b*) coplanar
(*c*) orthogonal to each other
(*d*) inclinded to the horizontal

Ans. (*c*) For irrotational flow the velocity potential lines and streamlines are always orthogonal to each other.

Q.88. The dimensions of surface tension is

(*a*) N/m^2 (*b*) J/m (*c*) J/m^2 (*d*) W/m

Ans. (*c*) Dimensions of surface tension are J/m^2.

Q.89. Which one of the following is the bulk modulus K of a fluid ? (Symbols have the usual meaning)

(*a*) $\rho\frac{dp}{d\rho}$ (*b*) $\frac{dp}{\rho d\rho}$ (*c*) $\frac{\rho d\rho}{dp}$ (*d*) $\frac{d\rho}{\rho dp}$

Ans. (*d*) Bulk modulus $K = \frac{d\rho}{\rho dp}$.

Q.90. A hydraulic jump occurs in a channel

(*a*) whenever the flow is supercritical
(*b*) if the flow is controlled by a sluice gate
(*c*) if the bed slope changes from mild to steep
(*d*) if the bed slope changes from steep to mild

Ans. (*b*) A hydraulic jump occurs in a channel when flow is controlled by a sluice gate.

Q.91. Which one of the following statements is true for fully developed flow through pipes ?

(*a*) The flow is parallel, has no inertia effects, the pressure gradient is of constant value and the pressure force is balanced by the viscous force
(*b*) The flow is parallel, the pressure gradient is proportional to the inertia force and there is no viscous effect
(*c*) The flow is parallel, the pressure gradient is negligible and the inertia force is balanced by the viscous force
(*d*) The flow is not parallel, the core region accelerates and the viscous drag is far too less than the inertia force

Ans. (*b*)

Q.92. Match List-I with List-II and select the correct answer using the codes given below the Lists :

List-I (*Measuring device*)	*List-II* (*Parameter measured*)
A. Anemometer	1. Flow rate
B. Piezometer	2. Velocity
C. Pitot tube	3. Static pressure
D. Orifice	4. Difference between static and stagnation pressure

Codes :

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

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

Q.93. Given,

H = height of liquid, b = width of notch,

a = cross-sectional area, a_1 = area at inlet,

a_2 = area at the throat and C_d = coefficient of drag,

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

	List-I		*List-II*
A.	Discharge through venturimeter	1.	$\frac{2}{3} C_d b \sqrt{2g}\ H^{3/2}$
B.	Discharge through an external mouthpiece	2.	$\frac{8}{15} C_d \sqrt{2g}\ H^{5/2}$
C.	Discharge over a rectangular notch	3.	$\frac{C_d a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \sqrt{2gH}$
D.	Discharge over right-angled notch	4.	$0.855\ a \sqrt{2gH}$

Codes :

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

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

Q.94. Flow separation is caused by

(*a*) reduction of pressure to local vapour pressure (*b*) a negative pressure gradient

(*c*) a positive pressure gradient (*d*) thinning of boundary layer thickness to zero

Ans. (*b*)

Q.95. In a turbulent flow, $\bar{u}$, $\bar{v}$ and $\bar{w}$ are time-average velocity components. The fluctuating components are u', v' and w' respectively. The turbulence is said to be isotropic if

(*a*) $\bar{u} = \bar{v} = \bar{w}$ (*b*) $\bar{u} + u' = \bar{v} + v' = \bar{w} + w'$

(*c*) $(\overline{u'})^2 = (\overline{v'})^2 = (\overline{w'})^2$ (*d*) none of the above situations prevails

Ans. (*d*)

Q.96. Shear stress in a turbulent flow is due to

(*a*) the viscous property of the fluid (*b*) the fluid density

(*c*) fluctuation of velocity in the direction of flow

(*d*) fluctuation of velocity in the direction of flow as well as transverse to it

Ans. (*a*)

Q.97. In a turbulent flow, 'l' is the Prandtl's mixing length and $\partial \bar{u} / \partial y$ is the gradient of the average velocity in the direction normal to flow. The final expression for the turbulent viscosity υ_t is given by

(*a*) $\upsilon_t = l \left(\frac{\partial \bar{u}}{\partial y} \right)$ (*b*) $\upsilon_t = \left| \frac{\partial \bar{u}}{\partial y} \right|$ (*c*) $\upsilon_t = l^2 \left(\frac{\partial \bar{u}}{\partial y} \right)$ (*d*) $\upsilon_t = l^2 \left| \frac{\partial \bar{u}}{\partial y} \right|$

Ans. (*d*)

Q.98. During the growth of turbulent boundary layer over a flat plate for a moderately high Reynolds number, the boundary layer thickness, δ varies as

(*a*) $x^{1/3}$ (*b*) $x^{1/2}$ (*c*) $x^{4/5}$ (*d*) $x^{7/8}$

Ans. (*c*)

Q.99. Given that

δ = boundary layer thickness, δ^* = displacement thickness

δ_e = energy thickness θ = momentum thickness

the shape factor H of a boundary layer is given by

(*a*) $H = \frac{\delta_e}{\delta}$ (*b*) $H = \frac{\delta^*}{\theta}$ (*c*) $H = \frac{\delta}{\theta}$ (*d*) $H = \frac{\delta}{\delta^*}$

Ans. (*b*) Shape factor is ratio of displacement thickness and momentum thickness.

Q.100. If U_∞ = free stream velocity, u = velocity at y, and δ = boundary layer thickness, then in a boundary layer flow, the momentum thickness θ is given by

(*a*) $\theta = \int_0^\delta \frac{u}{U_\infty}\left(1-\frac{u}{U_\infty}\right)dy$ (*b*) $\theta = \int_0^\delta \frac{u}{U_\infty}\left(1-\frac{u^2}{U_\infty^2}\right)dy$

(*c*) $\theta = \int_0^\delta \frac{u^2}{U_\infty^2}\left(1-\frac{u}{U_\infty}\right)dy$ (*d*) $\theta = \int_0^\delta \left(1-\frac{u}{U_\infty}\right)dy$

Ans. (*a*)

Q.101. Telephone wires often snap due to crossflow of wind past the wires. The main reason for this is :

(*a*) The force exerted by the wind on the wires is large in magnitude

(*b*) Poor quality of the work executed

(*c*) Wide variation of wind velocity in magnitude and direction

(*d*) Vortex shedding

Ans. (*d*)

Q.102. The variables controlling the motion of a floating vessel through water are the drag force F, the speed v, the length l, the density ρ, dynamic viscosity μ of water, and gravitational constant g. If the non-dimensional groups are Reynolds number (Re), Weber number (We), Prandtl number (Pr) and Froude number (Fr), the expression for F is given by

(*a*) $\frac{F}{\rho v^2 l^2} = f(\text{Re})$ (*b*) $\frac{F}{\rho v^2 l^2} = f(\text{Re, Pr})$

(*c*) $\frac{F}{\rho v^2 l^2} = f(\text{Fr, We})$ (*d*) $\frac{F}{\rho v^2 l^2} = f(\text{Re, Fr})$

Ans. (*d*)

Q.103. Euler number is defined as the ratio of inertia force to

(*a*) viscous force (*b*) elastic force (*c*) pressure force (*d*) gravity force

Ans. (*c*)

Q.104. An inviscid, irrotational flow field of free vortex motion has a circulation constant Ω. The tangential velocity at any point in the flow field is given by Ω/r, where, r is the radial distance from the centre. At the centre, there is a mathematical singularity which can be physically substituted by a forced vortex. At the interface of the free and forced vortex motion ($r = r_c$), the angular velocity ω is given by

(*a*) $\Omega/(r_c)^2$ (*b*) Ω/r_c (*c*) Ωr_c (*d*) Ωr_c^2

Ans. (*d*)

Q.105. Match List-I (Property ratios at the critical and stagnation conditions) with List-II (values of ratios) and select the correct answer using the codes given below the Lists :

List-I	*List-II*
A. $\frac{T^*}{T_0}$	1. $\left(\frac{2}{\gamma+1}\right)^{\frac{1}{\gamma-1}}$
B. $\frac{\rho^*}{\rho_0}$	2. $\frac{2}{\gamma+1}$
C. $\frac{p^*}{p_0}$	3. 1
D. $\frac{S^*}{S_0}$	4. $\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}$

Codes :

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

Ans. (*a*)

Q.106. For oblique shock, the downstream Mach number

(*a*) is always more than unity (*b*) is always less than unity

(*c*) may be less or more than unity (*d*) can never be unity

Ans. (*c*) A two dimensional shock can be considered as an oblique shock. In strong shock solution, Mach numbers is less than one. In weak shock solution, Mach number is always greater than 1.

Q.107. Fanno line flow is a flow in a constant area duct

(*a*) with friction and heat transfer but in the absence of work

(*b*) with friction and heat transfer and accompanied by work

(*c*) with friction but in the absence of heat transfer and work

(*d*) without friction but accompanied by heat transfer and work

Ans. (*c*)

Q.108. Reyleigh line flow is a flow in a constant area duct

(*a*) with friction but without heat transfer (*b*) without friction but with heat transfer

(*c*) with both friction and heat transfer (*d*) without either friction or heat transfer

Ans. (*b*)

Directions :

The following 12 (twelve) 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.109. *Assertion (A)* : The work done in Parson's reaction turbine is twice the work done during expansion in the moving blades.

Reason (R) : The steam expands both in the moving as well as in the fixed blades in a reaction turbine and in the Parson's turbine, the fixed and moving blades are identical.

Ans. (*a*)

Q.110. *Assertion* (*A*) : In axial flow compressors, momentum blading is more efficient than radial flow blading.

Reason (*R*) : In radial flow blading, the pressure head increases due to centrifugal head.

Ans. (*b*)

Q.111. *Assertion* (*A*) : The thermal efficiency of a gas turbine plant is low as compared to that of reciprocating IC engines.

Reason (*R*) : In a gas turbine plant, the maximum pressure and temperature are low when compared to those of reciprocating IC engines.

Ans. (*a*)

Q.112. *Assertion* (*A*) : Pump lifts water from a lower level to a higher level.

Reason (*R*) : In pump, mechanical energy is converted into pressure energy.

Ans. (*a*)

Q.113. *Assertion* (*A*) : In practice, the efficiency of diesel engines is higher than that of petrol engines.

Reason (*R*) : For the same compression ratio, the efficiency of diesel cycle is higher than that of Otto cycle.

Ans. (*c*) R is not correct because efficiency of otto cycle is higher than diesel cycle for same compression ratio.

Q.114. *Assertion* (*A*) : Pre-chamber diesel engines use higher injection pressures when compared to open combustion chamber engines.

Reason (*R*) : Pre-chamber engines have higher compression pressures.

Ans. (*d*) Precombustion diesel engines use lower injection pressures.

Q.115. *Assertion* (*A*) : One of the important requirements of a carburettor is to supply lean mixture at starting.

Reason (*R*) : A rather lean mixture is required at No-load and low-load operation of a SI engine.

Ans. (*d*) At starting rich mixture is required.

Q.116. *Assertion* (*A*) : Compared to a turbo-jet engine, a turbo-prop engine has a higher power for take-off and higher propulsive efficiency at low speeds.

Reason (*R*) : By mounting the propeller on the turbine shaft, the propeller can be run at a very high speed to obtain higher efficiency.

Ans. (*c*)

Q.117. *Assertion* (*A*) : To increase the stability of an empty ship, ballasts are loaded at the bottom level.

Reason (*R*) : The ballasts increase the weight of the ship.

Ans. (*c*) The ballasts at the bottom level make ship stable.

Q.118. *Assertion* (*A*) : Bernoulli's equation is an energy equation.

Reason (*R*) : Starting from Euler's equation, one can arrive at Bernoulli's equation.

Ans. (*a*)

Q.119. *Assertion* (*A*) : In the case of flow around pipe bends, there will be redistribution of pressure and velocity from inside bend to the outside bend.

Reason (*R*) : Flow will be such that the streamline spacing will decrease towards the inner bend resulting in decrease of pressure head and increase of velocity head at the inner wall.

Ans. (*c*) The velocity head at the inner wall will decrease and pressure head increase.

Q.120. *Assertion* (*A*) : In the case of Fanno line flow, in the subsonic region friction causes irreversible acceleration.

Reason (*R*) : In the case of Fanno line flow, decrease in entropy is not possible either for supersonic or subsonic flows.

Ans. (*b*)

C.E.S. (Objective)

MECHANICAL ENGINEERING – 1997

PAPER–II

Time Allowed : Two Hours *Maximum Marks : 200*

Instructions : See Paper-I, 1997.

Q.1. In orthogonal cutting, the depth of cut is 0.5 mm at a cutting speed of 2 m/s. If the chip thickness is 0.75 mm, the chip velocity is

(*a*) 1.33 m/s (*b*) 2 m/s (*c*) 2.5 m/s (*d*) 3 m/s

Ans. (*a*) Velocity of chip $= \frac{\sin \phi}{\cos (\phi - \alpha)} V$ = chip thickness ratio $\times V$

$$= \frac{\text{depth of cut}}{\text{chip thickness}} \times V = \frac{0.5}{0.75} \times 2 = 1.33 \text{ m/s}$$

Q.2. Consider the following elements :

1. Nose radius 2. Cutting speed 3. Depth of cut 4. Feed

The correct sequence of these elements in DECREASING order of their influence on tool life is

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

Ans. (*a*)

Q.3. The rake angle in a twist drill

(*a*) varies from minimum near the dead centre to a maximum value at the periphery

(*b*) is maximum at the dead centre and zero at the periphery

(*c*) is constant at every point of the cutting edge

(*d*) is a function of the size of the chisel edge.

Ans. (*c*)

Q.4. Which one of the following processes does not cause tool wear ?

(*a*) Ultrasonic machining (*b*) Electrochemical machining

(*c*) Electric discharge machining (*d*) Anode mechanical machining

Ans. (*b*)

Q.5. Consider the following forces acting on a finish turning tool :

1. Feed force. 2. Thrust force. 3. Cutting force.

The correct sequence of the decreasing order of the magnitudes of these forces is

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

Ans. (*c*)

Q.6. Match List-I (Type of drill) with List-II (Application) and select the correct answer using the codes given below the Lists :

List-I	*List-II*
A. Straight shank	1. Soft materials
B. Taper shank	2. Deep holes
C. Single flute	3. General purpose
D. High helix	4. Small hole diameter

Codes :

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

Ans. (*a*)

Q.7. Which of the following are the advantages of a hydraulic shaper over a mechanically driven shaper ?
1. More strokes per minute can be obtained at a given cutting speed.
2. The cutting stroke has a definite stopping point.
3. It is simpler in construction.
4. Cutting speed is constant throughout most of the cutting stroke.

Select the correct answer using the codes given below :
(*a*) 1 and 2 (*b*) 1 and 4 (*c*) 2 and 4 (*d*) 1, 3 and 4

Ans. (*b*)

Q.8. Consider the following operations :
1. Under cutting. 2. Plain turning. 3. Taper turning 4. Thread cutting.

The correct sequence of these operations in machining a product is
(*a*) 2, 3, 4, 1 (*b*) 3, 2, 4, 1 (*c*) 2, 3, 1, 4 (*d*) 3, 2, 1, 4

Ans. (*c*) Under cutting is performed to terminate a thread. Thread cutting is last operation.

Q.9. Which one of the following materials is used as the bonding material for grinding wheels ?
(*a*) Silicon carbide (*b*) Sodium silicate (*c*) Boron carbide (*d*) Aluminium oxide

Ans. (*b*)

Q.10. Consider the following statements :
In Up milling process,
1. the cutter starts the cut from the machined surface and proceeds upwards.
2. the cutter starts the cut from the top surface and proceeds downwards.
3. the job is fed in a direction opposite to that of cutter rotation.
4. the job is fed in the same direction as that of cutter rotation.

Of these statements :
(*a*) 1 and 3 are correct (*b*) 1 and 4 are correct (*c*) 2 and 3 are correct (*d*) 2 and 4 are correct

Ans. (*a*)

Q.11. Which of the following motions are not needed for spur gear cutting with a hob ?
1. Rotary motion of hob. 2. Linear axial reciprocatory motion of hob
3. Rotary motion of gear blank. 4. Radial advancement of hob.

Select the correct answer using the codes given below :
(*a*) 1, 2 and 3 (*b*) 1, 3 and 4 (*c*) 1, 2 and 4 (*d*) 2, 3 and 4

Ans. (*d*)

Q.12. Match List-I (Gear component) with List-II (Preferred method of manufacturing) and select the correct answer using the codes given below the Lists :

List-I	*List-II*
A. Gear for clocks	1. Hobbing
B. Bakelite gears	2. Stamping
C. Aluminium gears	3. Powder compacting
D. Automobile transmission gears	4. Sand casting
	5. Extrusion

Codes :

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

Ans. (*a*)

Q.13. Which one of the following pairs is not correctly matched ?
(*a*) Aluminium alloy piston ..... Pressure die casting
(*b*) Jewellery ..... Lost wax process
(*c*) Large pipes ..... Centrifugal casting
(*d*) Large bells ..... Loam moulding
Ans. (*d*)

Q.14. Consider the following statements :
MIG welding process uses
1. consumable electrode. 2. non-consumable electrode.
3. D.C. power supply. 4. A.C. power supply.
Of these statements :
(*a*) 2 and 4 are correct (*b*) 2 and 3 are correct (*c*) 1 and 4 are correct (*d*) 1 and 3 are correct
Ans. (*d*)

Q.15. If the melting ratio of a cupola is 10 : 1, then the coke requirement for one ton melt will be
(*a*) 0.1 ton (*b*) 10 tons (*c*) 1 ton (*d*) 11 tons
Ans. (*b*)

Q.16. For 50% penetration of work material, a punch with single shear equal to thickness will
(*a*) reduce the punch load to half the value (*b*) increase the punch load by half the value
(*c*) maintain the same punch load (*d*) reduce the punch load to quarter load
Ans. (*c*) When angle of shear = thickness, punch load increases from 0 to maximum at $t/3$, and then remains same from $t/3$ to t, and reduce to zero at $4t/3$.

