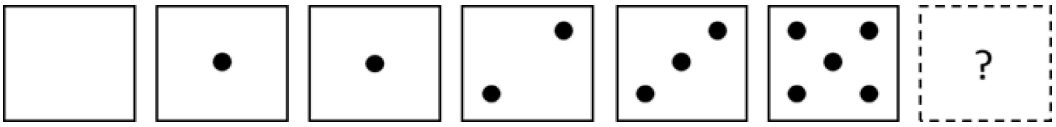
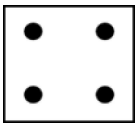
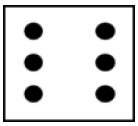
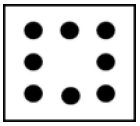
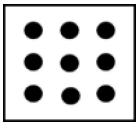
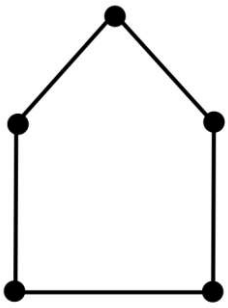
General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

Q.1	Suresh said, “I did it yesterday.” Which one of the following options is the correct form of this sentence in indirect speech?
(A)	Suresh said that I did it yesterday.
(B)	Suresh says I did it yesterday.
(C)	Suresh says that he did it the day before.
(D)	Suresh said that he had done it the day before.

Q.2	To continue the sequence of tiles shown, the tile indicated by the question mark should be 
(A)	
(B)	
(C)	
(D)	

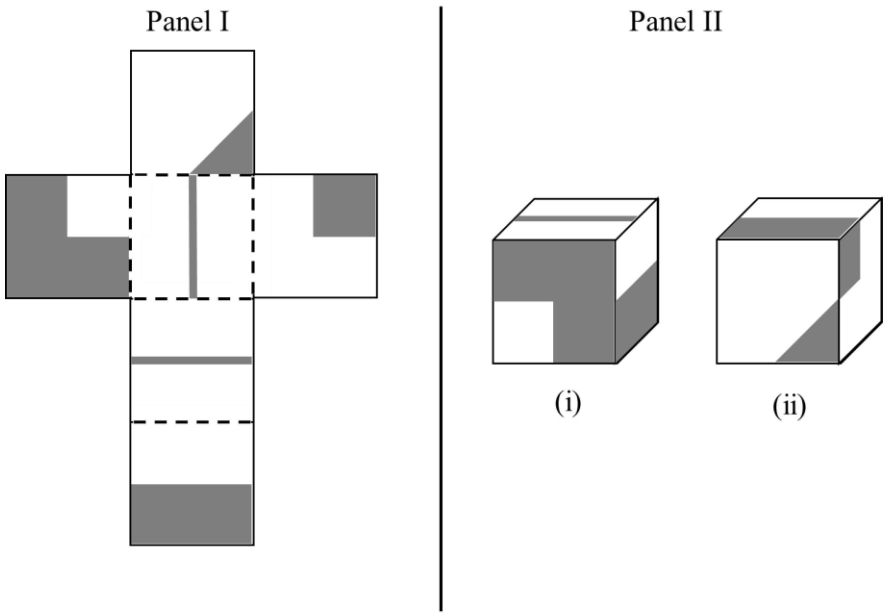
Q.3	Consider an art gallery whose walkways are shown as lines in the diagram. A black dot represents a junction of two walkways. A guard may be placed at a junction to watch over the walkways that join at that junction. The minimum number of guards needed to watch all the walkways is _____. 
(A)	2
(B)	3
(C)	4
(D)	5

Q.4	The 2nd of June is a Thursday in a certain year. Which day of the week is the 3rd of July in that year?
(A)	Thursday
(B)	Friday
(C)	Saturday
(D)	Sunday

Q.5	A coin with heads facing up is shown as (H) and a coin with tails facing up is shown as (T) . Six coins are placed in the Starting Arrangement, as shown in the figure below. A "step" is defined as interchanging a pair of adjacent coins without flipping them. The minimum number of steps needed to go from the Starting Arrangement to the Final Arrangement, as shown in the figure, is _____. Starting Arrangement  Final Arrangement 
(A)	3
(B)	6
(C)	9
(D)	12

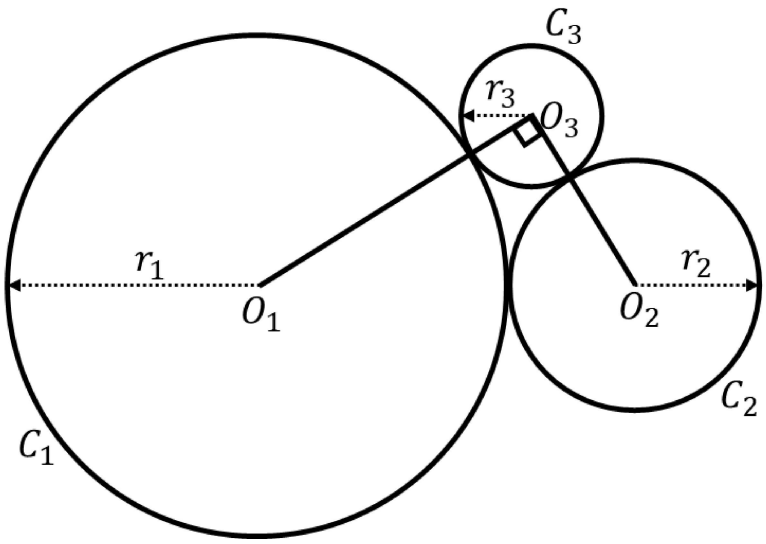
Q.6 – Q.10 Carry TWO marks Each

Q.6	Exacerbate : Mitigate :: _____ Choose the option with the correct pair of words to fill the blank.
(A)	Aggravate : Alleviate
(B)	Alleviate : Precipitate
(C)	Aggravate : Precipitate
(D)	Emancipate : Exonerate

Q.7	A paper shown in Panel I is folded along the dashed lines (- - -) to construct a cube. The shaded regions shown in Panel I appear on the outer surface of the cube. Referring to cubes shown in Panel II, which one of the options is correct? 
(A)	Only (i) can correspond to the unfolded cube in Panel I.
(B)	Only (ii) can correspond to the unfolded cube in Panel I.
(C)	Both (i) and (ii) can correspond to the unfolded cube in Panel I.
(D)	Neither (i) nor (ii) can correspond to the unfolded cube in Panel I.