Q.17. A cup of 10 cm height and 5 cm diameter is to be made from a sheet metal of 2 mm thickness. The number of deductions necessary will be
(*a*) one (*b*) two (*c*) three (*d*) four
Ans. (*c*)

Q.18. The type of quick return mechanism employed mostly in shaping machines is :
(*a*) DC reversible motor (*b*) Fast and loose pulleys
(*c*) Whitworth motion (*d*) Slotted link mechanism
Ans. (*d*)

Q.19. Which of the following are valid statements for point to point motion of the tool in APT language ?
1. GO / TO / ..... 2. GO DLTA / ..... 3. GO / TO, ...
Select the correct answer using the codes given below :
(*a*) 1 and 2 (*b*) 2 and 3 (*c*) 1 and 3 (*d*) 1, 2 and 3
Ans. (*a*)

Q.20. Match List-I with List-II and select the correct answer using the codes given below the Lists :

List-I *(Track numbers on paper tape)*	***List-II*** *(Holes on those tracks represent)*
A. Track no. 1 to 4	1. Alphabets
B. Track no. 5	2. Numerals
C. Track no. 6 and 7	3. End of block
D. Track no. 8	4. Block number
	5. Parity check

Codes :

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

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

Ans. (*a*)

Q.21. The highest stress that a material can withstand for a specified length of time without excessive deformation is called

(*a*) fatigue strength (*b*) endurance strength
(*c*) creep strength (*d*) creep rupture strength

Ans. (*c*) Where highest stress withstand is related with a specified length of time, it refers to creep strength.

Q.22. Guideways of lathe beds are hardened by

(*a*) carburising (*b*) cyaniding (*c*) nitriding (*d*) flame hardening

Ans. (*d*)

Q.23. A given steel test specimen is studied under metallurgical microscope. Magnification used is 100 X. In that different phases are observed. One of them is Fe_3C.
The observed phase Fe_3C is also known as

(*a*) ferrite (*b*) cementite (*c*) austenite (*d*) martensite

Ans. (*b*)

Q.24. Match List-I with List-II and select the correct answer using the codes given below the Lists :

List-I	*List-II*
A. Toughness	1. Moment area method
B. Endurance strength	2. Hardness
C. Resistance to abrasion	3. Energy absorbed before fracture in a tension test
D. Deflection in a beam	4. Fatigue loading

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. (*c*)

Q.25. In metals subjected to cold working, strain hardening effect is due to

(*a*) slip mechanism (*b*) twining mechanism
(*c*) dislocation mechanism (*d*) fracture mechanism

Ans. (*a*)

Q.26. Match List-I with List-II and select the correct answer using the codes are given below the Lists :

List-I	*List-II*
A. Neoprene	1. Electric switches
B. Bakelite	2. Adhesive
C. Foamed polyurethane	3. Thermal insulator
D. Araldite	4. Oil seal

Codes :

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

Ans. (*c*)

Q.27. Which one of the following materials is used for car types as a standard material ?

(*a*) Styrene-butadiene rubber (SBR) (*b*) Butyl rubber
(*c*) Nitrile rubber (*d*) Any of the above depending upon the need

Ans. (*a*)

Q.28. Which one of the following refractory materials is recommended for steel furnaces containing CaO slags ?

(*a*) Alumina (*b*) Silica (*c*) Magnesia (*d*) Fireclay

Ans. (*b*)

Q.29. Which of the following properties of a solid are dependent on crystal imperfections ?
1. Yield stress
2. Melting point
3. Semiconductivity
4. Ductility

Select the correct answer using the codes given below :
(*a*) 1 and 3 (*b*) 1, 3 and 4 (*c*) 2, 3 and 4 (*d*) 2 and 4

Ans. (*b*)

Q.30. Which of the following components can be manufactured by powder metallurgy methods ?
1. Carbide tool tips.
2. Bearings.
3. Filters.
4. Brake linings.

Select the correct answer using the codes given below :
(*a*) 1, 3 and 4 (*b*) 2 and 3 (*c*) 1, 2 and 4 (*d*) 1, 2, 3 and 4

Ans. (*d*)

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

List-I (*Topic*)	*List-II* (*Method of solving*)
A. Forecasting	1. North-West corner method
B. Linear programming	2. Rowan plan
C. Wage incentive	3. Method of penalty
D. Work measurement	4. Time series analysis
	5. Work factor system

Codes :

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

Ans. (*d*)

Q.32. If one state occurred four times in hundred observations while using the work-sampling technique, then the precision of the study using a 95% confidence level will be
(*a*) 90% (*b*) 92% (*c*) 95% (*d*) 98%

Ans. (*c*) Accuracy = $2\sqrt{\frac{p\,(1-p)}{N}}$ for 95% confidence level = $2\sqrt{\frac{.04\times.96}{100}} = 2\times.0196 = 0.0392 = 4\%$

$\therefore$ Precision = 95%.

Q.33. Process I requires 20 units of fixed cost and 3 units of variable cost per piece, while process II required 50 units of fixed cost and 1 unit of variable cost per piece. For a company producing 10 piece per day
(*a*) process I should be chosen
(*b*) process II should be chosen
(*c*) either of the two processes could be chosen
(*d*) a combination of process I and process II should be chosen

Ans. (*a*) For 10 pieces, it is economical to use process I.

Q.34. Given
T = underlying trend,
C = cyclic variations within the trend,
S = seasonal variation within the trend and
R = residual, remaining or random variation,
as per the time series analysis of sales forecasting, the demand will be a function of
(*a*) T and C (*b*) R and S (*c*) T, C and S (*d*) T, C, S and R

Ans. (*c*) In sale forecasting we should not be influenced by the random variations in demand.

Q.35. A production line is said to be balanced when
(*a*) there are equal number of machines at each work station
(*b*) there are equal number of operators at each work station
(*c*) the waiting time for service at each station is the same
(*d*) the operation time at each station is the same
Ans. (*d*)

Q.36. Annual demand for a product costing Rs. 100 per piece is Rs. 900. Ordering cost per order is Rs. 100 and inventory holding cost is Rs. 2 per unit per year. The economic lot size is
(*a*) 200 (*b*) 300 (*c*) 400 (*d*) 500
Ans. (*d*)

Q.37. When there are '*m*' rows and '*n*' columns in a transportation problem, degeneracy is said to occur when the number of allocations is
(*a*) less than $(m + n - 1)$ (*b*) greater than $(m + n - 1)$
(*c*) equal to $(m - n - 1)$ (*d*) less than $(m - n - 1)$
Ans. (*a*)

Q.38. Consider the following linear programming problem :
Max. $Z = 2A + 3B$, subject to $A + B \le 10$, $4A + 6B \le 30$, $2A + B \le 17$, $A, B \ge 0$
What can one say about the solution ?
(*a*) It may contain alternative optima (*b*) The solution will be unbounded
(*c*) The solution will be degenerate (*d*) It cannot be solved by simplex method
Ans. (*a*)

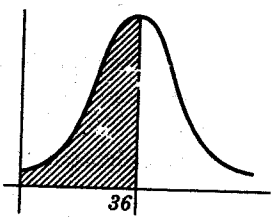
Q.39. Consider two queueing disciplines in a single server queue. Case 1 has a first come first served discipline and case 2 has a last come first served discipline. If the average waiting times in the two cases are W_1 and W_2 respectively, then which one of the following inferences would be true ?
(*a*) $W_1 > W_2$ (*b*) $W_1 < W_2$
(*c*) $W_1 = W_2$ (*d*) Data insufficient to draw any tangible inference
Ans. (*b*)

Q.40. In a single server queue customers are served at a rate of μ. If W and W_q represent the mean waiting time in the system and mean waiting time in the queue respectively, then W will be equal to
(*a*) $W_q - \mu$ (*b*) $W_q + \mu$ (*c*) $W_q + 1/\mu$ (*d*) $W_q - 1/\mu$
Ans. (*c*)

Q.41. Consider the following basic steps involved in value analysis :
1. Create. 2. Blast. 3. Refine.
The correct sequence of these steps is
(*a*) 1, 2, 3 (*b*) 3, 1, 2 (*c*) 1, 3, 2 (*d*) 2, 1, 3
Ans. (*d*)

Q.42. In a PERT network, expected project duration is found to be 36 days from the start of the project. The variance is four days. The probability that the project will be completed in 36 days is
(*a*) Zero
(*b*) 34%
(*c*) 50%
(*d*) 84%

Ans. (*c*) Variance = 4 days, Std. dev. = $\sqrt{4}$ = 2 days
Probability in this case is shaded area in given figure, which is 50%.



Q.43. The variance (V_1) for critical path
a ⟶ b = 4 time units, b ⟶ c = 16 time units, c ⟶ d = 4 time units, d ⟶ e = 1 time unit.
The standard deviation of the critical path a ⟶ e is :
(*a*) 3 (*b*) 4 (*c*) 5 (*d*) 6

Ans. (*c*) Standard Deviation = $\sqrt{4+16+4+1} = \sqrt{25} = 5$

Q.44. Consider the data given in the following table :

Period	*Demand*	*Production plan*		
		Regular production	*Overtime production*	*Others*
1	500	500	—	—
2	650	650	—	
3	800	650	150	—
4	900	650	150	?

Give the fact that production in regular and overtime is limited to 650 and 150 respectively, the balance demand of 100 units in the 4th period can be met by
(*a*) using overtime in period 2 (*b*) using regular production in period 1
(*c*) subcontracting
(*d*) using any of the steps indicated in (*a*), (*b*) and (*c*)

Ans. (*d*)

Q.45. M/s. ABC & Co. is planning to use the most competitive manufacturing process to produce an ultra-modern sports shoe. They can use a fully automatic robot-controlled plant with an investment of Rs. 100 million; alternately they can go in for a cellular manufacturing that has a fixed cost of Rs. 80 million. There is yet another choice of traditional manufacture that needs in investment of Rs. 75 million only. The fully automatic plant can turn out a shoe at a unit variable cost of Rs. 25 per unit, whereas the cellular and the job shop layout would lead to a variable cost of Rs. 40 and Rs. 50 respectively. The break even analysis shows that the break even quantities using automatic plant *vs* traditional plant are in the ratio of 1 : 2. The per unit revenue used in the break even calculation is
(*a*) Rs. 75 (*b*) Rs. 87 (*c*) Rs. 57 (*d*) Rs. 55

Ans. (*a*)

Q.46. Consider the following sets of tasks to complete the assembly of an engineering component :

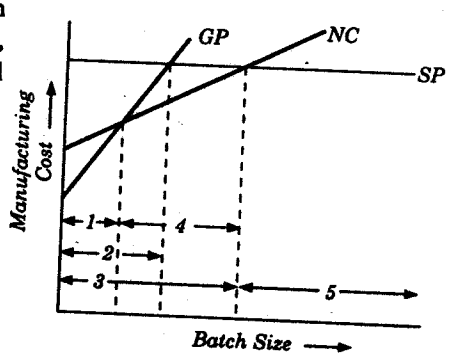
Task	*Time (in seconds)*	*Precedence*
A	10	—
B	20	—
C	15	A
D	5	B
E	30	C
F	15	E
G	5	D

The expected production rate is 3000 units per shift of 8 hour duration. The minimal number of workstations that are needed to achieve this production level is :
(*a*) 4 (*b*) 8 (*c*) 10 (*d*) 11

Ans. (*d*) Precedence is such that there is no waiting time. Total time for one assembly is 100 sec.

$$\therefore \text{ no. of stations} = \frac{3000 \times 100}{8 \times 60 \times 60} \simeq 11$$

Q.47. Based on the given graph, the economic range of batch sizes to be preferred for general purpose machine (GP), NC machine (NC) and special purpose machine (SP) will be :



Codes :

	GP	NC	SP
(*a*)	2	5	4
(*b*)	1	4	5
(*c*)	3	2	4
(*d*)	1	4	2

Ans. (*b*)

Q.48. Which one of the following is not a permissible FORTRAN IV character ?

(*a*) Slash (/) (*b*) Colon (:) (*c*) Dollar sign ($) (*d*) Blank ( )

Ans. (*d*)

Q.49. Consider the following statements :

In FORTRAN IV, the names of sub-routines must

1. not be more than 5 characters.
2. be upto 6 characters.
3. be free from special characters.
4. not be the same as names of standard functions.

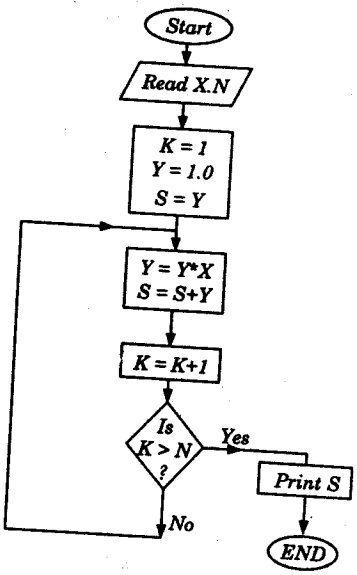
Of these statements

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

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

Ans. (*c*)

Q.50. Consider the following flowchart :



If this flowchart is followed, then the value of S for $N = 4$, $X = 2$ will be

(*a*) 20 (*b*) 16 (*c*) 15 (*d*) 31

Ans. (*d*)

Q.51. Consider the following four arithmetic statements in FORTRAN IV :

1. $P/Q + R/S ** L + T ** M$
2. $P/Q + (R/S) ** L + (T ** M)$
3. $(P/Q) + R/S ** L + (T ** M)$
4. $P/(Q + R)/(S ** L) + T ** M$

If these expressions are evaluated,

(*a*) all four of them will give the same answer (*b*) they will give four different answers

(*c*) 1 and 2 will give the same answer (*d*) 1 and 3 will give the same answer

Ans. (*d*)

Q.52. There are two machines *M*1 and *M*2 which process jobs *A*, *B*, *C*, *D*, *E* and *F*. The processing sequence for these jobs is *M*1 followed by *M*2. Consider the following data in this regard :

Process time required in minutes

Jobs	*A*	*B*	*C*	*D*	*E*	*F*
*M*1	4	7	3	12	11	9
*M*2	11	7	10	8	10	13

The processing sequence of jobs that would minimise the make span is :

(*a*) C–A–F–E–D–B (*b*) C–A–B–D–E–F (*c*) C–A–D–B–F–E (*d*) E–F–D–B–A–C

Directions :

The following 11 (eleven) 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 true and R is the correct explanation of A

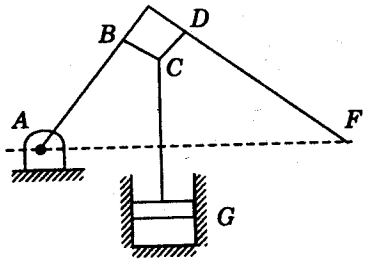
(*b*) Both A and R are true but R is NOT a correct explanation of A

(*c*) A is true but R is false

(*d*) A is false but R is true

Ans. (*a*) The first job should be selected which has least process time on machine *M*1 and last job having least time on machine *M*2. Other jobs need to be taken with increasing processing times on machine *M*1.

Q.53. *Assertion* (*A*) : The given line diagram of Watt's indicator mechanism is a type of crank and lever mechanism.



Reason (*R*) : *BCD* acts as a lever.

Ans. (*a*)

Q.54. *Assertion* (*A*) : The degree of hunting with an unstable governor will be less than with an isochronous governor.

Reason (*R*) : With an unstable governor, once the sleeve has moved from one extreme position to the other, a finite change of speed is required to cause it to move back again.