Q.8	In a population, patients who have high cholesterol also have high blood-pressure (BP). Some patients with high BP also have diabetes. There are no patients who have both high cholesterol and diabetes. Furthermore, 1. the total number of patients with at least one of these conditions is 75, 2. the number of patients with high cholesterol is 10, 3. the number of patients with high BP is 45, and 4. the number of patients with only high BP and no other conditions is 20. Then the number of patients who have both diabetes and high BP is _____
(A)	0
(B)	15
(C)	20
(D)	10

Q.9	Four people P, Q, R, and S, of different ages, make the following observations. P – I am younger than S. Q – I am neither the youngest nor the oldest. R – P is older than me. Based on these observations, the youngest person is _____.
(A)	P
(B)	Q
(C)	R
(D)	S

Q.10	Circles C_1, C_2, and C_3, with centers O_1, O_2, and O_3 , and radii r_1 , r_2, and r_3, respectively, touch each other as shown in the following figure. Given $r_1 = 2$ cm, $r_2 = 1$ cm and the angle $\angle O_1O_3O_2$ is 90°, r_3 = _____ cm. 
(A)	$\frac{1}{2}(-3+\sqrt{17})$
(B)	$\frac{1}{2}(3+\sqrt{17})$
(C)	$\frac{1}{2}(-2+\sqrt{17})$
(D)	$\frac{1}{2}(-3+2\sqrt{17})$

Q.11 – Q.17 Carry ONE mark Each

Q.11	For the complex function $$f(z) = f(x+iy) = x^3 - 4xy^2 + i(4x^2y - 2y^3),$$ consider the following two statements P: f is not analytic at $(0,0)$. Q: f does not satisfy the Cauchy-Riemann equations along the x-axis. Then, which one of the following statements is true?
(A)	P is false and Q is true
(B)	P is true and Q is false
(C)	Both P and Q are true, and Q implies P
(D)	Both P and Q are true, but Q does not imply P
Q.12	Let C be the circle $(x-1)^2 + y^2 = 25$ oriented counterclockwise. Then, the value of the line integral $$\oint_C [(x^5 - 3y)dx + (-2x + e^{y^2})dy]$$ is
(A)	10π
(B)	15π
(C)	20π
(D)	25π

Q.13	Let $W(x)$ denote the Wronskian of two linearly independent solutions $y_1(x)$ and $y_2(x)$ of the differential equation $$(x-1)\frac{d^2y}{dx^2}+2\frac{dy}{dx}+xe^xy=0, \qquad x>1.$$ If $W(2)=2$, then the value of $W(5)$ is
(A)	$\frac{1}{8}$
(B)	$\frac{1}{5}$
(C)	5
(D)	8
Q.14	Which of the following statements is/are true?
(A)	$Y=1+1.8X$ and $X=1-0.5Y$ are estimated as lines of regression of Y on X and X on Y, respectively.
(B)	$Y=1+1.3X$ and $X=2+1.1Y$ are estimated as lines of regression of Y on X and X on Y, respectively.
(C)	$Y=1+1.6X$ and $X=3+0.5Y$ are estimated as lines of regression of Y on X and X on Y, respectively.
(D)	$Y=1+X$ and $X=Y$ are estimated as lines of regression of Y on X and X on Y, respectively, and the correlation between X and Y is ± 1.

Q.15	Consider the matrix $A = \begin{bmatrix} 1 & \sqrt{2} & 0 \\ \sqrt{2} & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$. Then, which of the following statements is/are true?
(A)	All the eigenvalues of A are real numbers
(B)	The eigenvalues of A^{-1} are $1, \frac{1}{2}, -1$
(C)	The determinant of A is 3
(D)	The matrix $A - 2I$ is invertible, where I denotes the identity matrix of order 3×3
Q.16	Let L be the lamina of the form $x^2 + 4y^2 \leq 64$, $0 \leq y \leq 4$, with density $\rho(x, y) = \lvert x \rvert y$. Then, the mass of L (*in integer*) is _____
Q.17	Let X be a random variable having probability density function (pdf) $$f_X(x) = \begin{cases} \frac{e}{2(e-1)} e^{-x}, & 0 < x < 1, \\ \frac{1}{2}, & 1 < x < 2, \\ 0, & \text{elsewhere.} \end{cases}$$ Then, the value of the expectation of X, $E[X]$ (*rounded off up to two decimal places*) is _____

Q.18 – Q.21 Carry TWO marks Each

Q.18 Match each entry of **List-1** with a suitable entry in **List-2** and choose the correct option.

List-1		List-2	
P	The sum of the series $\sum_{n=1}^{\infty} \frac{1}{(n+2)(n+1)}$ is equal to	I	$\frac{3}{2}$
Q	$\lim_{x\to 0}\left(\frac{3}{x^2}\int_0^x \sin(t)\,dt\right)$ is equal to	II	1
R	Let $\frac{a_0}{2}+\sum_{n=1}^{\infty}(a_n\cos nx + b_n \sin nx)$ be the Fourier series expansion of the function $f(x)=\frac{1}{2}\sin x - \frac{1}{2}\cos x + \frac{1}{\sqrt{2}}\sin 2x\,, x\in[0,2\pi]$. Then, $\sum_{n=0}^{\infty}(a_n^2+b_n^2)$ is equal to	III	$\frac{1}{2}$

(A) P ⟶ I, Q ⟶ III, R ⟶ II

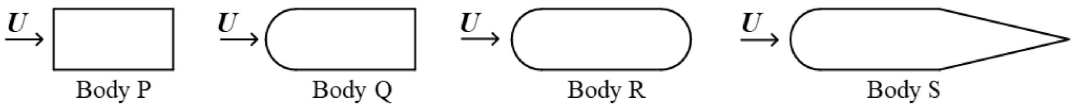
(B) P ⟶ III, Q ⟶ II, R ⟶ I

(C) P ⟶ III, Q ⟶ I, R ⟶ II

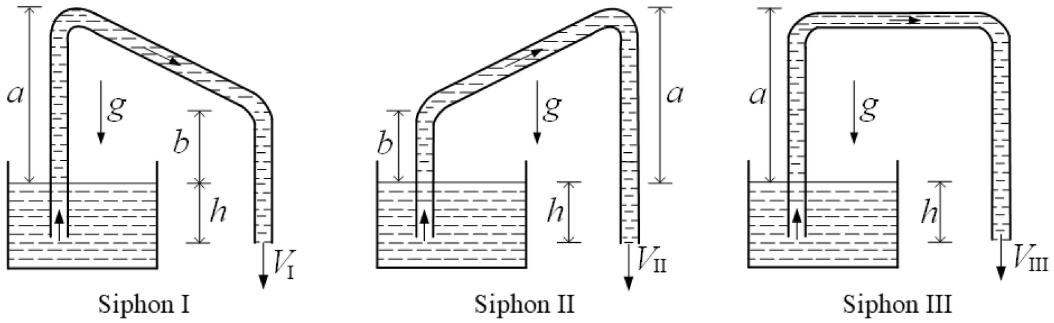
(D) P ⟶ II, Q ⟶ I, R ⟶ III

Q.19	Consider the following partial differential equation (PDE) $$(y-1)\frac{\partial^2 u}{\partial x^2} - (x-3)^2\frac{\partial^2 u}{\partial y^2} + y^2\frac{\partial u}{\partial x} + x^2\frac{\partial u}{\partial y} + (x-y)u = 0.$$ Then, which of the following statements is/are true?
(A)	In the region $\{(x,y) \in \mathbb{R}^2 : y > 1,\ x > 3\}$, the PDE is hyperbolic
(B)	In the region $\{(x,y) \in \mathbb{R}^2 : y > 1,\ x < 3\}$, the PDE is elliptic
(C)	In the region $\{(x,y) \in \mathbb{R}^2 : y < 1,\ x > 3\}$, the PDE is elliptic
(D)	In the region $\{(x,y) \in \mathbb{R}^2 : y < 1,\ x < 3\}$, the PDE is hyperbolic
Q.20	Let $\begin{bmatrix} l_{11} & 0 & 0 \\ l_{21} & l_{22} & 0 \\ l_{31} & l_{32} & -10 \end{bmatrix}\begin{bmatrix} 1 & u_{12} & u_{13} \\ 0 & 1 & u_{23} \\ 0 & 0 & 1 \end{bmatrix}$ be the LU decomposition of the matrix $A = \begin{bmatrix} 1 & 1 & 1 \\ 4 & 3 & -1 \\ 3 & 5 & a \end{bmatrix}$. Then, the value of a (*in integer*) is _____
Q.21	The initial value problem $$\frac{du}{dt} = u^2 + t^2, \qquad t \geq 0,$$ $$\text{with} \quad u(0) = 1,$$ is solved by using the explicit Euler method with step size $h = 0.2$. Then, the value of $u(0.4)$ (*rounded off upto two decimal places*) is _____

Q.22 – Q.30 Carry ONE mark Each

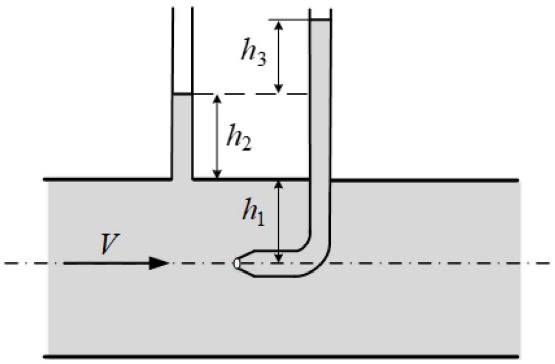
Q.22	For a laminar, incompressible, and fully-developed flow through a circular pipe, the ratio of the maximum velocity to the average velocity of the flow is
(A)	1.5
(B)	2
(C)	3
(D)	4
Q.23	Air flows with a freestream velocity U over four different bodies having same frontal area facing the flow direction, as shown in the figure. Which one of the following bodies has the lowest pressure (form) drag force for Reynolds number, $Re \geq 10^4$? 
(A)	Body P
(B)	Body Q
(C)	Body R
(D)	Body S

Q.24	Consider a steady, and incompressible flow over a body with characteristic length L. The boundary layer thickness at a distance x from the leading edge is δ. Which one of the following assumptions is correct for deriving the Prandtl boundary layer equations?
(A)	$\delta \approx L$
(B)	$\delta > L$
(C)	$\delta \gg L$
(D)	$\delta \ll L$

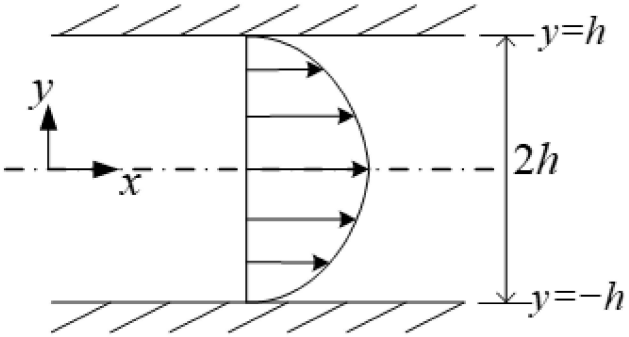
Q.25	Three different siphons steadily discharge water at velocities V_I, V_{II}, and V_{III}, as shown in the figure. The tubes of the siphons are of same diameter. If the frictional losses are neglected, which one of the following options is correct? In the figure, g is acceleration due to gravity; a, b, and h are different heights. 
(A)	$V_I > V_{III} > V_{II}$
(B)	$V_I > V_{II} > V_{III}$
(C)	$V_I = V_{II} = V_{III}$
(D)	$V_{II} > V_{III} > V_I$

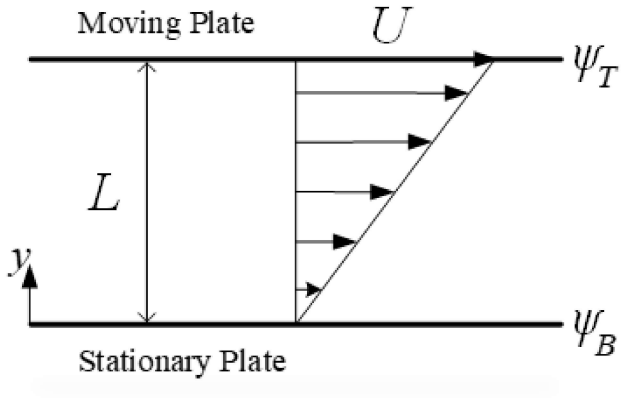
Q.26	Consider the following statements: Assertion (**a**) Surface tension acts along the interface of two fluids. Reason (**r**) The pressure of the fluid inside a bubble is higher than that of the fluid outside the bubble. Which one of the following options is correct?
(A)	Both (**a**) and (**r**) are true, and (**r**) is the correct explanation of (**a**).
(B)	Both (**a**) and (**r**) are true, however (**r**) is not the correct explanation of (**a**).
(C)	(**a**) is true, but (**r**) is false.
(D)	(**a**) is false, but (**r**) is true.