Ans. (*a*)

Q.55. *Assertion* (*A*) : The notch sensitivity of cast iron component is zero.
Reason (*R*) : Cast iron does not have a yield point.
Ans. (*a*)

Q.56. *Assertion* (*A*) : For high speed turning of cast iron pistons, carbide tool bits are provided with chip breakers.
Reason (*R*) : High speed turning may produce long, ribbon type continuous chips which must be broken into small lengths which otherwise would be difficult to handle and may prove hazardous.
Ans. (*c*)

Q.57. *Assertion* (*A*) : Ceramic tools are used only for light, smooth and continuous cuts at high speeds.
Reason (*R*) : Ceramics have a high wear resistance and high temperature resistance.
Ans. (*a*)

Q.58. *Assertion* (*A*) : In a slow speed high pressure metal cutting process such as gear cutting, chlorinated or sulphonated oils are used.
Reason (*R*) : Reduction of coefficient of friction is achieved by the formation of a solid film at the rubbing interface of tool and chip.
Ans. (*a*)

Q.59. *Assertion* (*A*) : Steel can be melted in hot blast cupola.
Reason (*R*) : In hot blast cupola, the flue gases are used to preheat the air blast to the cupola so that the temperature in the furnace is considerably higher than that in a conventional cupola.
Ans. (*a*)

Q.60. *Assertion* (*A*) : The electrodes of ac arc welding are coated with sodium silicate, whereas electrodes used for dc arc welding are coated with potassium silicate binders.
Reason (*R*) : Potassium has a lower ionisation potential than sodium.
Ans. (*a*)

Q.61. *Assertion* (*A*) : In drop forging besides the provision for flash, provision is also to be made in the forging die for additional space called gutter.
Reason (*R*) : The gutter helps to restrict the outward flow of metal thereby helping to fill thin ribs and bases in the upper die.
Ans. (*a*)

Q.62. *Assertion* (*A*) : Austenitic stainless steel contains 18% chromium and 8% nickel. Since it retains its austenitic structure at room temperature, it is called austenitic stainless steel.
Reason (*R*) : Chromium present in the steel improves its corrosion resistance by forming a thin film of chromium oxide on the surface.
Ans. (*a*)

Q.63. *Assertion* (*A*) : A larger margin of safety in break-even analysis is helpful for management decision.
Reason (*R*) : If the margin of safety is large, it would indicate that there will be profit even when there is a serious drop in production.
Ans. (*c*)

Q.64. Given θ = angle through which the axis of the outer forward wheel turns
ϕ = angle through which the axis of the inner forward wheel turns
a = distance between the pivots of front axle and
b = wheel base.
For correct steering, centre lines of the axes of four wheels of an automobile should meet at a common point. This condition will be satisfied if
(*a*) $\cos\theta - \cos\phi = a/b$ (*b*) $\cot\theta - \cot\phi = a/b$ (*c*) $\cos\theta + \cos\phi = a/b$ (*d*) $\tan\theta + \tan\phi = b/a$
Ans. (*b*)

Q.65. If air resistance is neglected, while it is executing small oscillations the acceleration of the bob of a simple pendulum at the mid-point of its swing will be

(*a*) zero (*b*) a minimum but not equal to zero

(*c*) a maximum

(*d*) not determinable unless the length of the pendulum and the mass of the bob are known

Ans. (*a*)

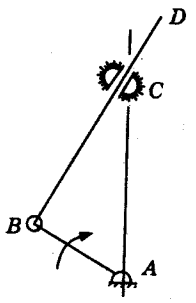
Q.66. In the figure shown crank *AB* is 15 cm long and is rotating at 10 *rad/s*. *C* is vertically above *A*. *CA* equals 24 cm. *C* is a swivel trunnion through which *BD* (40 cm) slides. If *ABCD* becomes a vertical line during its motion, the angular velocity of the swivel trunnion at that instant will be

(*a*) zero

(*b*) (100/25) rad/s

(*c*) (100/15) rad/s

(*d*) (100/10) rad/s



Ans. (*a*)

Q.67. In order to draw the acceleration diagram, it is necessary to determine the Coriolis componet of acceleration in the case of

(*a*) crank and slotted lever quick return mechanism

(*b*) slider-crank mechanism (*c*) four bar mechanism

(*d*) pantograph

Ans. (*a*)

Q.68. What is the correct sequence of the following steps in engine analysis ?

1. Vibration analysis. 2. Inertia force analysis.
3. Balancing analysis. 4. Velocity and Acceleration analysis.

Select the correct answer using the codes given below :

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

Ans. (*b*)

Q.69. In μ is the actual coefficient of friction in a belt moving in grooved pulley, the groove angle being 2α, the virtual coefficient of friction will be

(*a*) $\mu/\sin\alpha$ (*b*) $\mu/\cos\alpha$ (*c*) $\mu \sin\alpha$ (*d*) $\mu \cos\alpha$

Ans. (*a*)

Q.70. Match List-I (Positioning of two shafts) with List-II (Possible connection) and select the correct answer using the codes given below the Lists :

List-I	*List-II*
A. Parallel shafts with slight offset	1. Hookes joint
B. Parallel shafts at a reasonable distance	2. Worm and wheel
C. Perpendicular shafts	3. Oldham coupling
D. Intersecting shafts	4. Belt and pulley

Codes :

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

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

Ans. (*d*)

Q.71. Match List-I with List-II and select the correct answer using the codes given below the Lists :

List-I	*List-II*
A. Quadric cycle chain	1. Rapson's slide
B. Single slider crank chain	2. Oscillating cylinder engine mechanism
C. Double slider crank chain	3. Ackermann steering mechanism
D. Crossed slider crank chain	4. Oldham coupling

Codes :

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

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

Ans. (*d*)

Q.72. Match List-I with List-II and select the correct answer using the codes given below the Lists :

List-I (*Bearing*)	*List-II* (*Purpose*)
A. Ball bearing	1. Heavy loads with oscillatory motion
B. Tapered Roller bearings	2. Light loads
C. Spherical Roller bearings	3. Carrying both radial and thrust loads
D. Needle Roller bearings	4. Self-aiigning property

Codes :

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

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

Ans. (*d*)

Q.73. In a journal bearings, the radius of the friction circle increases with the increase in

(*a*) load (*b*) radius of the journal

(*c*) speed of the journal (*d*) viscosity of the lubricant

Ans. (*b*)

Q.74. Match List-I with List-II and select the correct answer using the codes given below the Lists :

List-I	*List-II*
A. Flywheel	1. Dunkerley Method
B. Governor	2. Turning Moment
C. Critical speed	3. *d'* Alempbert's Principle
D. Inertia Force	4. Speed control on par with load

Codes :

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

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

Ans. (*d*)

Q.75. The sensitivity of an isochronous governor is

(*a*) zero (*b*) one (*c*) two (*d*) infinity

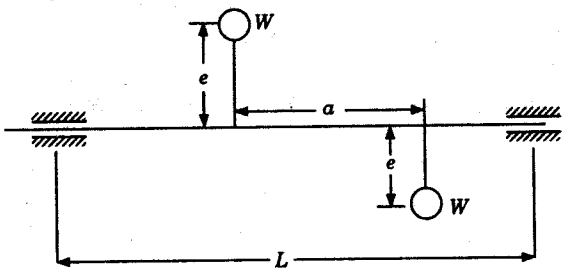
Ans. (*d*) Sensitivity = $\frac{N_1 + N_2}{2(N_1 - N_2)}$, since $N_1 = N_2$ for isochronous governer, sensitivity = α.

Q.76. When the primary direct crank of a reciprocating engine is positioned at 30° clockwise, the secondary reverse crank for balancing will be at

(*a*) 30 ° anticlockwise (*b*) 60° anticlockwise (*c*) 30° clockwise (*d*) 60° clockwise

Ans. (*d*)

Q.77. A statically-balanced system is shown in the given Figure. Two equal weights W, each with an eccentricity e, are placed on opposite sides of the axis in the same axial plane. The axial distance between them is 'a'. The total dynamic reactions at the supports will be



(*a*) zero (*b*) $\frac{W}{g}\omega^2 e\frac{a}{L}$ (*c*) $\frac{W}{g}\omega^2 e\frac{a}{L}$ (*d*) $\frac{W}{g}\omega^2 e\frac{L}{a}$

Ans. (*c*)

Q.78. A damped free vibration is expressed by the general equation $x = Xe^{-\zeta\omega_n t}\sin\left(\sqrt{1-\zeta^2}\,\omega_n t+\phi\right)$ which is shown graphically below :

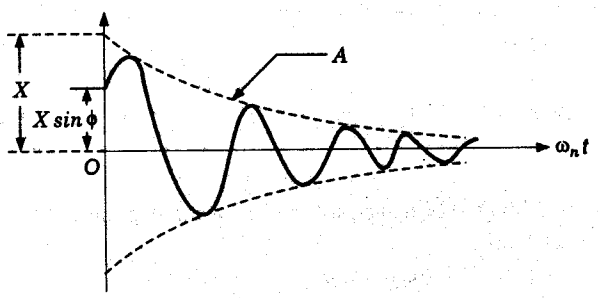
The envelope A has the equation :

(*a*) $X e^{-t}$

(*b*) $X\sin\left(\sqrt{1-\zeta^2}\right)\omega_n t$

(*c*) $e^{-\zeta\omega_n t}$

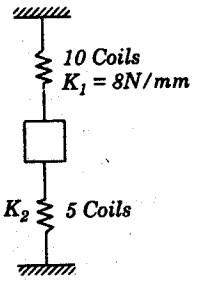
(*d*) $Xe^{-\zeta\omega_n t}$



Ans. (*d*)

Q.79. What is the equivalent stiffness (*i.e.* spring constant) of the system shown in the given figure ?

(*a*) 24 N/mm
(*b*) 16 N/mm
(*c*) 4 N/mm
(*d*) 5.3 N/mm



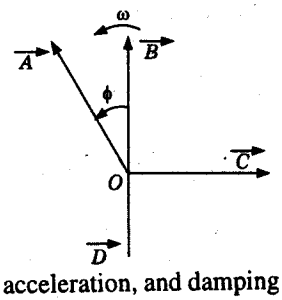
Ans. (*d*) Stiffness K_1 of 10 coils spring = 8 N/mm

$\therefore$ Stiffness K_2 of 5 coils spring = 16 N/mm

Since these are in series, $\therefore \frac{1}{K}=\frac{1}{8}+\frac{1}{16}=\frac{2+1}{16}$

and $K = 5.3$ N/mm

Q.80. The given figure depicts a vector diagram of forces and displacements in the case of Forced Damped Vibration. If vector A represents the forcing function $P = P_0 \sin \omega t$, vector B the displacement $y = Y \sin \omega t$, and ϕ the phase single between them, then the vectors C and D represent respectively



(*a*) the force of intertia and the force of damping
(*b*) the elastic force and the damping force
(*c*) the damping force and the inertia force
(*d*) the damping force and the elastic force

Ans. (*c*) Inertia force is in phase with displacement but opposite in direction to acceleration, and damping force lags displacement by 90°.

Q.81. Two heavy rotating masses are connected by shafts of length l_1, l_1 and l_3 and the corresponding diameters are d_1, d_2 and d_3. This system is reduced to a torsionally equivalent system having uniform diameter d_1 of the shaft. The equivalent length of the shaft is equal to

(a) $l_1 + l_2 + l_3$ (b) $\frac{l_1 + l_2 + l_3}{3}$

(c) $l_1 + l_2\left(\frac{d_1}{d_2}\right)^3 + l_3\left(\frac{d_1}{d_3}\right)^3$ (d) $l_1 + l_2\left(\frac{d_1}{d_2}\right)^4 + l_3\left(\frac{d_1}{d_3}\right)^4$

Ans. (d)

Q.82. An axial flow fan balanced at one speed often exhibits substantial vibrational effects when operated at other speeds, mainly due to

(a) primary critical speed effect (b) secondary critical speed effect

(c) unbalanced parts of the fan (d) aerodynamic unbalance

Ans. (d)

Q.83. A reverted gear train is one in which the output shaft and input shaft

(a) rotate in opposite directions (b) are co-axial

(c) are at right angles to each other (d) are at an angle to each other

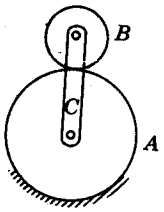
Ans. (b)

Q.84. In the case of an involute toothed gear, involute starts from

(a) addendum circle (b) dedundum circle (c) pitch circle (d) base circle

Ans. (d) Involute can't exist below base circle.

Q.85. In the epicyclic gear train shown in the given figure, A is fixed. A has 100 teeth and B has 20 teeth. If the arm C makes three revolutions, the number of revolutions made by B will be



(a) 12 (b) 15 (c) 18 (d) 24

Ans. (c) For 1 revolution of C, $N_B = 1 + \frac{T_A}{T_B} = 1 + \frac{100}{20} = 6$

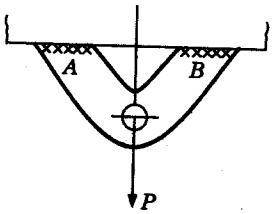
$\therefore$ for 3 revolution, $N_D = 6 \times 3 = 18$

Q.86. Given that G = forward path gain and H = feedback path gain, if G and H are functions of frequency, then the feedback would affect gain G of a non-feedback system by a value equal to

(a) $1 + GH$ (b) $1 - GH$ (c) GH (d) $1/GH$

Ans. (a)

Q.87. In the welded joint shown in the given figure,



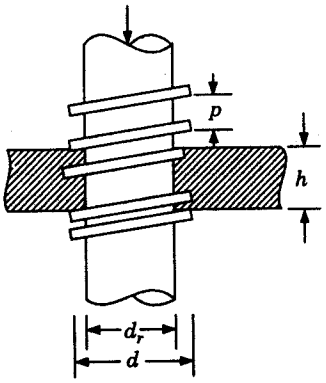
if the weld at B has thicker fillets than that at A, then the load carrying capacity P, of the joint will

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

(*c*) remain unaffected (*d*) exactly get doubled

Ans. (*c*)

Q.88. Consider the case of a square-threaded screw loaded by a nut as shown in the given figure. The value of the average shearing stress of the screw is given by (symbols have the usual meaning)



(*a*) $\frac{2F}{\pi d_r h}$ (*b*) $\frac{F}{\pi d_r h}$

(*c*) $\frac{2F}{\pi dh}$ (*d*) $\frac{F}{\pi dh}$

Ans. (*b*)

Q.89. The maximum efficiency of a self-locking screw is

(*a*) 50% (*b*) 70% (*c*) 75% (*d*) 80%

Ans. (*a*)

Q.90. Match List-I (Type of keys) with List-II (Characteristic) and select the correct answer using the codes given below the Lists :

List-I	*List-II*
A. Woodruff key	1. Loose fitting, light duty
B. Kennedy key	2. Heavy duty
C. Feather key	3. Self-aligning
D. Flat key	4. Normal industrial use

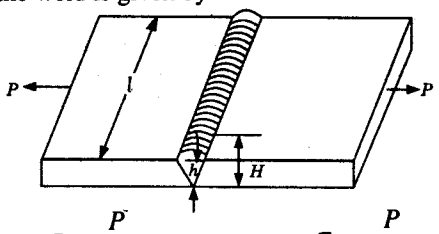
Codes :

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

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

Ans. (*d*)

Q.91. A butt welded joint, subjected to tensile force P is shown in the given figure, l = length of the weld (in *mm*) h = throat of the butt weld (in *mm*) and H is the total height of weld including reinforcement. The average tensile stress σ_t in the weld is given by



(*a*) $\sigma_t = \frac{P}{H\,l}$ (*b*) $\sigma_t = \frac{P}{h\,l}$ (*c*) $\sigma_t = \frac{P}{2h\,l}$ (*d*) $\sigma_t = \frac{2P}{H\,l}$

Ans. (*b*)

Q.92. In the case of a vertical belt pulley drive with T_C as centrifugal tension and T_O as the initial tension, the belt would tend to hang clear of the tower pulley when

(*a*) $T_C < T_O$ (*b*) $T_C = T_O/3$ (*c*) $T_C > T_O$ (*d*) $T_C = T_O/2$

Ans. (*c*)

Q.93. Given that T_1 and T_2 are the tensions on the tight and slack sides of the belt respectively, the initial tension of the belt taking into account centrifugal tension T_c, is equal to

(a) $\frac{T_1+T_2+T_c}{3}$ (b) $\frac{T_1+T_2+2T_c}{2}$ (c) $\frac{T_1+T_2+3T_c}{3}$ (d) $\frac{T_1-T_2+3T_c}{3}$

Ans. (b)

Q.94. Given that W = weight of load handled, W_r = weight of rope and f = acceleration, the additional load in ropes of a hoist during starting is given by

(a) $F_a=\left(\frac{W-W_r}{g}\right)f$ (b) $F_a=\left(\frac{W+W_r}{g}\right)f$ (c) $F_a=\frac{W}{g}f$ (d) $F_a=\frac{W_r}{g}f$

Ans. (b)

Q.95. When a shaft transmits power through gears, the shaft experiences

(a) torsional stresses alone (b) bending stresses alone
(c) constant bending and varying torsional stresses
(d) varying bending and constant torsional stresses

Ans. (d)

Q.96. The limiting wear load of spur gear is proportional to (where E_p = Young's modulus of pinion material; E_g = Young's modulus of gear material)

(a) $(E_p+E_g)^{-1}$ (b) $\left(\frac{E_p+E_g}{E_pE_g}\right)$ (c) $\left(1+\frac{E_p}{E_g}\right)$ (d) $\left(1+\frac{E_g}{E_p}\right)$

Ans. (b)

Q.97. Which one of the following statements is NOT true of rolling contact bearing ?