Q.27	The basic dimensions, i.e., mass, length, and time are represented by M, L, and T, respectively. The correct dimension of dynamic viscosity is
(A)	MLT^{-2}
(B)	$M^0L^2T^{-1}$
(C)	$ML^{-1}T^{-1}$
(D)	$M^0L^{-2}T^2$
Q.28	The velocity components in x- and y-directions of a two-dimensional, incompressible flow field are $u(x,y) = 2x^2 + y^3$ and $v(x,y) = x^3 - 2xy + f(x,y)$, respectively. Here, $f(x,y)$ is a polynomial function and $g(x)$ is a polynomial function of x only. Which one of the following options for $f(x,y)$ is correct?
(A)	$f(x,y) = -xy^2 + g(x)$
(B)	$f(x,y) = -2x + g(x)$
(C)	$f(x,y) = -2xy + g(x)$
(D)	$f(x,y) = -2x^2y + g(x)$

Q.29	Which of the following statements about streamlines, pathlines, and streaklines is/are correct?
(A)	A streamline is a curve that is everywhere tangent to the instantaneous local velocity vector.
(B)	Two streamlines can intersect at a point in a flow.
(C)	A pathline is the locus of fluid particles passing sequentially through a particular point.
(D)	For steady flow, streamlines, pathlines, and streaklines are the same.
Q.30	A piezometer and a Pitot tube are tapped into a horizontal water pipe, as shown in the figure, where $h_1 = 4$ cm, $h_2 = 6$ cm and $h_3 = 5$ cm. Consider the flow to be steady, laminar, and incompressible. Assume the density of water as 1000 kg.m^{-3} and acceleration due to gravity as 10 m.s^{-2}. The water velocity V (in m.s^{-1}) at the center of the pipe is _____. (*rounded off to one decimal place*) 

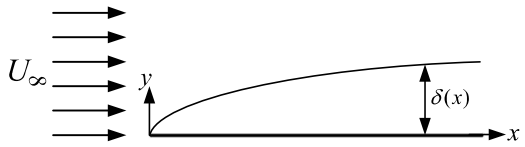
Q.31 – Q.43 Carry TWO marks Each

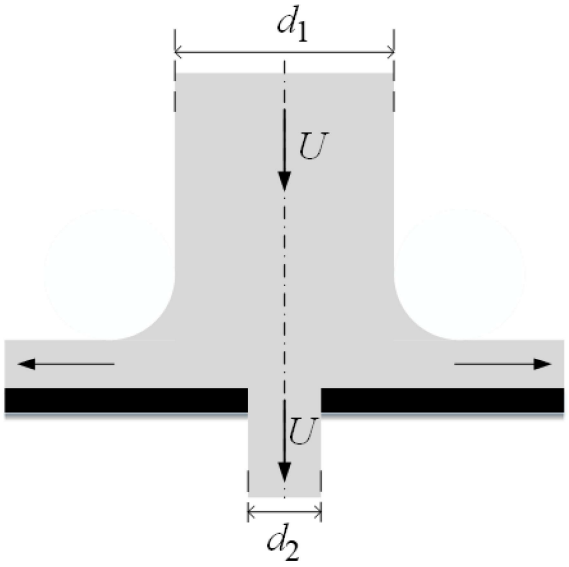
Q.31	A steady, laminar, and incompressible flow between a pair of infinite parallel plates is driven by a constant pressure gradient $(-dp/dx)$. The plates are separated by a distance $2h$, as shown in the figure. The fully-developed velocity profile of the flow is $$u(y) = -\frac{dp}{dx}\frac{h^2}{2\mu}\left(1-\frac{y^2}{h^2}\right),$$ where μ is the dynamic viscosity. The values of y, for which the local flow velocity is equal to the average flow velocity, are 
(A)	$\pm\frac{h}{2}$
(B)	$\pm\frac{h}{\sqrt{2}}$
(C)	$\pm\frac{h}{3}$
(D)	$\pm\frac{h}{\sqrt{3}}$

Q.32	An incompressible fluid flows between a pair of infinite plates separated by a distance L. The top plate is moving with a constant velocity U, whereas the bottom plate is stationary, as shown in the figure. The difference of the stream functions $(\psi_T - \psi_B)$ at the two plates for a laminar and fully-developed flow is equal to 
(A)	$\frac{UL}{2}$
(B)	UL
(C)	$2UL$
(D)	$4UL$

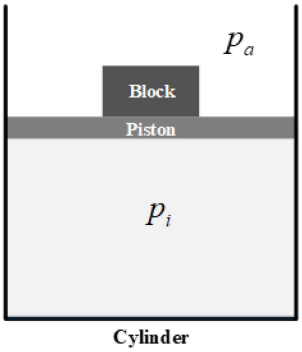
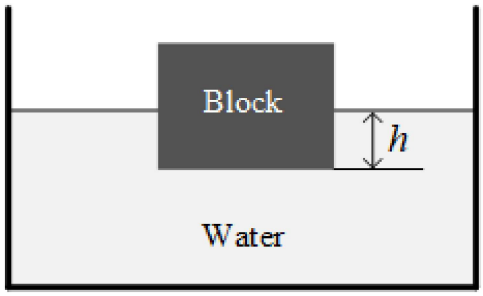
Q.33	Consider two different cases of water flowing through a smooth pipe of 50 cm diameter. The mass flow rates for the two cases are (i) 0.25 $kg.s^{-1}$, and (ii) 0.8 $kg.s^{-1}$. Assume the density and dynamic viscosity of water as 1000 $kg.m^{-3}$ and 10^{-3} Pa.s, respectively. Which one of the following options is correct?
(A)	The flow is laminar for both (i), and (ii).
(B)	The flow is laminar for (i), and turbulent for (ii).
(C)	The flow is turbulent for (i), and laminar for (ii).
(D)	The flow is turbulent for both (i), and (ii).

Q.34	A two-dimensional source flow (with stream function, $\psi_1 = m\tan^{-1}\frac{y}{x}$) is placed at the origin in a uniform flow (with stream function, $\psi_2 = Uy$). Here, the strength of the source is m and the freestream velocity is U. The velocity components u and v of the combined flow in x- and y-directions, respectively, are
(A)	$u = U + \frac{mx}{x^2+y^2}\ ;\ \ v = \frac{my}{x^2+y^2}$
(B)	$u = \frac{mx}{x^2+y^2}\ ;\ \ v = U + \frac{my}{x^2+y^2}$
(C)	$u = U + \frac{mx}{x^2+y^2}\ ;\ \ v = -\frac{my}{x^2+y^2}$
(D)	$u = \frac{mx}{x^2+y^2}\ ;\ \ v = U - \frac{my}{x^2+y^2}$

Q.35	Consider a steady, laminar, and incompressible flow over a flat plate, as shown in the figure. With freestream velocity U_∞ and kinematic viscosity ν_1, the boundary layer thickness at a distance x_1 from the leading edge is δ_1. If the kinematic viscosity of the fluid is increased by a factor of four ($\nu_2 = 4\nu_1$), the boundary layer thickness (δ_2) at x_1 with same U_∞ will be equal to 
(A)	$\frac{\delta_1}{2}$
(B)	δ_1
(C)	$2\delta_1$
(D)	$4\delta_1$

Q.36	A vertical jet of diameter d_1 strikes a horizontal plate with a velocity U, as shown in the figure. The plate has a hole of diameter $d_2 (< d_1)$ concentric to the flow through which a portion of fluid passes with the same velocity U. The remaining fluid moves radially outward along the plate. If F is the force acting vertically upward to hold the horizontal plate at its initial place, which of the following statements is/are true? 
(A)	Radially outward flow has no effect on F.
(B)	F decreases as d_2 decreases keeping other parameters unchanged.
(C)	F increases as U increases keeping other parameters unchanged.
(D)	F remains constant as d_1 increases keeping other parameters unchanged.

Q.37	The velocity of a fluid particle in a flow is given as: $\vec{V} = (a - x)\hat{\imath} + (b + y)\hat{\jmath} + (c + z)\hat{k}$ where a, b, c are constants, and $\hat{\imath}$, $\hat{\jmath}$, $\hat{k}$ are unit vectors in x-, y-, z-directions, respectively. Which of the following statements is/are correct?
(A)	The flow is steady for any value of a, b, and c.
(B)	At a point (2, 3, 6), the velocity component in x-direction is higher than the velocity components in y- and z-directions for $a = 2$, $b = 6$, and $c = 2$.
(C)	The point (2, 3, 6) is a stagnation point for $a = 2$, $b = -3$, and $c = -6$.
(D)	The acceleration of the flow along the x-direction is not constant for any value of a, b, and c.

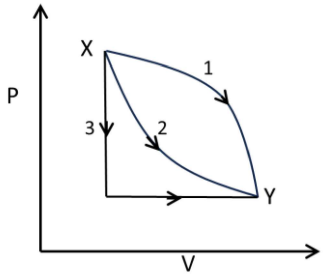
Q.38	A gas is pressurized in a vertical frictionless piston-cylinder device, as shown in the figure. The piston has a mass of 4 kg and a cross-sectional area of 40 cm^2. A metallic block of 13 kg is placed on the piston. The atmospheric pressure (p_a) is 1 bar. Assume acceleration due to gravity as 10 $m.s^{-2}$. The pressure inside the cylinder, p_i (in bar) is _____. (*rounded off to three decimal places*) 
Q.39	A ship is designed to sail at a speed of 8 $m.s^{-1}$. A designer makes a 1/10 scaled model to test the ship in a water tunnel. The model and the ship satisfy the dynamic similarity. The speed (in $m.s^{-1}$) of the model is _____. (*rounded off to two decimal places*)
Q.40	A rectangular block (density = 600 $kg.m^{-3}$) with base area of 0.06 m^2 and height 15 cm is partially submerged in water (density = 1000 $kg.m^{-3}$), as shown in the figure. Assume acceleration due to gravity as 10 $m.s^{-2}$. The submerged depth, h (in m) of the block in the water is _____. (*rounded off to two decimal places*) 
Q.41	For a steady, laminar, and incompressible flow over a flat plate, the local skin friction coefficient is given as $C_f = \frac{0.664}{\sqrt{Re_x}}$, where Re_x is the local Reynolds number. The density and kinematic viscosity of the fluid are 1.2 $kg.m^{-3}$ and 1.5×10^{-5} $m^2.s^{-1}$, respectively. If the freestream velocity is 3 $m.s^{-1}$, then the local shear stress (in $N.m^{-2}$) at $x = 0.05$ m is _____. (*rounded off to three decimal places*)

Q.42	The axial velocity profile of a laminar, incompressible, and fully-developed flow in a circular pipe of radius R is given as $v_z = \frac{1}{4\mu}\frac{dp}{dz}(r^2 - R^2)$, where μ, p, z, and r are dynamic viscosity, pressure, axial coordinate, and radial coordinate, respectively. If the magnitude of shear stress at the pipe wall is given as $\lvert\tau_w\rvert = \frac{R}{K}\frac{dp}{dz}$, then the value of K is _____. (*answer in integer*)
Q.43	Air flows through a pipe of diameter D with an average velocity of 3 m.s^{-1}. The Darcy friction factor of the pipe is 0.02. Assume acceleration due to gravity as 10 m.s^{-2}. If the head loss per meter is 0.05, the diameter (in m) of the pipe is _____. (*rounded off to two decimal places*)

Q.44 – Q.52 Carry ONE mark Each

Q.44	The band gap of a material is E_g and the energy of an incident photon is E_p. Optical absorption will occur in this material if,
(A)	$E_g < E_p$
(B)	$E_g > E_p$
(C)	Electron-electron recombination occurs
(D)	Electron-hole recombination occurs
Q.45	Discoloration and loss of mechanical strength of plastic chairs exposed to sunlight for several days is due to
(A)	Hydrophilic degradation
(B)	Oxidative degradation
(C)	Photo-degradation
(D)	Thermal degradation

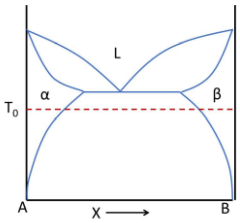
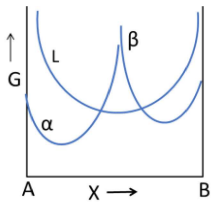
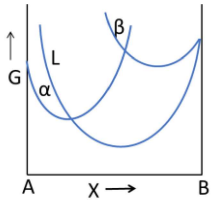
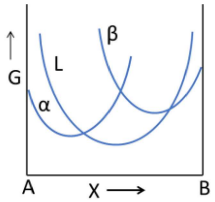
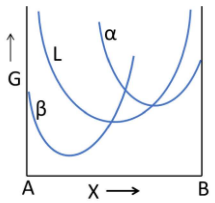
Q.46	Which one of the following polymer processing techniques involves shaping a heated sheet?
(A)	Thermoforming
(B)	Injection molding
(C)	Blow molding
(D)	Extrusion

Q.47	The plot shows three different paths (1, 2, and 3) connecting the initial equilibrium state X to the final equilibrium state Y in a thermodynamic process. Which of the following statements is/are correct? 
(A)	The change in internal energy is the same for all three paths.
(B)	The work done is the same for all three paths.
(C)	The heat exchange will differ depending on the path taken.
(D)	The first law of Thermodynamics is violated if work differs along the paths.

Q.48	Which of the following is/are polarization mechanisms in dielectric solids?
(A)	Mechanical polarization
(B)	Ionic polarization
(C)	Electronic polarization
(D)	Thermal polarization
Q.49	Which of these methods is/are used for the synthesis of ceramic powders?
(A)	Sol-gel
(B)	Hydromechanical
(C)	Thermomechanical
(D)	Hydrothermal
Q.50	The degrees of freedom of a system with 2 components and 2 phases in equilibrium is _____ (answer in integer).
Q.51	The interplanar spacing of $(h\ k\ l)$ planes is 4.5 nm in a given crystal. For the $(3h\ 3k\ 3l)$ planes, the interplanar spacing, in nm, is _____ (rounded off to one decimal place).