(a) The bearing characteristic number is given by ZN/p where Z is the absolute viscosity of the lubricant, N is the shaft speed and p is the bearing pressure.
(b) Inner race of a radial ball bearing has an interference fit with the shaft and rotates along with it
(c) Outer race of the bearing has an interference fit with bearing housing and does not rotate
(d) In some cases, the inner race is stationary and outer race rotates

Ans. (d)

Q.98. In the multiple disc clutch, if there are 6 discs on the driving shaft and 5 discs on the driven shaft, then the number of pairs of contact surfaces will be equal to

(a) 11 (b) 12 (c) 10 (d) 22

Ans. (a) No. of active plates = $6 \times 2 - 1 = 11$.

Q.99. Match List-I with List-II and select the correct answer using the codes given below the Lists :

List-I (*Bearing materials*)	*List-II* (*Properties*)
A. Babbits	1. Porous
B. Bronze	2. Good Embeddability
C. C.I.	3. Suitable for high loads and low speeds
D. Sintered powdered metal	4. Runs well with C.I. journals

Codes :

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

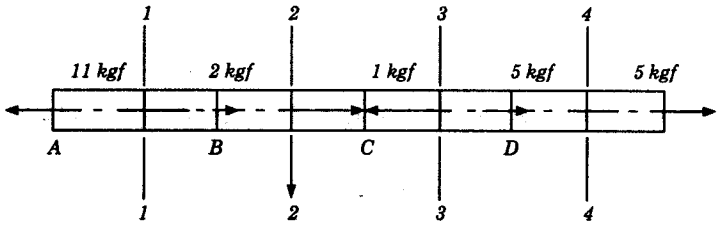
Ans. (a)

Q.100. Wahl stress factor takes into account

(a) direct shear stress (b) torsional shear stress
(c) wire curvature effect (d) direct shear and wire curvature effect

Ans. (d)

Q.101. A bar is uniform cross-section of one sq. cm is subjected to a set of five forces as shown in the given figure, resulting in its equilibrium. The maximum tensile stress (in kg/cm^2) produced in the bar is :



(*a*) 1 (*b*) 2 (*c*) 10 (*d*) 11

Ans. (*d*)

Q.102. A plane stressed element is subjected to the state of stress given by $\sigma_x = \tau_{xy} = 100$ kgf/cm^2 and $\sigma_y = 0$. Maximum shear stress in the element is equal to

(*a*) $50\sqrt{3}$ kgf/cm^2 (*b*) 100 kgf/cm^2 (*c*) $50\sqrt{5}$ kgf/cm^2 (*d*) 150 kgf/cm^2

Ans. (*c*) $\sigma_{n1,2} = \dfrac{\sigma_x + 0}{2} \pm \sqrt{\left(\dfrac{0-\sigma_x}{2}\right)^2 + T_{xy}^{\ 2}} = \dfrac{100}{2} \pm \sqrt{50^2 + 100^2} = 50 \pm 50\sqrt{5}$

$$\text{Max. shear stress} = \frac{\sigma_{n1} - \sigma_{n2}}{2} = 50\sqrt{5}$$

Q.103. Match List-I (Elastic properties of an isotropic elastic material) with List-II (Nature of strain produced) and select the correct answer using the codes given below the Lists :

List-I	*List-II*
A. Young's modulus	1. Shear strain
B. Modulus of rigidity	2. Normal strain
C. Bulk modulus	3. Transverse strain
D. Poisson's ratio	4. Volumetric strain

Codes :

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

Ans. (*c*)

Q.104. The relationship between the Lame's constant 'λ', Young's modulus 'E' and the Poisson's ratio 'υ' is

(*a*) $\lambda = \dfrac{E\upsilon}{(1+\upsilon)(1-2\upsilon)}$ (*b*) $\lambda = \dfrac{E\upsilon}{(1+2\upsilon)(1-\upsilon)}$ (*c*) $\lambda = \dfrac{E\upsilon}{1+\upsilon}$ (*d*) $\lambda = \dfrac{E\upsilon}{(1-\upsilon)}$

Ans. (*a*)

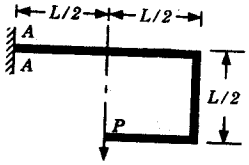
Q.105. A 10 cm long and 5 cm diameter steel rod fits snugly between two rigid walls 10 cm apart at room temperature. Young's modulus of elasticity and coefficient of linear expansion of steel are 1×10^6 kg$_f$/cm^2 and 12×10^{-6}/°C respectively. The stress developed in rold due to a 100°C rise in temperature will be

(*a*) 6×10^{-10} kg$_f$/cm^2 (*b*) 6×10^{-9} kg$_f$/cm^2 (*c*) 2.4×10^3 kg$_f$/cm^2 (*d*) 2.4×10^4 kg$_f$/cm^2

Ans. (*d*) Extension in rod = $10 \times 12 \times 10^{-6} \times 100 = 12 \times 10^{-3}$ cm

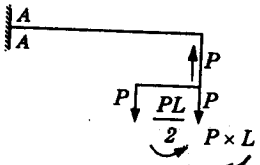
stress = strain $\times E = 12 \times 10^{-3} \times 2 \times 10^6 = 2.4 \times 10^4$ kg/cm^2

Q.106. A beam subjected to a load P is shown in the given figure. The bending moment at the support AA of the beam will be

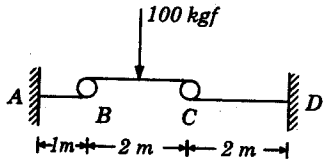


(*a*) *PL* (*b*) *PL*/2
(*c*) 2*PL* (*d*) zero

Ans. (*b*) Load *P* at end produces moment $\frac{PL}{2}$ in anticlockwise direction. Load *P* at end produces moment of *PL* in clockwise direction. Net moment at *AA* is $\frac{PL}{2}$.



Q.107. A 2 m long beam *BC* carries a single concentrated load at its mid-span and is simply supported at its ends by two cantilevers *AB* = 1 m long and *CD* = 2 m long as shown in the figure. The shear force at end *A* of the cantilever *AB* will be



(*a*) zero (*b*) 40 kg_f (*c*) 50 kg_f (*d*) 60 kg_f

Ans. (*c*)

Q.108. If a beam is subjected to a constant bending moment along its length, then the shear force will
(*a*) also have a constant value everywhere along its length
(*b*) be zero at all sections along the beam
(*c*) be maximum at the centre and zero at the ends
(*d*) zero at the centre and maximum at the ends

Ans. (*b*)

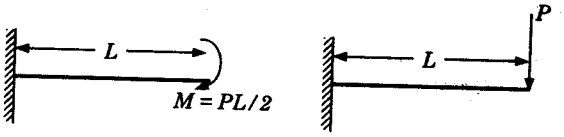
Q.109. A simply supported beam with width '*b*' and depth '*d*' carries a central load *W* and undergoes deflection δ at the centre. If the width and depth are interchanged, the deflection at the centre of the beam would attain the value

(*a*) $\frac{d}{b}\delta$ (*b*) $\left(\frac{d}{b}\right)^2\delta$ (*c*) $\left(\frac{d}{b}\right)^3\delta$ (*d*) $\left(\frac{d}{b}\right)^{3/2}\delta$

Ans. (*b*) Deflection at centre $\propto \frac{1}{I} \propto \frac{1^2}{bd^3} = \frac{k}{bd^3}$

In second case, deflection $= \frac{k}{bd^3} = \frac{k}{bd^3}\cdot\frac{d^2}{b^2}$

Q.110. Two identical cantilevers are loaded as shown in the respective figures. If slope at the three end of the cantilever in figure *E* is θ, the slope at free and of the cantilever in figure F will be

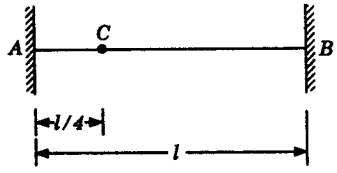


(*a*) $\frac{1}{3}\theta$ (*b*) $\frac{1}{2}\theta$ (*c*) $\frac{2}{3}\theta$ (*d*) θ

Ans. (*d*) When B.M. is applied at the end of cantilever, $\theta = \frac{M\,L}{EI} = \frac{PLL}{2EI} = \frac{PL^2}{2EI}$

When cantilever is subjected to a single concentrated load at end, then $\theta = \frac{PL^2}{2EI}$

Q.111. A round shaft of diameter '*d*' and length '*l*' fixed at both ends '*A*' and '*B*' is subjected to a twisting moment '*T*' at '*C*', at a distance of 1/4 from *A* (see figure). The torsional stresses in the parts *AC* and *CB* will be



(*a*) equal (*b*) in the ratio of 1 : 3 (*c*) in the ratio of 3 : 1 (*d*) indeterminate

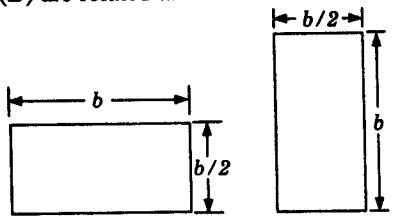
Ans. (*a*)

Q.112. A wooden beam of rectangular cross-section 10 cm deep by 5 cm wide carries maximum shear force of 2000 kg. Shear stress at neutral axis of the beam section is

(*a*) zero (*b*) 40 kgf/cm^2 (*c*) 60 kgf/cm^2 (*d*) 80 kgf/cm^2

Ans. (*c*) Shear stress at neutral axis $= \frac{3}{2}\times\frac{F}{bd} = \frac{3}{2}\times\frac{2000}{10\times5} = 60$ kg/cm^2

Q.113. A beam cross-section is used in two different orientations as shown in the figure given below : Bending moments applied to the beam in both cases are same. The maximum bending stresses induced in cases (A) and (B) are related as



(*a*) $\sigma_A = \sigma_B$ (*b*) $\sigma_A = 2\sigma_B$ (*c*) $\sigma_A = \frac{\sigma_B}{2}$ (*d*) $\sigma_A = \frac{\sigma_B}{4}$

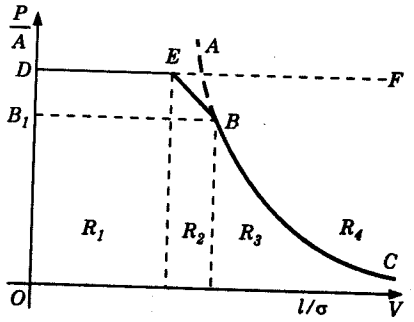
Ans. (*a*) Z for rectangular section is $\frac{bd^2}{6}$,

$$Z_A = \frac{b\left(\frac{b}{2}\right)^2}{6} = \frac{b^3}{48}, \quad Z_B = \frac{\frac{b}{2}\times b^2}{6} = \frac{b^3}{12}$$

$$M = Z_A\cdot\sigma_A = Z_B\cdot\sigma_B,$$

or $$\frac{b^3}{48}\sigma_A = \frac{b^3}{12}\times\sigma_B, \text{ or } \frac{\sigma_A}{4} = \sigma_B$$

Q.114.



The curve *ABC* is the Euler's curve for stability of column. The horizontal line *DEF* is the strength limit. With reference to this figure Match List-I with List-II and select the correct answer using the codes given below the lists :

List-I (*Regions*)	*List-II* (*Column specification*)
A. R_1	1. Long, stable
B. R_2	2. Short
C. R_3	3. Medium
D. R_4	4. Long, unstable

Ans. (*b*)

Codes :

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

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

Q.115. The ratio of the compressive critical load for a long column fixed at both the ends and a column with one end fixed and the other end free is

(*a*) 1 : 2 (*b*) 1 : 4 (*c*) 1 : 8 (*d*) 1 : 16

Ans. (*d*)

Q.116. Maximum shear stress in a solid shaft of diameter *D* and length *L* twisted through an angle θ is τ. A hollow shaft of same material and length having outside and inside diameters of D and D/2 respectively is also twisted through the same angle of twist θ. The value of maximum shear stress in the hollow shaft will be

(*a*) $\frac{16}{15}\tau$ (*b*) $\frac{8}{7}\tau$ (*c*) $\frac{4}{3}\tau$ (*d*) τ

Q.117. From design point of view, spherical pressure vessels are preferred over cylindrical pressure vessels because they

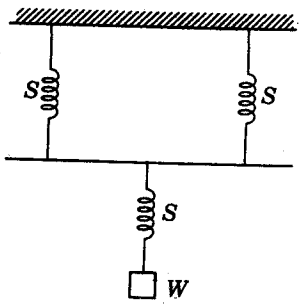
(*a*) are cost effective in fabrication (*b*) have uniform higher circumferential stress

(*c*) uniform lower circumferential stress

(*d*) have a larger volume for the same quantity of material used

Ans. (*d*)

Q.118. If two identical helical springs are connected in parallel and to these two, another identical spring is connected in series and the system is loaded by a weight *W*, as shown in the figure, then the resulting deflection will be given by (δ = deflection, *S* = stiffness, *W* = load)



(*a*) $\delta = \frac{3W}{2S}$ (*b*) $\delta = \frac{W}{2S}$

(*c*) $\delta = \frac{2W}{3S}$ (*d*) $\delta = \frac{W}{3S}$

Ans. (*a*) For springs in parallel, effective stiffness = $S + S = 2S$

For this effective spring and other one in series;

$$\text{New stiffness} = \frac{S \times 2S}{S + 2S} = \frac{2S^2}{3S} = \frac{2S}{3}$$

$$\therefore \qquad S = \frac{W \times 3}{2S} = \frac{3W}{2S}$$

Q.119. Which one of the following gives the correct expression for strain energy stored in a beam of length L and of uniform cross-section having moment of inertia 1 and subjected to constant bending moment M ?

(*a*) $\frac{ML}{EI}$ (*b*) $\frac{ML}{2EI}$ (*c*) $\frac{M^2L}{EI}$ (*d*) $\frac{M^2L}{2EI}$

Ans. (*d*)

Q.120. Match List-I (Failure theories) with List-II (Figures representing boundaries of these theories) and select the correct answer using the codes given below the Lists :

List-I

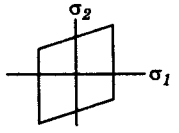
A. Max. principal stress theory

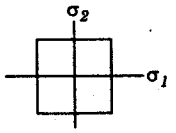
B. Max. shear stress theory

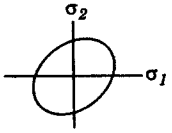
C. Max. octahedral shear stress theory

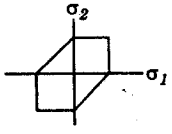
D. Max. shear strain energy theory

List-II

1. 

2. 

3. 

4. 

Codes :

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

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

Ans. (*d*)

I.E.S. (Objective)

MECHANICAL ENGINEERING–1998

PAPER–I

Time Allowed : Two Hours *Maximum Marks : 200*

INSTRUCTIONS

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET DOES NOT HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS, ETC. IF SO, GET IT REPLACED BY A COMPLETE REST BOOKLET.
2. ENCODE CLEARLY THE TEST BOOKLET SERIES **A, B, C, D** AS THE CASE MAY BE IN THE APPROPRIATE PLACE IN THE ANSWER SHEET.
3. You have to enter your Roll Number on the Testbooklet in the Box provideed alongside. DO NOT write anything else on the Test Booklet.
4. This Test Booklet contains **120** items (questions). Each item comprises four responses (answers). You will select the response which you want to mark on the Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose only one response for each item.
5. You have to mark all your responses ONLY on the separate Answer Sheet provided. See directions in the Answer Sheet.
6. All items carry equal marks. Attempt ALL items. Your total marks will depend only on the number of *correct* responses marked by you in the Answer Sheet.
7. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.
8. After you have completed filling in all responses onthe Answer Sheet and the examiantion has concluded, you should hand over to the invigilator *only the Answer Sheet.* You are permitted to take away with you the Test Booket and rough sheets issued to you.

Q.1. The spectral emissive power E_λ for a diffusely emitting surface is

$E_\lambda = 0$ for $\lambda < 3\ \mu m$

$E_\lambda = 150\ W/m^2\ \mu m$ for $3 < \lambda < 12\ \mu m$

$E_\lambda = 300\ W/m^2\ \mu m$ for $12 < \lambda < 25\ \mu m$

$E_\lambda = 0$ for $\lambda > 25\ \mu m$

The total emissive power of the surface over the entire spectrum is

(*a*) $1250\ W/m^2$ (*b*) $2500\ W/m^2$

(*c*) $4000\ W/m^2$ (*d*) $5250\ W/m^2$

Ans. (*d*) Total emissive power is defined as the total amount of radiation emitted by a body per unit time

i.e. $E = \int E_\lambda\ \lambda d\lambda = 0 \times 3 + 150 \times (12 - 3) + 300 \times (25 - 12) + 0\ [\alpha]$

$= 150 \times 9 + 300 \times 13 = 1350 + 3900$

$= 5250\ W/m^2$

Q.2. Consider the following statements :

1. For metals, the value of absorptivity is high.
2. For non-conducting materials, reflectivity is low.
3. For polished surfaces, reflectivity is high.
4. For gases, reflectivity is very low.

Of these statements

(*a*) 2, 3 and 4 are correct (*b*) 3 and 4 are correct

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

Ans.(*a*) Statements 2, 3 and 4 are correct.

Q.3. On a summer day, a scooter rider feels more comfortable while on the move than while at a stop light because

(*a*) an object in motion captures less solar radiation.

(*b*) air is transparent to radiation and hence it is cooler than the body.

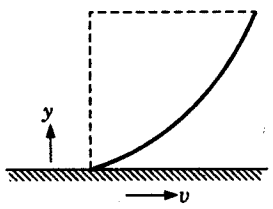
(*c*) more heat is lost by convection and radiation while in motion

(*d*) Air has a low specific heat and hence it is cooler.

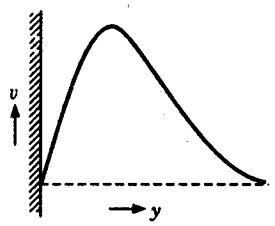
Ans.(*a*) A body in motion captures less solar radiation.

Q.4.

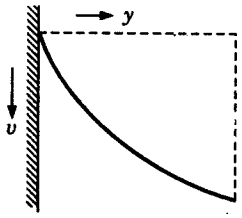
(*a*)



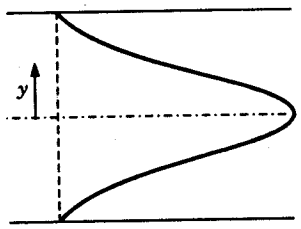
(*b*)



(*c*)



(*d*)



Match the velocity profiles labelled A, B, C and D with the following situations :

1. Natural convection. 2. Condensation
3. Forced convection 4. Bulk viscosity ≠ wall viscosity.
5. Flow in pipe entrance

Select the correct answer using the codes given below :

Codes :

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

Ans. (*a*) It provides right matching.

Q.5. Heat is mainly transferred by conduction, convection and radiation in

(*a*) insulated pipes carrying hot water (*b*) refrigerator freezer coil

(*c*) boiler furnaces (*d*) condensation of steam in a condenser

Ans. (*c*) All modes of heat transfer occur in boiler furnace.

Q.6. Consider the following statements :

1. If a condensing liquid does not wet a surface dropwise, then condensation will take place on it.

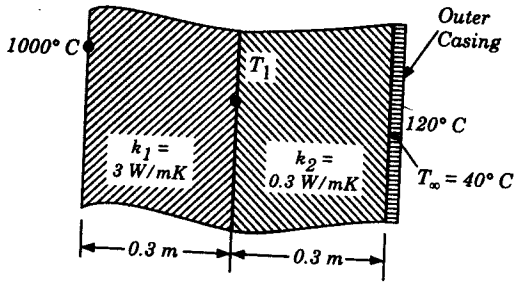
2. Dropwise condensation gives a higher heat transfer rate than film-wise condensation.
3. Reynolds number of condensing liquid is based on its mass flow rate.
4. Suitable coating or vapour additive is used to promote film-wise condensation.

Of these statements

(*a*) 1 and 2 are correct
(*b*) 2, 3 and 4 are correct
(*c*) 4 alone is correct
(*d*) 1, 2 and 3 are correct

Ans. (*c*) Only statement 4 is correct.

Q.7.



A furnace wall is constructed as shown in the above figure. The interface temperature T_i will be

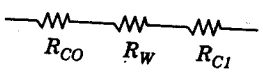
(*a*) 560°C (*b*) 200°C (*c*) 920°C (*d*) 1120°C

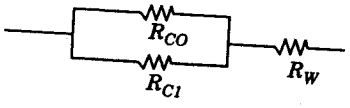
Ans. (*c*) For two insulating layers, $\frac{Q}{A} = \frac{t_1 - t_2}{\frac{\Delta x_1}{k_1} + \frac{\Delta x_2}{k_2}} = \frac{1000 - 120}{\frac{0.3}{3} + \frac{0.3}{0.3}} = \frac{880}{1.1} = 800$

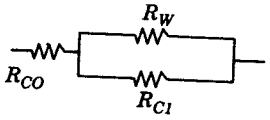
Cosidering first layer, $\frac{Q}{A} = \frac{1000 - T_i}{\frac{0.3}{3}} = 800$

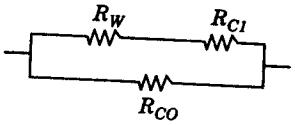
or $T_i = 1000 - 80 = 920°C$

Q.8.

(*a*) 

(*c*) 

(*b*) 

(*d*) 

Solar energy is absorbed by the wall of a building as shown in the above figure. Assuming that the ambient temperature inside and outside are equal and considering steady-state, the equivalent circuit will be as shown in

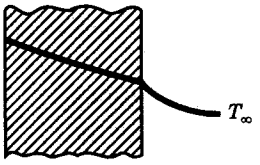
(symbols : $R_{CO} = R_{\text{convection, outside}}$, $R_{CI} = R_{\text{convection, inside}}$ and $R_W = R_{\text{Wall}}$)

(*a*)
(*b*)
(*c*)
(*d*)

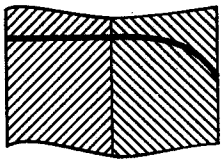
Ans. (*a*) All resistances are in series.

Q.9. Temperature profiles for four cases are shown in the following figures and are labelled A, B, C and D.

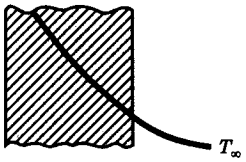
(*a*)



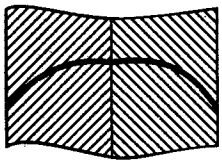
(*b*)



(*c*)



(*d*)



Match the above figures with

1. High conductivity fluid.
2. Low conductivity fluid.
3. Insulating body.
4. Guard heater

Select the correct answer using the codes given below :

Codes :

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

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

Ans. (*a*) Temperature slope is higher for low conducting and lower for high conducting fluid. Thus A is for 1, B for 2. Temperature profile in C is for insulator. Temperature rise is possible only for heater and as such D is for guard heater.

Q.10. Air refrigeration cycle is used in

(*a*) commercial refrigerators
(*b*) domestic refrigerators
(*c*) gas liquefaction
(*d*) air-conditioning

Ans. (*a*) Air refrigeration cycle finds use in commercial refrigerators.

Q.11. The flash chamber in a single stage simple vapour compression cycle

(*a*) increases the refrigerating effect
(*b*) decreases the refrigerating effect
(*c*) increases the work of compression
(*d*) has no effect on refrigerating effect

Ans. (*d*) Flash chamber has no effect on refrigerating effect.

Q.12. Consider the following statements :

In a vapour compression system, a thermometer placed in the liquid line can indicate whether the

1. refrigerant flow is too low.
2. water circulation is adequate.
3. condenser is fouled.
4. pump is functioning properly.

Of these statements

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

Ans. (*d*) Thermometer in liquid line can't detect that refrigerant flow is too low.

Q.13. Match List-I with List-II and select the correct answer using the codes given below the Lists :

List-I	***List-II***
A. Bell Colemn refrigeration	1. Compressor
B. Vapour compression refrigeration	2. Generator
C. Absorption refrigeration	3. Flash chamber
D. Jet refrigeration	4. Expansion cylinder

Codes :

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

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

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

Q.14. The maximum COP for the absorption cycle is given by (T_G = generator temperature, T_C = environment temperature, T_E = refrigerated space temperature)

(*a*) $\frac{T_E(T_G - T_C)}{T_G(T_C - T_E)}$ (*b*) $\frac{T_G(T_C - T_E)}{T_E(T_G - T_C)}$ (*c*) $\frac{T_C(T_G - T_E)}{T_G(T_C - T_E)}$ (*d*) $\frac{T_G(T_C - T_E)}{T_C(T_G - T_E)}$

Ans. (*a*) is right answer.

Q.15. In milk chilling plants, the usual secondary refrigerant is

(*a*) ammonia solution (*b*) sodium silicate (*c*) glycol (*d*) brine

Ans. (*c*)

Q.16. The desirable combination of properties for a refrigerant include

(*a*) high specific heat and low specific volume

(*b*) high heat transfer coefficient and low latent heat

(*c*) high thermal conductivity and low freezing point

(*d*) high specific heat and high boiling point

Ans. (*a*) High thermal conductivity enables better heat transfer in evaporator and condenser. Lower specific volume implies smaller compressor can be used and refrigerating effect per kg of refrigerant increases.

Q.17. Which of the following method(s) is/are adopted in the design of air duct system ?

1. Velocity reduction method 2. Equal friction method.
3. Static regain method.

Select the correct answer using the codes given below :

Codes :

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

Ans. (*c*)

Q.18. To fix the state point in respect of air-vapour mixtures, three intrinsic properties are needed. Yet, the psychrometric chart requires only two because

(*a*) water vapour is in the superheated state (*b*) the chart is for a given pressure

(*c*) the chart is an approximation to true values (*d*) the mixtures can be treated as a perfect gas

Ans.(*b*) Psychrometric chart is plotted for standard atmospheric pressure and as such only 2 coordinates are used to fix the state point. For pressures other than standard atmospheric, some correction is required.

Q.19. During sensible cooling of air,

(*a*) its wet bulb temperature increases and dew point remains constant

(*b*) its wet bulb temperature decreases and the dew point remains constant

(*c*) its wet bulb temperature increases and the dew point decreases

(*d*) its wet bulb temperature decreases and dew point increases

Ans. (*b*) During sensible cooling of air, its wet bulb temperature decreases but dew point remains unchanged.

Q.20. The expression $\frac{0.622\,P_v}{P_t - P_v}$ is used to determine

(*a*) relative humidity (*b*) specific humidity (*c*) degree of saturation (*d*) partial pressure

Ans. (*b*) Specific humidity = $\frac{0.622\,P_v}{P_t - P_v}$

Q.21. The effective temperature is a measure of the combined effects of
(*a*) dry bulb temperature and relative humidity (*b*) dry bulb temperature and air motion
(*c*) wet bulb temperature and air motion
(*d*) dry bulb temperature, relative humidity and air motion

Ans. (*d*) The effective temperature is the combined effect of dry bulb temperature, relative humidity and air motion.

Q.22. In air-conditioning design for summer months, the condition inside a factory where heavy work is performed as compared to a factory in which light work is performed should have
(*a*) lower dry bulb temperature and lower relative humidity
(*b*) lower dry bulb temperature and higher relative humidity
(*c*) lower dry bulb temperature and same relative humidity
(*d*) same dry bulb temperature and same relative humidity

Ans. (*d*) Air conditioning parameters are same for all conditions of loading. Air conditioning capacity has to be designed for the heat load to maintain the parameters.

Q.23. For low bypass factor a cooling coil, the fin spacing and the number of tube rows will be respectively
(*a*) high and high (*b*) high and low (*c*) low and high (*d*) low and low

Ans. (*d*) Low bypass factor is indication of poor heat transfer. For better transfer, no. of coils should be more and fin spacing should be higher.

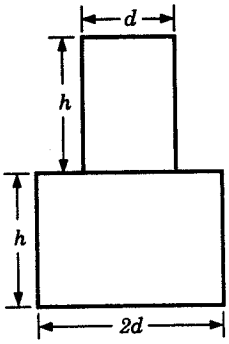
Q.24. The normal stress is the same in all directions at a point in a fluid only when
(*a*) the fluid is frictionless (*b*) the fluid is frictionless and incompressible
(*c*) the fluid has zero viscosity and is at rest
(*d*) one fluid layer has no motion relative to an adjacent layer

Ans. (*b*) The normal stress is the same in all directions at a point in a fluid if it is frictionless and incompressible.

Q.25. Which of the following forces act on a fluid at rest ?
1. Gravity force 2. Hydrostatic force 3. Surface tension 4. Viscous force
Select the correct answer using the codes given below :
Codes :
(*a*) 1, 2, 3 and 4 (*b*) 1, 2 and 3 (*c*) 2 and 4 (*d*) 1, 3 and 4

Ans. (*c*) When a fluid is at rest then gravity, hydrostatic force and surface tension forces act on it.

Q.26. A stepped cylindrical container is filled with a liquid as shown in the given figure. The container with its axis vertical, is first placed with its larger diameter downward and then upward. The ratio of the forces at the bottom in the two cases will be



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

Ans. (*d*) Force at bottom depends on area and height. Height is same in both cases. Ratio of forces is ratio of areas = $\frac{(2d)^2}{d^2} = 4$.

Q.27. A circular annular plate having outer and inner diameters of 1.4 m and 0.6 m respectively is immersed in water with its plane making an angle of 60° with the horizontal. The centre of the circular annular plate is 1.85 m below the free surface. The hydrostatic thrust on one side of the plate is
(*a*) 1975 N (*b*) 19.75 N (*c*) 11.4 N (*d*) 22.8 N

Ans. (*d*) Hydrostatic thrust on inclined plate.

$$= \rho g A\bar{x} = 9.81\times10^3\times\frac{\pi}{4}\left(1.4^2\times0.6^2\right)\times1.85 = 22.8 \text{ kN}$$

Q.28. A house-top water tank is made of flat plates and is full to the brim. Its height is twice that of any side. The ratio of force on the bottom of the tank to that on any side will be

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

Ans. (*b*) Force at bottom $= \rho gA \times 2h$

Force at side of tank $= \rho g A\times\frac{2h}{2}$

$\therefore$ Ratio of forces at bottom to side = 2.

Q.29. A right-circular cylinder, open at the top is filled with liquid of relative density 1.2. It is rotated about its vertical axis at such a speed that half the liquid spills out. The pressure at the centre of the bottom will be

(*a*) zero

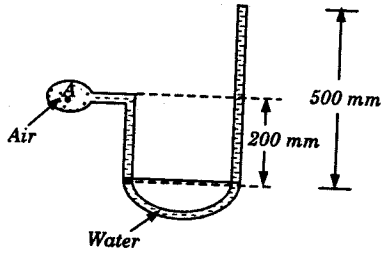
(*b*) one-fourth of the value when the cylinder was full

(*c*) half of the value when the cylinder was full

(*d*) not determinable from the given data

Ans. (*a*) When half the liquid is spilled, there will be no liquid at centre because in such a case the height of paraboloid formed is half above and half below the liquid level at rest. Thus pressure at the centre of bottom will be zero.

Q.30.



In the figure shown above, air is contained in the pipe and water is the manometer liquid. The pressure at '*A*' is approximately

(*a*) 10.14 m of water absolute (*b*) 0.2 m of water

(*c*) 0.2 m of water vacuum (*d*) 4901 Pa

Ans. (*d*) Considering plane AA, neglecting static head due to air, pressure of air in bulb A

$$= \rho g h_w = 9.81\times1000\times\frac{500}{1000} = 4901 \text{ Pa}$$

Q.31. Consider the following statements :
Filling up a part of the empty hold of a ship with ballasts will
1. reduce the metacentric height
2. lower the position of the centre of gravity.
3. elevate the position of centre of gravity.
4. elevate the position of centre of buoyancy.
Of these statements
(*a*) 1, 3 and 4 are correct (*b*) 1 and 2 are correct (*c*) 3 and 4 are correct (*d*) 2 and 4 are correct

Ans. (*d*) Making bottom heavy lowers the c.g. of ship. It also increases displaced volume of water and thus the centre of displaced water, *i.e.* centre of buoyancy is elevated.

Q.32. A cylindrical piece of cork weighing 'W' floats with its axis is horizontal position in a liquid of relative density 4. By anchoring the bottom, the cork piece is made to float at neutral equilibrium position with its axis vertical. The vertically downward force exerted by anchoring would be
(*a*) 0.5 W (*b*) W (*c*) 2 W (*d*) 4 W

Ans. (*d*) Due to own weight of cylinder, it will float upto 1/4th of its height in liquid of relative density of 4. To make it float in neutral equilibrium, centre of gravity and centre of buoyancy must coincide, i.e. cylinder upto full height must get immersed. For this purpose downward anchoring force by anchor equal to buoyancy on cylinder has to be exerted. Since density of fluid is 4, the buoyancy force will be $4W$.

Q.33. Consider the following assumptions :
1. The fluid is compressible.
2. The fluid is inviscid.
3. The fluid is incompressible and homogeneous.
4. The fluid is viscous and compressible.
The Euler's equation of motion requires assumptions indicated in
(*a*) 1 and 2 (*b*) 2 and 3 (*c*) 1 and 4 (*d*) 3 and 4

Ans. (*b*) Euler's equation of motion is based on assumption that fluid is inviscid and incompressible and homogeneous.

Q.34. The area of a 2 m long tapered duct decreases as $A = (0.5 - 0.2x)$ where 'x' is the distance in metres. At a given instant a discharge of 0.5 m^3/s is flowing in the duct and is found to increase at a rate of 0.2 m^3/s. The local acceleration (in m^2/s) at $x = 0$ will be
(*a*) 1.4 (*b*) 1.0 (*c*) 0.4 (*d*) 0.667

Ans. (*b*)

$$A = 0.5 - 0.2x, \quad \frac{dA}{dx} = 0.2, \quad u = \frac{dQ}{dA}$$

$$a = \frac{dv}{dt} = \frac{dQ}{dt} \bullet \frac{dt}{dA} = \frac{dQ}{dt} \bullet \frac{dt}{dA} \bullet \frac{dx}{dx} = \frac{dQ}{dt} \bullet \frac{dx}{dA} \bullet \frac{dt}{dx}$$

$$\frac{dQ}{dt} = 0.2 \text{ m}^3/\text{s}, \quad \frac{dA}{da} = 0.2$$

$$\text{At } x = 0, \quad \frac{dx}{dt} = \frac{0.5}{0.5} = \frac{1m}{s}$$

$$\therefore \text{ At } x = 0, \quad a = 0.2 \times \frac{1}{0.2} \times 1 = 1 \text{ m/sec}^2$$

Q.35. Surface tension is due to
(*a*) viscous forces
(*b*) cohesion
(*c*) adhesion
(*d*) the difference between adhesive and cohesive forces

Ans. (*d*) Surface tension is due to combined effect of adhesion and cohesive forces.