Q.52	The equilibrium vacancy concentration in aluminum at 900 K is 1.1×10^{-4}. The enthalpy of formation of vacancies, in $kJ.mol^{-1}$, is _____ (rounded off to one decimal place). Given: Universal gas constant = 8.314 $J.K^{-1}.mol^{-1}$

Q.53 – Q.65 Carry TWO marks Each

Q.53	Three phases, α, β and L are shown in the binary phase diagram below. Identify the correct G – X (Gibbs free energy vs Composition) plot corresponding to temperature T_0. 
(A)	
(B)	
(C)	
(D)	

Q.54	In a cubic crystal, the Burgers vector for a mixed dislocation line is $\frac{a}{2}[110]$. The dislocation line lies along the $[011]$ direction. The slip plane of the dislocation is
(A)	$(1\bar{1}1)$
(B)	(111)
(C)	$(0\bar{1}1)$
(D)	$(1\bar{1}0)$

Q.55 Match the Thermodynamic laws in **Column I** with the description given in **Column II**

Column I		**Column II**	
P	Zeroth law	1	Entropy of a perfect crystal at 0 K is zero
Q	First law	2	Introduces Entropy
R	Second law	3	Defines thermal equilibrium
S	Third law	4	Defines internal energy

(A) P → 3; Q → 4; R → 2; S → 1

(B) P → 1; Q → 2; R → 4; S → 3

(C) P → 1; Q → 4; R → 3; S → 2

(D) P → 3; Q → 1; R → 2; S → 4

Q.56 Match the material property in **Column I** with the measurement technique in **Column II**.

Column I		**Column II**	
P	Electrical conductivity	1	UV-Vis spectroscopy
Q	Band gap energy	2	4-Probe method
R	Young's modulus	3	Differential scanning calorimetry
S	Heat of fusion	4	Acoustic measurement

(A) P → 2; Q → 1; R → 4; S → 3

(B) P → 1; Q → 2; R → 4; S → 3

(C) P → 2; Q → 3; R → 4; S → 1

(D) P → 1; Q → 4; R → 2; S → 3

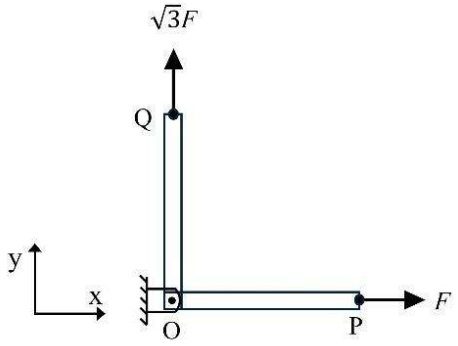
Q.57	Which one of the following statements regarding point defects in ionic solids is correct?
(A)	Frenkel defects are dominant in those ionic solids where there is a considerable size difference between the cation and anion.
(B)	Schottky defects are dominant in those ionic solids where there is a considerable size difference between the cation and anion.
(C)	Schottky defects are the dominant defects in all ionic solids.
(D)	Similar density of both Frenkel and Schottky defects is present in all ionic solids.

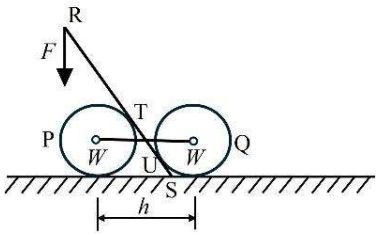
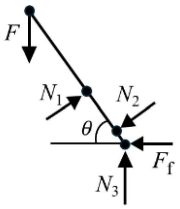
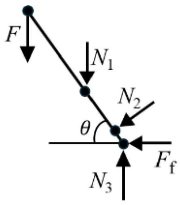
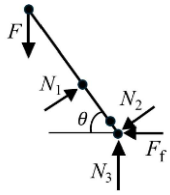
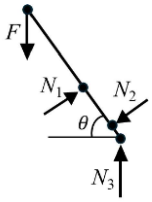
Q.58	Consider 3 crystals (all having FCC lattice) labelled as P, Q and R as described below: Crystal P: Cu crystal with 4 Cu atoms per unit cell Crystal Q: NaCl crystal with 4 Na^+ ions and 4 Cl^- ions per unit cell Crystal R: Diamond crystal with 8 C atoms per unit cell Which of the following options is/are correct?
(A)	Only crystal P is a close packed structure.
(B)	Only crystal Q is a close packed structure.
(C)	Crystal R has the smallest packing factor.
(D)	All the crystals P, Q and R are close packed structures.
Q.59	Which of the following statements is/are applicable to Fick's second law:
(A)	Concentration changes with time
(B)	Steady state condition prevails
(C)	Diffusion is time dependent
(D)	Concentration profile is linear

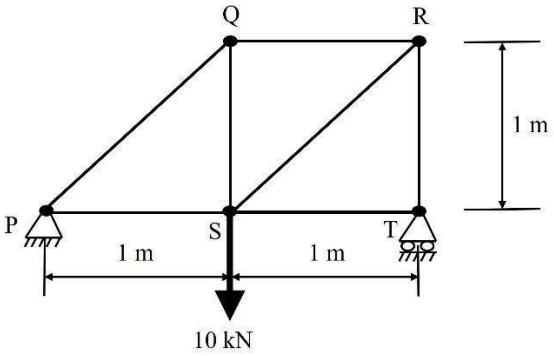
Q.60	According to quantum free electron theory, which of the following statements is/are correct regarding the behavior of valence electrons in a metal?
(A)	Valence electrons are localized to individual atoms.
(B)	Valence electrons are delocalized within the crystal.
(C)	Energy distribution of valence electrons follows Fermi-Dirac statistics.
(D)	Energy distribution of valence electrons follows Maxwell-Boltzmann statistics.
Q.61	Fe has a density of 7.87 g.cm^{-3}, atomic mass of 55.84 g.mol^{-1} and net magnetic moment per atom of 2.22 Bohr magnetons (μ_B). The saturation magnetization of Fe, in A.m^{-1}, is _____ $\times 10^5$ (rounded off to one decimal place). Given: $\mu_B = 9.27\times10^{-24}$ A.m^2, Avogadro number = 6.023×10^{23} mol^{-1}
Q.62	At the peak (also denoted as UTS) of an engineering stress vs. engineering strain curve for ductile metal, the engineering strain is 0.2. The corresponding true stress (σ) vs. true strain (ϵ) relationship follows the equation: $\sigma = K\epsilon^n$, where K and n are constants. The engineering stress at the peak, in MPa, is _____ (rounded off to one decimal place). Given: K = 200 MPa