Q.36. Newton's law of viscosity depends upon the
(*a*) stress and strain in a fluid
(*b*) shear stress, pressure and velocity

(c) shear stress and rate of strain (d) viscosity and shear stress

Ans. (a) Newton's law of viscosity depends upon the stress and strain in a fluid.

Q.37. Irrotational flow occurs when

(a) flow takes place in a duct of uniform cross-section at constant mass flow rate

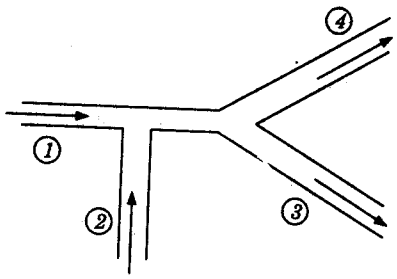
(b) streamlines are curved

(c) there is no net rotation of the fluid element about its mass centre

(d) fluid element does not undergo any change in size or shape

Ans. (a) Irrotational flow can be represented by a flow net. The flow in a duct of uniform cross-section at constant mass flow rate fulfills this condition.

Q.38. A pipe flow system with flow direction is shown in the given figure. The following table gives the velocities and the corresponding areas :



Pipe No.	*Area (cm^2)*	*Velocity (cm/s)*
1.	50	10
2.	50	V_2
3.	80	5
4.	70	5

The value of V_2 is

(a) 2.5 cm/s (b) 5.0 cm/s (c) 7.5 cm/s (d) 10.0 cm/s

Ans. (b) Flow in = Flow out

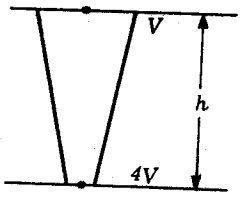
or $50 \times 10 + 50 \times V_2 = 80 \times 5 + 70 \times 5$

or $$V_2 = \frac{400+350-500}{50} = \frac{250}{50} = 5 \text{ cm/s}$$

Q.39. A liquid flows downward through a tapered vertical portion of a pipe. At the entrance and exit of the pipe, the static pressures are equal. If for a vertical height 'h' the velocity becomes four times, then the ratio of 'h' to the velocity head at entrance will be

(a) 3 (b) 8 (c) 15

(d) 24

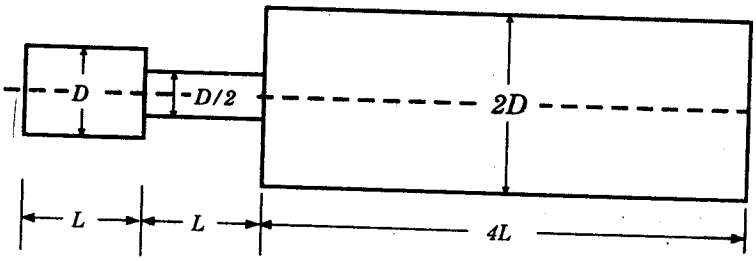


Ans. (c) As per Bernoulli's theorem,

$$\frac{V^2}{2g} + h = \frac{(4V)^2}{2g} \quad \text{or} \quad h = 15\frac{V^2}{2g}$$

$\therefore$ Ratio of h to velocity head at inlet = 15.

Q.40.



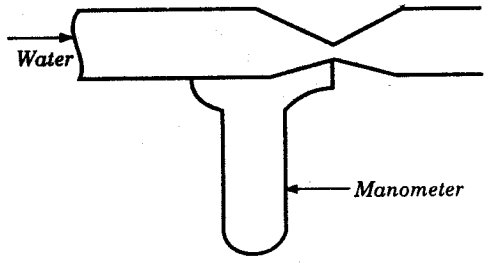
The equivalent length of the stepped pipeline shown in the above figure, can be expressed in terms of the diameter 'D' as

(*a*) 5.25 *L* (*b*) 9.5 *L* (*c*) $33\frac{1}{32}L$ (*d*) $33\frac{1}{8}L$

Ans. (*d*) For equivalent pipe, $\frac{L_e}{D^5}=\frac{L}{D^5}+\frac{L}{\left(D/2\right)^5}+\frac{4L}{(2D)^5}=\frac{L}{D^5}+\frac{32}{D^5}+\frac{4L}{32D^5}=\frac{L}{D^5}\left(1+32+\frac{1}{8}\right)$

Length of equivalent pipe = $33\frac{1}{8}L$.

Q.41. A horizontal pipe of cross-sectional area 5 cm^2 is connected to a venturimeter of throat area 3 cm^2 as shown in the given figure. The manometer reading is equivalent to 5 cm of water. The discharge in cm^3/s is nearly



(*a*) 0.45 (*b*) 5.5
(*c*) 21.0 (*d*) 370

Ans. (*d*) $Q=\frac{a_1a_2\sqrt{29}}{\sqrt{a_1^2-a_2^2}}.\sqrt{h}$

$$=\frac{5\times3\times\sqrt{2\times981}}{\sqrt{25-9}}.\sqrt{5}=\frac{15}{4}\sqrt{9810}=370\frac{\text{cm}^3}{\text{s}}$$

Q.42. In a fully turbulent flow through a rough pipe, the friction factor '*f*' is (Re is the Reynolds number and ξ_s/D is relative roughness)

(*a*) a function of Re (*b*) a function of Re and x_s/D
(*c*) a function of x_s/D (*d*) independent of Re and x_s/D

Ans. (*b*)

Q.43. In a boundary layer developed along the flow, the pressure decreases in the downstream direction. The boundary layer thickness would

(*a*) tend to decrease (*b*) remain constant
(*c*) increase rapidly (*d*) increase gradually

Ans. (*d*)

Q.44. Which one of the following statements is true of flow around a submerged body ?

(*a*) For subsonic, non-viscous flow, the drag is zero
(*b*) For supersonic flow, the drag coefficient is dependent equally on Mach number and Reynolds number
(*c*) The lift and drag coefficient of an aerofoil is independent of Reynolds number
(*d*) For incompressible flow around an aerofoil, the profile drag is the sum of form drag and skin friction drag

Ans. (*b*)

Q.45. If '*n*' variables in a physical phenomenon contained 'm' fundamental dimensions, then the variables can be arranged into

(*a*) *n* dimensionless terms (*b*) m dimensionless terms
(*c*) (*n* – m) dimensionless terms (*d*) (*n* + m) dimensionless terms

Ans. (*c*)

Q.46. Given power '*P*' of a pump, the head '*H*' and the discharge '*Q*' and the specific weight '*w*' of the liquid, dimensional analysis would lead to the result that '*P*' is proportional to

(a) $H^{1/2}Q^2w$ (b) $H^{1/2}Qw$ (c) $HQ^{1/2}w$ (d) HQw

Ans. (d)

Q.47. A 1 : 20 model of a spillway dissipates 0.25 *hp*. The corresponding prototype horsepower dissipated will be

(a) 0.25 (b) 5.00 (c) 447.20 (d) 8944.30

Ans. (d) $P \propto (\text{model ratio})^{7/2} \propto 20^{7/2}$

$\therefore$ H.P. lost in prototype $= 0.25 \times 20^{7/2} = 8944.30$.

Q.48. If the stream function is given by $\Psi = 3xy$, then the velocity at a point (2, 3) will be

(a) 7.21 unit (b) 10.82 unit (c) 18 unit (d) 54 unit

Ans. (c)

Q.49. The stagnation temperature of an isentropic flow of air ($k = 1.4$) is 400 K. If the temperature is 200 K at a section, then the Mach number of the flow will be

(a) 1.046 (b) 1.264 (c) 2.236 (d) 3.211

Ans. (c) $T_s = 400\ K$, $T_1 = 200\ K$, $k = 1.4$,

Now $\frac{T_s}{T_1} = 1 + \left(\frac{k-1}{2}\right)M^2$, or $\frac{400}{200} = 1 + \frac{0.4}{2}M^2$, or $0.2\ M^2 = 1$ and $M = \sqrt{5} = 2.236$

Q.50. In isentropic flow between two points, the stagnation

(a) pressure and stagnation temperature may vary

(b) pressure would decrease in the direction of the flow

(c) pressure and stagnation temperature would decrease with an increase in velocity

(d) pressure, stagnation temperature and stagnation density would remain constant throughout the flow

Ans. (a)

Q.51. The prime parameter causing change of state in a Fanno flow is

(a) heat transfer (b) area change (c) friction (d) buoyancy

Ans. (b)

Q.52. In a normal shock in a gas, the

(a) upstream flow is supersonic (b) upstream flow is subsonic

(c) downstream flow is sonic

(d) both downstream flow and upstream flow are supersonic

Ans. (a)

Directions :

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

Codes :

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

(b) Both A and R are true but R is NOT a correct explanation of A

(c) A is true but R is false.

(d) A is false but R is true.

Q.53. *Assertion* (A) : At a given temperature, the enthalpy of super-heated steam is the same as that of saturated steam.

Reason (R) : The enthalpy of vapour at lower pressures is dependent on temperature alone.

Ans. (d)

Q.54. *Assertion* (*A*) : If a graph is plotted for absolute temperature as a function of entropy, the area under the curve would give the amount of heat supplied.
Reason (*R*) : Entropy represents the maximum fraction of work obtainable from heat per degree drop in temperature.
Ans. (*c*)

Q.55. *Assertion* (*A*) : The purpose of employing reheat in a steam power plant is mainly to improve its thermal efficiency.
Reason (*R*) : The use of regeneration in a steam power plant improves the efficiency.
Ans. (*b*)

Q.56. *Assertion* (*A*) : Specific output of a diesel engine is higher than that of the SI engine.
Reason (*R*) : Diesel engine is built stronger and heavier with higher compression ratio.
Ans. (*a*)

Q.57. *Assertion* (*A*) : Cooling system in an IC engine must be such that there is no excessive cooling.
Reason (*R*) : Overcooling would result in increased viscosity of the lubricant due to which the overall efficiency of the engine will decrease.
Ans. (*b*) Both statements are true but cooling system in an IC engine is mainly to cool engine. Thus R is not correct explanation of A.

Q.58. *Assertion* (*A*) : Propulsion efficiency of propeller driven aircraft is low at very high speeds.
Reason (*R*) : At high speeds, shock waves are formed over propeller blades.
Ans. (*a*)

Q.59. *Assertion* (*A*) : A bypass jet engine gives a better propulsive efficiency and better fuel economy than a straight jet engine.
Reason (*R*) : A bypass jet engine gives lower velocity of jet efflux than a straight jet engine.
Ans. (*a*)

Q.60. *Assertion* (*A*) : In a fluid coupling, hydrodynamic transmission is done by a pump and turbine.
Reason (*R*) : Fluid coupling is a type of machine in which fluid is used as a means of energy transfer.
Ans. (*b*)

Q.61. *Assertion* (*A*) : Reaction turbines are not built on pure reaction principle.
Reason (*R*) : Pure reaction is difficult to realise in practice.
Ans. (*a*)

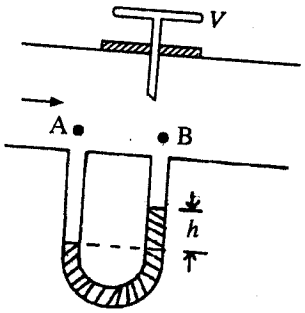
Q.62. *Assertion* (*A*) : A reciprocating air compressor at sea level would deliver a greater mass of air than a compressor on a mountain.
Reason (*R*) : The compressor ratings are given for "free air".
Ans. (*b*)

Q.63. *Assertion* (*A*) : In gas turbines, regenerative heating always improves the efficiency unlike that in the case of reheating.
Reason (*R*) : Regenerative heating is isentropic.
Ans. (*c*)

Q.64. *Assertion* (*A*) : In a furnace, reradiation from the walls has the same wavelength as the incident radiation from the heat source.
Reason (*R*) : Surfaces at the same temperature radiate at the same wavelength.
Ans. (*a*)

Q.65. *Assertion* (*A*) : The LMTD for counterflow is larger than that of parallel flow for a given temperature of inlet and outlet.
Reason (*R*) : The definition of LMTD is the same for both counterflow and parallel flow.
Ans. (*b*) Both statements are correct but R is not exactly correct explanation for A.

Q.66. A mercury manometer is fitted to a pipe. It is mounted on the delivery line of a centrifugal pump. One limb of the manometer is connected to the upstream side of the pipe at '*A*' and the other limb at '*B*', just below the valve '*V*' as shown in the figure. The manometer reading '*h*' varies with different valve positions.

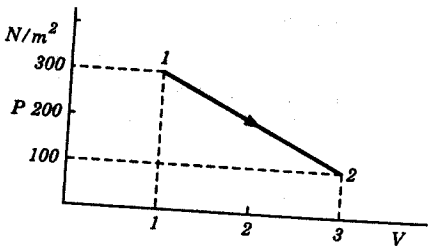


Assertion (*A*) : With gradual closure of the valve, the magnitude of '*h*' will go on increasing and even a situation may arise when mercury will be sucked in by the water flowing around '*B*'.
Reason (*R*) : With the gradual closure of the valve, the pressure at '*A*' will go on increasing.
Ans. (*a*)

Q.67. *Assertion* (*A*) : Work output per stage of an impulse turbine is double that of a 50% reaction stage at the same speed.
Reason (*R*) : Maximum speed ratio is limited for any class of turbine.
Ans. (*d*)

Q.68. Two blocks which are at different states are brought into contact with each other and allowed to reach a final state of thermal equilibrium. The final temperature attained is specified by the
(*a*) Zeroth law of thermodynamics (*b*) First law of thermodynamics
(*c*) Second law of thermodynamics (*d*) Third law of thermodynamics
Ans. (*a*)

Q.69. A control mass undergoes a process from state 1 to state 2 as shown in the given figure. During this process, the heat transfer to state 2 to state 1 by another process, then the work interaction during the return process (in kN.m) would be



(*a*) –400
(*b*) –200
(*c*) 200
(*d*) 400
Ans. (*b*) During adiabatic process, work done = change in internal energy.

Q.70.

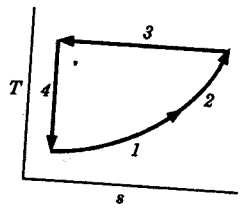


Fig. I

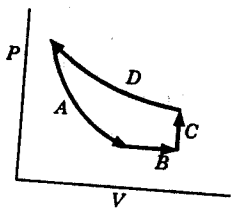


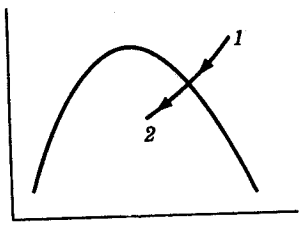
Fig. II

Four processes of a thermodynamic cycle are shown above in Fig. I on the *T-s* plane in the sequence 1-2-3-4. The corresponding correct sequence of these processes in the *p-V* plane as shown above in Fig. II will be

(*a*) (C-D-A-B) (*b*) (D-A-B-C) (*c*) (A-B-C-D) (*d*) (B-C-D-A)

Ans. (*d*)

Q.71. The given diagram shows an isometric cooling process 1-2 of a pure substance. The ordinate and abscissa are respectively



(*a*) pressure and volume
(*b*) enthalpy and entropy
(*c*) temperature and entropy
(*d*) pressure and enthalpy

Ans. (*c*)

Q.72. For a thermodynamic cycle to be irreversible, it is necessary that

(*a*) $\oint \frac{\delta Q}{T} = 0$ (*b*) $\oint \frac{\delta Q}{T} < 0$ (*c*) $\oint \frac{\delta Q}{T} > 0$

(*d*) $\oint \frac{\delta Q}{T} \geq 0$

Ans. (*b*)

Q.73. Neglecting changes in kinetic energy and potential energy, for unit mass the availability in a non-flow process becomes $a = \phi - \phi_0$, where ϕ is the availability function of the

(*a*) open system (*b*) closed system
(*c*) isolated system (*d*) steady flow process

Ans. (*b*)

Q.74. It can be shown that for a simple compressible substance, the relationship

$$C_p - C_v = -T \left(\frac{\partial V}{\partial T}\right)_p^2 \left(\frac{\partial P}{\partial V}\right)_2 \text{ exists}$$

where C_p and C_v and specific heats at constant pressure and constant volume respectively. T is temperature, V is volume and P is pressure.

Which one of the following statements is NOT true ?

(*a*) C_p is always greater than C_v.

(*b*) The right side of the equation reduces to R for an ideal gas

(*c*) Since $\left(\frac{\partial P}{\partial V}\right)_T$ can be either positive or negative, and $\left(\frac{\partial V}{\partial T}\right)_p^2$ must be positive, T must have a sign that is opposite to that of $\left(\frac{\partial P}{\partial V}\right)_T$

(*d*) C_p is very nearly equal to C_v for liquid water

Ans. (*d*) C_p is very nearly equal to C_v at absolute zero.

Q.75. Consider the following statements :

In an irreversible process

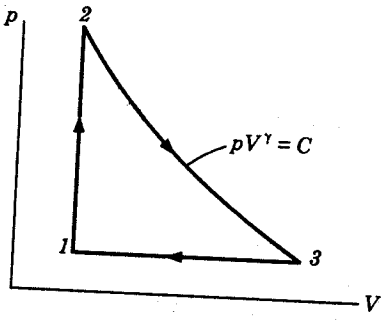
1. entropy always increases.
2. the sum of the entropy of all the bodies taking part in a process always increases.
3. once created, entropy cannot be destroyed.

Of these statements

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

Ans. (*a*)

Q.76. An ideal cycle is shown in the figure. Its thermal efficiency is given by



(a) $1-\dfrac{\left(\dfrac{v_3}{v_1}-1\right)}{\left(\dfrac{p_2}{p_1}-1\right)}$ (b) $1-\dfrac{1}{\gamma}\dfrac{\left(\dfrac{v_3}{v_1}-1\right)}{\left(\dfrac{p_2}{p_1}-1\right)}$

(c) $1-\gamma\dfrac{(v_3-v_1)}{(p_2-p_1)}\dfrac{p_1}{v_1}$ (d) $1-\dfrac{1}{\gamma}\dfrac{(p_2-p_1)}{(v_3-v_1)}\dfrac{v_1}{p_1}$

Ans. (b)

Q.77. Consider the following statements regarding Otto cycle :
1. It is not a reversible cycle.
2. Its efficiency can be improved by using a working fluid of higher value of ratio of specific heats.
3. The practical way of increasing its efficiency is to increase the compression ratio.
4. Carburetted gasolene engines working on Otto cycle can work with compression ratios more than 12.

Of these statements
(a) 1, 3 and 4 are correct
(b) 1, 2 and 3 are correct
(c) 1, 2 and 4 are correct
(d) 2, 3 and 4 are correct

Ans. (b)

Q.78. Consider the following statements :
The difference between higher and lower heating values of the fuels is due to
1. heat carried by steam from the moisture content of fuel.
2. sensible heat carried away by the flue gases.
3. heat carried away be steam from the combustion of hydrogen in the fuel.
4. heat lost by radiation

On these statements
(a) 2, 3 and 4 are correct
(b) 1 and 2 are correct
(c) 3 alone is correct
(d) 1, 2, 3 and 4 are correct

Ans. (c)

Q.79. Match List-I (Gadgets undergoing a thermodynamic process) with List-II (Property of the system that remains constant) and select the correct answer using the codes given below the Lists :

List-I
A. Bomb calorimeter
B. Exhaust gas calorimeter
C. Junker gas calorimeter
D. Throttling calorimeter

List-II
1. Pressure
2. Enthalpy
3. Volume
4. Specific heats

Codes :

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

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

Ans. (d)

Q.80. Consider the following statements :
The maximum temperature produced by the combustion of a unit mass of fuel depends upon
1. LCV.
2. ash content.
3. mass of air supplied
4. pressure in the furnace

Of these statements

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

Ans. (*b*)

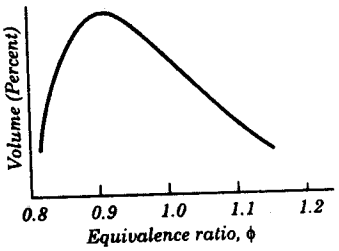
Q.81. The graph shown in the given figure represents the emission of a pollutant from an SI engine for different fuel/air ratios. The pollutant in question is

(*a*) CO

(*b*) CO_2

(*c*) hydrocarbons

(*d*) NO_x



Ans. (*d*) Maximum temperature is produced at slightly rich air mixture and NO_x emission is proportional to temperature.

Q.82. Which of the following are the assumptions involved in the auto-ignition theory put forth for the onset of knock in SI engines ?

1. Flame velocity is normal before the onset of autoignition.
2. A number of end-gas elements autoignite simultaneously.
3. Preflame reactions are responsible for preparing the end-gas to ignite.

Select the correct answer using the codes given below :

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

Ans. (*d*)

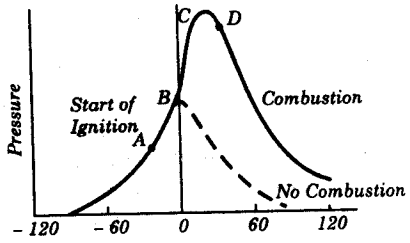
Q.83. Hypothetical pressure diagram for a compression ignition engine is shown in the given figure. The diesel knock is generated during the period

(*a*) *AB*

(*b*) *BC*

(*c*) *CD*

(*d*) after *D*



Ans. (*b*)

Q.84. In some carburettors, meter rod and economiser device is used for

(*a*) cold starting (*b*) idling (*c*) power enrichment (*d*) acceleration

Ans. (*b*)

Q.85. Which of the following pairs of engine and performance/characteristics is/are correctly matched ?

1. Turbojet — Efficiency increases with flight speed
2. SI engine — Lowest specific fuel consumption
3. Turboprop — Suitable for low flight speeds

Select the correct answer using the codes given below :

Codes :

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

Ans. (*c*)

Q.86. Which one of the following is the correct sequence of the position of the given components in a turboprop ?

(*a*) Propeller, Compressor, Turbine, Burner (*b*) Compressor, Propeller, Burner, Turbine

(*c*) Propeller, Compressor, Burner, Turbine (*d*) Compressor, Propeller, Turbine, Burner

Ans. (*c*)

Q.87. Consider the following statements :

The thrust of a rocket engine depends upon

1. effective jet velocity 2. weight of the rocket 3. rate of propellant consumption

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

Ans. (*b*)

Q.88. Consider the following statements :
In a turbojet engine, thrust may be increased by
1. increasing the jet velocity 2. increasing the mass flow rate of air.
3. after burning of the fuel.

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

Ans. (*a*)

Q.89. The effective jet exit velocity from a rocket is 2700 m/s. The forward flight velocity is 1350 m/s. The propulsive efficiency of the unit is
(*a*) 200% (*b*) 100% (*c*) 66.666% (*d*) 33.333%

Ans. (*c*) Propulsive $\eta = \dfrac{2}{V_i/V_f + 1} = \dfrac{2}{(2700/1350)+1} = \dfrac{2}{3} = 66.66\%$

Q.90. Consider the following statements regarding nuclear reactors :
1. In a gas-cooled thermal reactor, if CO_2 is used as the coolant, a separate moderator is not necessary as the gas contains carbon.
2. Fast reactors using enriched uranium fuel do not require a moderator.
3. In liquid metal-cooled fast breeder reactors, molten sodium is used as the coolant because of its high thermal conductivity.
4 Fast reactors rely primarily on slow neutrons for fission.

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

Ans. (*c*)

Q.91. Which of the following form part (s) of boiler mountings ?
1. Economiser 2. Feed check valve. 3. Steam trap. 4. Superheater

Select the correct answer using the codes given below :

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

Ans. (*a*)

Q.92. Which of the following power plants use heat recovery boilers (unfired) for steam generation ?
1. Combined cycle power plants. 2. All thermal power plants using coal.
3. Nuclear power plants. 4. Power plants using fluidised bed combustion.

Select the correct answer using the codes given below :
(*a*) 1 and 2 (*b*) 3 and 4 (*c*) 1 and 3 (*d*) 2 and 4

Ans. (*c*)

Q.93. Under ideal conditions, the velocity of steam at the outlet of a nozzle for a heat drop of 400 kJ/kg will be approximately.
(*a*) 1200 m/s (*b*) 900 m/s
(*c*) 600 m/s (*d*) the same as the sonic velocity

Ans. (*b*) $V = \sqrt{2 \times \text{enthalpy drop}} = \sqrt{2 \times 400 \times 1000} \simeq 900 \text{m/s}$

Q.94. In an impulse-reaction turbine stage, the heat drop in fixed and moving blades are 15 kJ/kg and 30 kJ/kg respectively. The degree of reaction for this stage will be
(*a*) 1/3 (*b*) 1/2 (*c*) 2/3 (*d*) 3/4

Ans. (*c*) Degree of reaction $= \dfrac{\text{heat drop in moving blade}}{\text{heat drop in both blades}} = \dfrac{30}{45} = \dfrac{2}{3}$

Q.95. If '*D*' is the diameter of the turbine wheel and '*U*' is its peripheral velocity, then the disc friction loss will be proportional to
(*a*) $(DU)^3$ (*b*) D^2U^3 (*c*) D^3U^2 (*d*) DU^4

Ans. (*c*)

Q.96. Once-through boilers will NOT have
(*a*) drums, headers and pumps (*b*) drums, steam separators and pumps
(*c*) drums, headers and steam separators (*d*) drums, headers, steam separators and pumps

Ans. (*c*)

Q.97. A four-stage compressor with perfect intercooling between stages, compresses air from 1 bar to 16 bar. The optimum pressure in the last intercooler will be
(*a*) 6 bar (*b*) 8 bar (*c*) 10 bar (*d*) 12 bar

Ans. (*b*) For four stage compressor, optimum pressure in last inter cooler $= \left(\dfrac{p_5}{p_1}\right)^{3/4} = (16)^{3/4} = 8$ bar

Q.98. In the centrifugal air compressor design practice, the value of polytropic exponent of compression is generally taken as
(*a*) 1.2 (*b*) 1.3 (*c*) 1.4 (*d*) 1.5

Ans. (*c*)

Q.99. The turbomachine used to circulate refrigerant in a large refrigeration plant is
(*a*) a centrifugal compressor (*b*) a radial turbine
(*c*) an axial compressor (*d*) an axial turbine

Ans. (*c*)

Q.100. The energy transfer process is
(*a*) continuous in a reciprocating compressor and intermittent in an axial compressor
(*b*) continuous in an axial compressor and intermittent in a reciprocating compressor
(*c*) continuous in both reciprocating and axial compressors
(*d*) intermittent in both reciprocating and axial compressors

Ans. (*c*)

Q.101. In an axial flow compressor stage, air enters and leaves the stage axially. If the whirl component of the air leaving the rotor is half the mean peripheral velocity of the rotor blades, then the degree of reaction will be
(*a*) 1.00 (*b*) 0.75 (*c*) 0.50 (*d*) 0.25

Ans. (*d*) Degree of reaction $= \dfrac{V_f}{2V_b}(\tan\beta_1 + \tan\beta_2)$

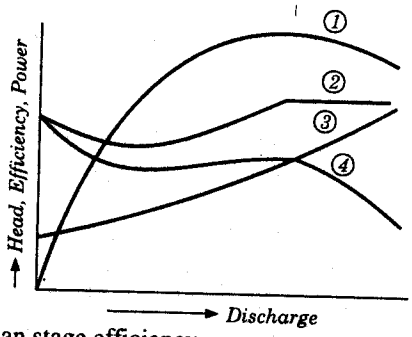
$$\frac{V_f}{V_b} = \frac{1}{2};\ \tan\beta_1 = \frac{V_f}{V_b} = \frac{1}{2};\ \text{Similarly } \tan\beta_2 = \frac{1}{2}$$

$$\therefore \text{ Degree of reaction} = \frac{1}{2\times 2}(1) = \frac{1}{4} = 0.25$$

Q.102. If an axial flow compressor is designed for a constant velocity through all stages, then the area of annulus of the succeeding stages will
(*a*) remain the same
(*b*) progressively decrease
(*c*) progressively increase
(*d*) depend upon the number of stages
Ans. (*a*)

Q.103. What will be the shape of the velocity triangle at the exit of a radial bladed centrifugal impeller, taking into account slip ?
(*a*) Right-angled
(*b*) Isosceles
(*c*) All angles less than 90°
(*d*) One angle greater than 90°
Ans. (*c*) In ideal case, triangle is right angled. But considering slip etc, the angle shape changes and all angles are less than 90°.

Q.104. The characteristics of a centrifugal fan are shown in the given figure. The curves (in the figure) representing total head and static head characteristics are respectively
(*a*) 1 and 2
(*b*) 3 and 4
(*c*) 1 and 3
(*d*) 2 and 4
Ans. (*b*)



Q.105. Which one of the following statements is true ?
(*a*) In a multi-stage compressor, adiabatic efficiency is less than stage efficiency
(*b*) In a multi-stage turbine, adiabatic efficiency is less than the stage efficiency
(*c*) Preheat factor for a multi-stage compressor is greater than one
(*d*) Preheat factor does not affect the multi-stage compressor performance
Ans. (*c*)

Q.106. At constant efficiency, the horse power of a fan is
(*a*) proportional to rpm
(*b*) proportional to $(\text{rpm})^2$
(*c*) proportional to $(\text{rpm})^3$
(*d*) a polynomial function of rpm
Ans. (*b*)

Q.107. At the eye tip of a centrifugal impeller, blade velocity is 200 m/s while the uniform axial velocity at the inlet is 150 m/s. If the sonic velocity is 300 m/s, then the inlet Mach number of the flow will be
(*a*) 0.50 (*b*) 0.66 (*c*) 0.83 (*d*) 0.87
Ans. (*a*) Mach number $= \dfrac{\text{axial velocity at inlet}}{\text{sonic velocity}} = \dfrac{150}{300} = 0.5$

Q.108. A gas turbine works on which one of the following cycles ?
(*a*) Brayton (*b*) Rankine (*c*) Stirling (*d*) Otto
Ans. (*a*)

Q.109. Reheating in a gas turbine
(*a*) increases the compressor work
(*b*) decreases the compressor work
(*c*) increases the turbine work
(*d*) decreases the turbine work
Ans. (*c*)

Q.110. Which one of the following forms of draft tube will NOT improve the hydraulic efficiency of the turbine ?
(*a*) Straight cylindrical (*b*) Conical type (*c*) Bell-mouthed (*d*) Bent tube
Ans. (*a*)

Q.111. Which one of the following turbines is used in underwater power stations ?
(*a*) Pelton turbine (*b*) Deriaz turbine
(*c*) Tubular turbine (*d*) Turgo-impulse turbine
Ans. (*c*)

Q.112. A Pelton wheel is ideally suited for
(*a*) high head and low discharge (*b*) high head and high discharge
(*c*) low head and low discharge (*d*) medium head and medium discharge
Ans. (*a*)

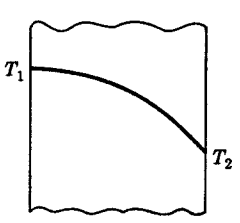
Q.113. Consider the following turbines :
1. Kaplan. 2. Pelton wheel 3. Francis
The correct sequence in increasing order of the specific speeds of these turbines is
(*a*) 2, 3, 1 (*b*) 2, 1, 3 (*c*) 3, 1, 2 (*d*) 1, 2, 3
Ans. (*a*)

Q.114. Consider the following statements regarding the specific speed of a centrifugal pump :
1. Specific speed is defined as the speed of a geometrically similar pump developing unit power under unit head.
2. At the same specific speed, the efficiency is greater with larger capacity.
3. The specific speed increases with the increase in outer blade angle.
4. The specific speed varies directly as the square root of the pump discharge.
Of these statements
(*a*) 1 and 2 are correct (*b*) 2 and 4 are correct (*c*) 3 and 4 are correct (*d*) 2 and 3 are correct
Ans. (*a*)

Q.115. Which of the following purposes are served by the volute casing of a centrifugal pump ?
1. Increase in the efficiency of the pump.
2. Conversion of part of the pressure head to velocity head.
3. Giving uniform flow of the fluid coming out of the impeller.
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. (*d*)

Q.116. Consider the following statements :
The Fourier heat conduction equation $Q = kA\dfrac{dT}{dx}$ presumes
1. steady-state conditions. 2. constant value of thermal conductivity.
3. uniform temperatures at the wall surfaces 4. one-dimensional heat flow.
Of these statements
(*a*) 1, 2 and 3 are correct (*b*) 1, 2 and 4 are correct
(*c*) 2, 3 and 4 are correct (*d*) 1, 3 and 4 are correct
Ans. (*b*)

Q.117. The temperature variation in a large plate, as shown in the given figure, would correspond to which of the following condition (s) ?
1. Unsteady heat. 2. Steady-state with variation of k.
3. Steady-state with heat generation.
Select the correct answer using the codes given below :
Codes :
(*a*) 2 alone (*b*) 1 and 2 (*c*) 1 and 3
(*d*) 1, 2 and 3
Ans. (*a*)



Q.118. In a long cylindrical rod of radius R and a surface heat flux of q_0, the uniform internal heat generation rate is

(*a*) $2\,q_0/R$ (*b*) $2\,q_0$ (*c*) q_0/R (*d*) q_0/R^2

Ans. (*c*)

Q.119. Boundary layer is defined as

(*a*) a thin layer at the surface where gradients of both velocity and temperature are small

(*b*) a thin layer at the surface where velocity and velocity gradients are large

(*c*) a thick layer at the surface where velocity and temperature gradients are large

(*d*) a thin layer at the surface where gradients of both velocity and temperature are large

Ans. (*a*)

Q.120. A large spherical enclosure has a small opening. The rate of emission of radiative flux through this opening is 7.35 kW/m^2. The temperature at the inner surface of the sphere will be about (assume Stefan Boltzmann constants $\sigma = 5.67 \times 10^{-8}$ W/m^{2}K^4)

(*a*) 600°C (*b*) 330°C (*c*) 373 K (*d*) 1000 K

Ans. (*a*) Rate of emission of radiative flux $= \sigma T^4$ or $7.35 \times 10^3 = 5.67 \times 10^{-8} \times T^4$

or $$T = \sqrt[4]{\frac{7.35\times10^3}{5.67\times10^{-8}}} = \sqrt[4]{\frac{7350}{5.67}} \times 100 = 6\times100 = 600°K\,.$$

I.E.S. (Objective)
MECHANICAL ENGINEERING – 1998
PAPER–II

Time Allowed : Two Hours *Maximum Marks : 200*

Instructions : See Paper-I, 1998.