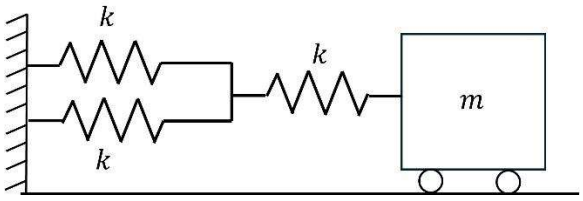
Q.63	A 1 cm^3 Si cube is doped with As with a concentration of 1 atom per 10^9 Si atoms. The resistance of the doped Si cube, in Ohms, is _____ (rounded off to one decimal place). Given: Atomic concentration of Si = 5×10^{22} cm^{-3} Intrinsic concentration of electrons in Si = 1×10^{10} cm^{-3} Electron mobility in Si = 1350 $cm^2.V^{-1}.s^{-1}$ Hole mobility in Si = 450 $cm^2.V^{-1}.s^{-1}$ Electronic charge = 1.6×10^{-19} C
Q.64	A circular disk-shaped ceramic green body has a relative density of 50%. On sintering, both the height and the diameter of the disk shrink by 20%. The sintered disk's relative density, in %, is _____ (rounded off to one decimal place).
Q.65	The standard electrode potential of Cu^{2+} | Cu is $+0.34$ V and Zn^{2+} | Zn is -0.76 V. For the Zn | Zn^{2+} || Cu^{2+} | Cu cell, the EMF, in Volts, is _____ (rounded off to two decimal places).

Q.66 – Q.74 Carry ONE mark Each

Q.66	Two axial members, namely OP and OQ, are pin joined at O as shown in the figure. A force F acts at point P along the positive x direction and a force $\sqrt{3}F$ acts at point Q along the positive y direction. The resultant of the applied forces makes an angle θ (anticlockwise from the positive x-axis). The value of θ is _____. 
(A)	30°
(B)	45°
(C)	60°
(D)	75°

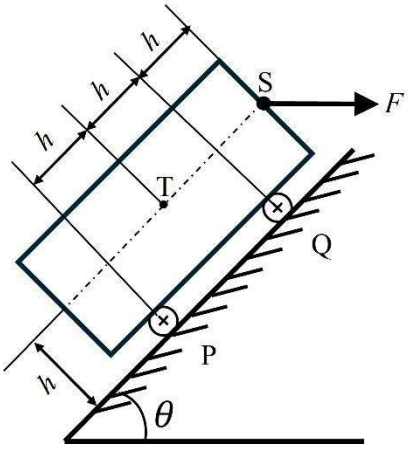
Q.67	Two smooth drums each weighing W and radius, r are connected by a stiff rope of length, h as shown in the figure. Force F is applied using a massless lever (RS) of length, l. The friction between the drums and the lever (RS) is negligible. The system is in static equilibrium. Which one of the following represents the CORRECT free body diagram of the lever (RS)? Figures are not to scale. N_1, N_2, and N_3 in the options are reaction forces and F_f is the frictional force. 
(A)	
(B)	
(C)	
(D)	

Q.68	Identify the zero-force member in the truss structure as shown in the figure.  Figure is not to scale
(A)	ST
(B)	SR
(C)	SP
(D)	SQ

Q.69	A rigid block of mass m on a horizontal surface is connected to three springs each having spring constant k as shown in the figure. Which one of the following is the CORRECT natural frequency of the system? 
(A)	$\sqrt{\frac{3k}{4m}}$
(B)	$\sqrt{\frac{2k}{3m}}$
(C)	$\sqrt{\frac{3k}{2m}}$
(D)	$\sqrt{\frac{3k}{m}}$

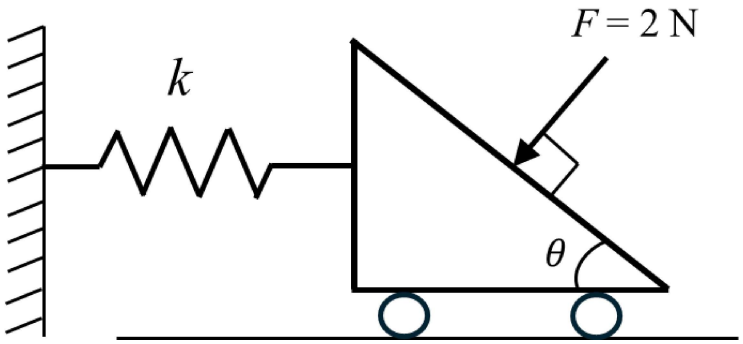
Q.70	Which among the following options is/are CORRECT unit(s) of stress?
(A)	Nm^2
(B)	Pa
(C)	Nm
(D)	N/m^2

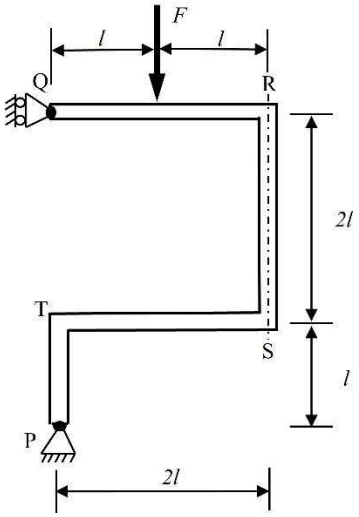
Q.71	A car is moving on a horizontal surface in a straight line with a constant velocity of 3 m/s. A ball is thrown vertically upwards at time $t = 0$ from the top of the moving car with a velocity of 20 m/s. The acceleration due to gravity is 10 m/s^2. At what value(s) of time t in second(s), the ball is at a height of 15 m from the top of the moving car?
(A)	1
(B)	2
(C)	3
(D)	4

Q.72	A cart of weight (W) 5 kN, stands on an inclined smooth surface at an angle (θ) of 45° as shown in the figure. The cart is maintained in equilibrium by a horizontal force F acting at point S. The value of F is _____ kN (*in integer*).  Figure is not to scale

Q.73	A 2D state of stress at a point in a body is given by $\sigma_{xx} = -40$ MPa, $\sigma_{yy} = 100$ MPa and $\tau_{xy} = 50$ MPa. The radius of the Mohr's circle for the given state of stress is _____MPa (*rounded off to two decimal places*).
Q.74	Sum of the principal stresses of a 2D stress state $\begin{bmatrix} 11 & 4 \\ 4 & 5 \end{bmatrix}$ is _____ (*in integer*).