Q.1. A closed-coil helical spring is subjected to a torque about its axis. The spring wire would experience a
(*a*) bending stress
(*b*) direct tensile stress of uniform intensity at its cross-section
(*c*) direct shear stress
(*d*) torsional shearing stress

Ans. (*a*) When a coiled wire is twisted, this action is equivalent to bending it and as such bending stress will be introduced.

Q.2. When a thin cylinder of diameter '*d*' and thickness '*t*' is pressurized with an internal pressure of '*p*', ($1/m$ is the Poisson's ratio and E is the modulus of elasticity), then
(*a*) the circumferential strain will be equal to $\frac{pd}{2tE}\left(\frac{1}{2}-\frac{1}{m}\right)$
(*b*) the longitudinal strain will be equal to $\frac{pd}{2tE}\left(1-\frac{1}{2m}\right)$
(*c*) the longitudinal stress will be equal to $\frac{pd}{2t}$.
(*d*) the ratio of the longitudinal strain to circumferential strain will be equal to $\frac{m-2}{2m-1}$

Ans. (*d*) Ratio of longitudinal strain to circumferential strain

$$= \frac{mf_2 - f_1}{m} \times \frac{m}{mf_1 - f_2} = \frac{mf_2 - 2f_2}{2mf_2 - f_2} = \frac{m-2}{2m-1}$$

Q.3. A thick-walled hollow cylinder having outside and in-side radii of 90 mm and 40 mm respectively is subjected to an external pressure of 800 MN/m^2. The maximum circumferential stress in the cylinder will occur at a radius of
(*a*) 40 mm (*b*) 60 mm (*c*) 65 mm (*d*) 90 mm

Ans. (*a*) In thick hollow cylinder, maximum circumferential stress occurs at inner fibres, *i.e.* at radius of 40 *mm* in this case.

Q.4. In a thick cylinder pressurized from inside, the hoop stress is maximum at
(*a*) the centre of the wall thickness
(*b*) the outer radius
(*c*) the inner radius
(*d*) both the inner and the outer radii

Ans. (*c*)

Q.5. The Euler's crippling load for a 2 m long slender steel rod of uniform cross-section hinged at both the ends is 1 *kN*. The Euler's crippling load for a 1 *m* long steel rod of the same cross-section and hinged

at both ends will be

(*a*) 0.25 kN (*b*) 0.5 kN (*c*) 2 kN (*d*) 4 kN

Ans. (*d*) For column with both ends hinged, $P = \frac{\pi^2 E\tau}{l^2}$. If l is halved, P will be 4 times.

Q.6. For the state of stress of pure shear τ, the strain energy stored per unit volume in the elastic, homogeneous isotropic material having elastic constants E and ν will be

(*a*) $\frac{\tau^2}{E}(1+\nu)$ (*b*) $\frac{\tau^2}{2E}(1+\nu)$ (*c*) $\frac{2\tau^2}{E}(1+\nu)$ (*d*) $\frac{\tau^2}{2E}(2+\nu)$

Ans. (*a*)

Q.7. Euler's formula gives 5 to 10% error in crippling load as compared to experimental results in practice because

(*a*) effect of direct stress is neglected
(*b*) pin joints are not free from friction
(*c*) the assumptions made in using the formula are not met in practice
(*d*) the material does not behave in an ideal elastic way in tension and compression

Ans. (*a*)

Q.8. According to the maximum shear stress theory of failure, permissible twisting moment in a circular shaft is 'T'. The permissible twisting moment in the same shaft as per the maximum principal stress theory of failure will be

(*a*) $T/2$ (*b*) T (*c*) $\sqrt{2T}$ (*d*) $2T$

Ans. (*b*)

Q.9. Match List-I (Alloying element in steel) with List-II (Property conferred on steel by the element) and select the correct answer using the codes given below the lists :

List-I	*List-II*
A. Nickel	1. Corrosion resistance
B. Chromium	2. Magnetic permeability
C. Tungsten	3. Heat resistance
D. Silicon	4. Hardenability

Codes :

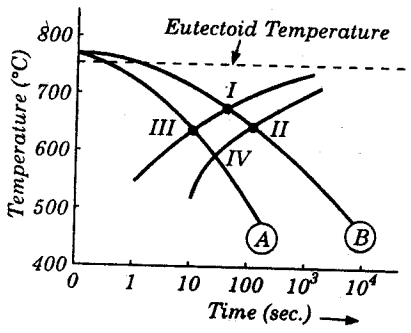
	A	B	C	D
(*a*)	4	1	3	2
(*c*)	1	4	3	2

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

Ans. (*a*)

Q.10. Two cooling curves A and B for a eutectoid iron-carbon alloy are superimposed on a continuous cooling transformation diagram as shown in the given figure. Fine pearlite microstructure is represented by the points labelled

(*a*) I and III
(*b*) II
(*c*) IV
(*d*) I



Ans. (*a*) Fine pearlite structure is formed near eutectoid temperature and on very slow cooling.

Q.11. Match List-I (Alloys) with List-II (Applications) and select the correct answer using the codes given below the lists :

List-I	*List-II*
A. Chromel	1. Journal bearing
B. Babbit alloy	2. Milling cutter
C. Nimonic alloy	3. Thermocouple wire
D. High speed steel	4. Gas turbine blades

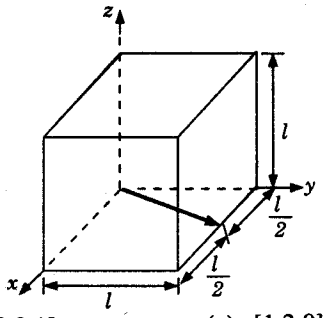
Codes :

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

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

Ans. (*a*)

Q.12. A unit cell of a crystal is shown in the given figure. The Miller indices of the direction (arrow) shown in the figure is



(*a*) [0 1 2] (*b*) [0 2 1] (*c*) [1 2 0] (*d*) [2 0 1]

Ans. (*c*)

Q.13. Match List-I with List-II and select the correct answer using the codes given below the lists :

List-I (*Material*)	*List-II* (*Structure*)
A. Charcoal	1. F.C.C.
B. Graphite	2. H.C.P.
C. Chromium	3. Amorphous
D. Copper	4. B.C.C.

Codes :

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

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

Ans. (*c*)

Q.14. Which one of the following processes is most commonly used for the forging of bolt heads of hexagonal shape ?

(*a*) Closed die drop forging (*b*) Open die upset forging
(*c*) Close die press forging (*d*) Open die progressive forging

Ans. (*d*)

Q.15. The bending force required for V-bending, U-bending and Edge-bending will be in the ratio of

(*a*) 1 : 2 : 0.5 (*b*) 2 : 1 : 0.5 (*c*) 1 : 2 : 1 (*d*) 1 : 1 : 1

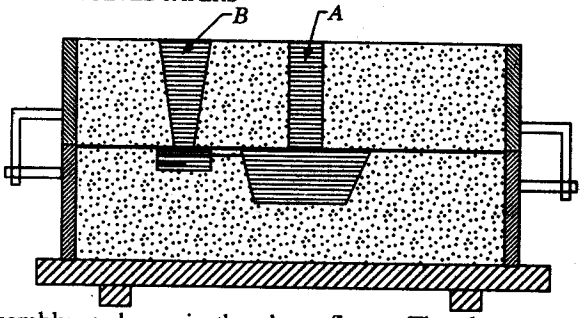
Ans. (*a*)

Q.16. In powder metallurgy, the operation carried out to improve the bearing property of a bush is called

(*a*) infiltration (*b*) impregnation (*c*) plating (*d*) heat treatment

Ans. (*a*)

Q.17.



A sand casting mould assembly is shown in the above figure. The elements marked A and B are respectively

(*a*) sprue and riser (*b*) ingate and riser (*c*) drag and runner (*d*) riser and runner

Ans. (*a*)

Q.18. Which of the following are the requirements of an ideal gating system ?

1. The molten metal should enter the mould cavity with as high a velocity as possible.
2. It should facilitate complete filling of the mould cavity.
3. It should be able to prevent the absorption of air or gases from the surroundings on the molten metal while flowing through it.

Select the correct answer using the codes given below :

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

Ans. (*c*)

Q.19. A spherical drop of molten metal of radius 2 mm was found to solidify in 10 seconds. A similar drop of radius 4 mm would solidify in

(*a*) 14.14 seconds (*b*) 20 seconds (*c*) 28.30 seconds (*d*) 40 seconds

Ans. (*d*) Solidification time for sphere $\propto \left(\frac{V}{A}\right)^2$

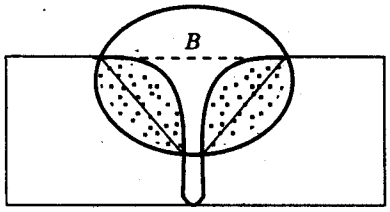
$\therefore$ If radius is doubled, time will be $\propto \left(\frac{8}{4}\right)^2 \propto 4$ times.

Q.20. In oxy-acetylene gas welding, for complete combustion, the volume of oxygen required per unit of acetylene is

(*a*) 1 (*b*) 1.5 (*c*) 2 (*d*) 2.5

Ans. (*d*)

Q.21.



An arc welded joint is shown in the above figure. The part labelled 'B' in the figure is known as

(*a*) weld preparation (*b*) penetration (*c*) reinforcement (*d*) slag

Ans. (*c*)

Q.22. The voltage-current characteristics of a dc generator for arc welding is a straight line between an open-circuit voltage of 80 *V* and short-circuit current of 300 *A*. The generator settings for maximum arc power will be

(*a*) 80 *V* and 150 *A* (*b*) 40 *V* and 300 *A* (*c*) 40 *V* and 150 *A* (*d*) 80 *V* and 300 *A*

Ans. (*c*) Maximum arc power will be somewhere in the middle, *i.e.* voltage of 40 *V* and current of 150 *A*.

Q.23. Which of the following joining processes are best suited for manufacturing pipes to carry gas products?

1. Rivetting 2. Welding 3. Bolts and nuts.

Select the correct answer using the codes given below :

Codes :

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

Ans. (*c*)

Q.24. A 400 mm long shaft has a 100 mm tapered step at the middle with 4° included angle. The tailstock offset required to produce this taper on a lathe would be

(*a*) 400 sin 4° (*b*) 400 sin 2° (*c*) 100 sin 4° (*d*) 100 sin 2°

Ans. (*b*)

Q.25. A single short thread of pitch 2 mm is to be produced on a lathe having a lead screw with a double start thread of pitch 4 mm. The ratio of speeds between the spindle and lead screw for this operation is

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

Ans. (*d*)

Q.26. Match List-I with List-II and select the correct answer using the codes given below the lists :

List-I	***List-II***
A. Reaming	1. Smoothing and squaring surface around the hole for proper seating
B. Counter-boring	2. Sizing and finishing the hole
C. Counter-sinking	3. Enlarging the end of the hole
D. Spot facing	4. Making a conical enlargement at the end of the hole

Codes :

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

Ans. (*d*)

Q.27. Which one of the following pairs of parameters and effects is not correctly matched ?

(*a*) Large wheel diameter .... Reduced wheel wear
(*b*) Large depth of cut .... Increased wheel wear
(*c*) Large work diameter .... Increased wheel wear
(*d*) Large wheel speed .... Reduced wheel wear

Ans. (*d*)

Q.28. A component requires a hole which must be within the two limits of 25.03 and 25.04 mm diameter. Which of the following statements about the reamer size are correct ?

1. Reamer size cannot be below 25.03 mm. 2. Reamer size cannot be above 25.04 mm.
3. Reamer size can be 25.04 mm. 4. Reamer size can be 25.03 mm.

Select the correct answer using the codes given below :

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

Ans. (*a*)

Q.29. Consider the following criteria in evaluating machinability :

1. Surface finish. 2. Type of chips. 3. Tool life. 4. Power consumption.

In modern high speed CNC machining with coated carbide tools, the correct sequence of these criteria in DECREASING order of their importance is

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

Ans. (*c*)

Q.30. In tape preparation for an NC machine tool the code *S* 624 would represent spindle speeds of
(*a*) 624 rpm, 240 rpm and 246 rpm (*b*) 624 rpm and 240 rpm
(*c*) 624 rpm and 246 rpm (*d*) 240 rpm and 246 rpm

Ans. (*d*) In speed code, number 3 is added to number of digits to left of decimal of rpm. First two digits are placed after this. Thus 6 represents three digits in rpm and these will start with 24. Thus it could be 240 and 246 rpm.

Q.31. Which of the following are the rules of programming NC machine tools in APT language ?
1. only capital letters are used. 2. A period is placed at the end of each statement.
3. Insertion of space does not affect the APT word.
Select the correct answer using the codes given below :
(*a*) 1 and 2 (*b*) 2 and 3 (*c*) 1 and 3 (*d*) 1 alone

Ans. (*c*)

Q.32. In metal cutting operation, the approximate ratio of heat distributed among chip, tool and work, in that order is
(*a*) 80 : 10 : 10 (*b*) 33 : 33 : 33 (*c*) 20 : 60 : 10 (*d*) 10 : 10 : 80

Ans. (*a*)

Q.33. The gauge factor of a resistive pick-up of cutting force dynamometer is defined as the ratio of
(*a*) applied strain to the resistance of the wire
(*b*) the proportional change in resistance to the applied strain
(*c*) the resistance to the applied strain
(*d*) change in resistance to the applied strain

Ans. (*d*)

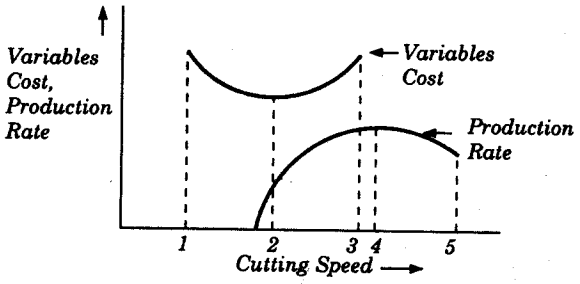
Q.34. Poor machinability of centrifugally cast iron pipe is due to
(*a*) chilling (*b*) segregation (*c*) dense structure (*d*) high mould rotation speed

Ans. (*a*)

Q.35. On a lathe, the actual machining time required per work piece is 30 minutes. Two types of carbide tools are available, both having a tool life of 60 minutes.
Type I : Brazed type of original cost Rs. 50/-.
Type II : Throw away tip (square) of original cost Rs. 70/-
If the overall cost of grinding the cutting edge is Rs. 10/-, assuming all the costs are the same for both the types, for break even costs, the appropriate batch size would be
(*a*) 2 pieces (*b*) 4 pieces (*c*) 6 pieces (*d*) 8 pieces

Ans. (*b*)

Q.36. The variable cost and production rate of a machining process against cutting speed are shown in the given figure. For efficient machining, the range of best cutting speed would be between



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

Ans. (*d*)

Q.37. Match List-I (Machining process) with List-II (Associated medium) and select the correct answer using the codes given below the lists :

List-I	*List-II*
A. Ultrasonic machining	1. Kerosene
B. EDM	2. Abrasive slurry
C. ECM	3. Vacuum
D. EBM	4. Salt solution

Codes :

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

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

Ans. (*b*)

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

List-I (*Measuring Device*)	*List-II* (*Parameter Measured*)
A. Diffraction grating	1. Small angular deviations on long flat surfaces
B. Optical flat	2. On-line measurement of moving parts
C. Auto collimators	3. Measurement of gear pitch
D. Laser scan micrometer	4. Surface texture using interferometry
	5. Measurement of very small displacements

Codes :

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

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

Ans. (*d*)

Q.39. One of the pins in a dual pin locator of a jig or fixture is shaped as a "diamond pin locator" because

(*a*) diamond pin does not wear fast (*b*) it is easy to clamp

(*c*) any variation between the centres of the hole is taken care of

(*d*) it will be easy to machine afterwards when the locator is worn out

Ans. (*c*)

Q.40. Match List-I (Methods) with List-II (Problems) and select the correct answer using the codes given below the lists :

List-I	*List-II*
A. Moving average	1. Assembly
B. Line balancing	2. Purchase
C. Economic batch size	3. Forecasting
D. Johnson algorithm	4. Sequencing

Codes :

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

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

Ans. (*d*)

Q.41. Consider the following statements :

Dispatching

1. is the action of operations, planning and control.
2. releases work to the operating divisions.
3. conveys instructions to the shop floor.