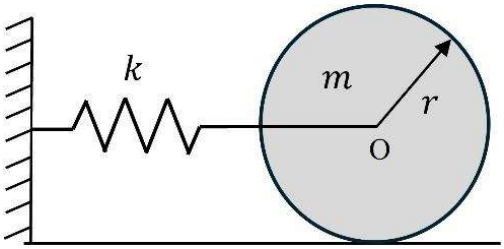
Q.75 – Q.87 Carry TWO marks Each

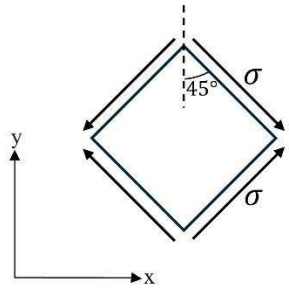
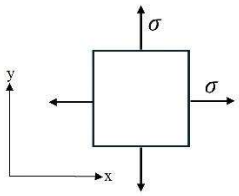
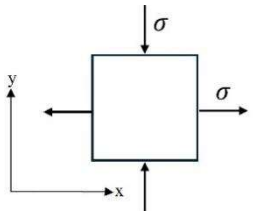
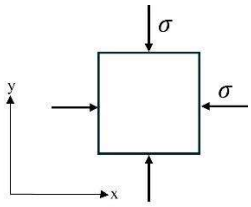
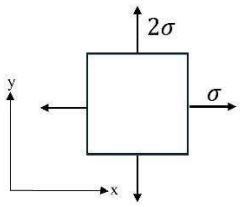
Q.75	The force (F) acting on the block, as shown in the figure is 2 N. The stiffness of the spring (k) is 100 N/m. Assume that the block is in static equilibrium and its mass is negligible. If the static deflection of the spring (Δ) is 0.01 m, which one of the following is the corresponding angle (θ) in radians? 
(A)	$\frac{\pi}{3}$
(B)	$\frac{\pi}{4}$
(C)	$\frac{\pi}{5}$
(D)	$\frac{\pi}{6}$

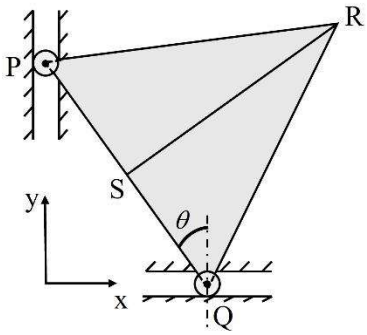
Q.76	Which one of the following options is the CORRECT absolute value of the bending moment at R in the frame as shown in the figure?  Figure is not to scale
(A)	0
(B)	*Fl*
(C)	*2Fl*
(D)	*3Fl*

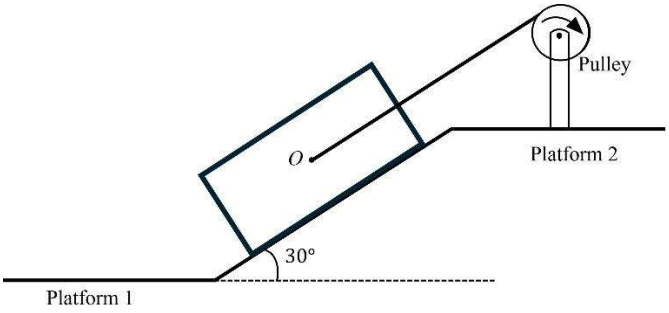
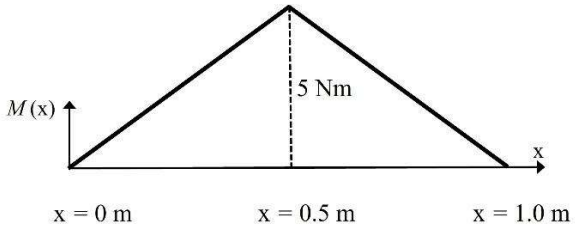
Q.77	One column with square cross section of side r and another column with rectangular cross section of breadth p and width q $(< p)$ are made from the same material. Both the columns have one end fixed, and the other end is free. They are subjected to axial loads along the centroidal axis. Consider the area of cross sections of both the columns to be the same. The minimum critical Euler buckling loads of the columns with rectangular and square cross-sections are F_{rect} and F_{sq}, respectively. Then $\frac{F_{\text{rect}}}{F_{\text{sq}}}$ is _____.
(A)	$\frac{p}{q}$
(B)	$\frac{q}{p}$
(C)	$\frac{r}{q}$
(D)	$\frac{r^2}{pq}$

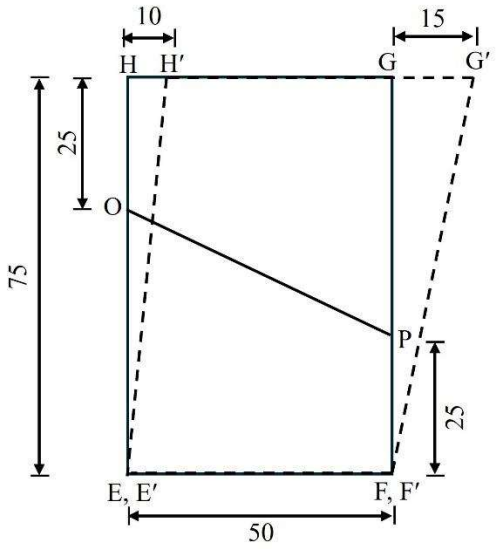
Q.78	Two prismatic rods of identical lengths are designed for the same strain energy density when subjected to the same axial load. One of the rods is made of steel (Young's modulus = 210 GPa) and another is made of aluminum (Young's modulus = 70 GPa). If the diameter of the aluminum rod is 70 mm, then which one of the following options corresponds to the diameter of the steel rod in mm?
(A)	53.19
(B)	70
(C)	210
(D)	29.13

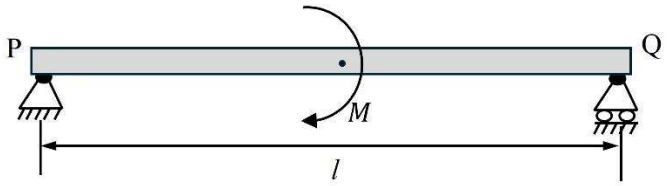
Q.79	A spring of stiffness k is connected to the center of a homogeneous right circular cylinder of radius r placed on a horizontal surface as shown in the figure. The cylinder is assumed to be rolling without slipping. Considering small amplitude of oscillation, which one of the following options is the CORRECT natural frequency of the system? 
(A)	$\sqrt{\frac{k}{2m}}$
(B)	$\sqrt{\frac{3k}{2m}}$
(C)	$\sqrt{\frac{k}{m}}$
(D)	$\sqrt{\frac{2k}{3m}}$

Q.80	A 2D stress state of pure shear is shown in the figure. Which one of the following options is equivalent to the given stress state? Figures are not to scale. 
(A)	
(B)	
(C)	
(D)	

Q.81	The point Q of a thin rigid equilateral triangular plate PQR is constrained to move in a horizontal channel. Point P of the same plate is constrained to move in the vertical channel as shown in the figure. The length of the side PQ is 4 m. At the instant when the angle $\theta = \frac{\pi}{3}$ rad and the velocity of point Q in the positive x direction is 20 m/s, which one of the following options is the magnitude of the angular velocity vector of the line SR on the plate in rad/s?  Figure is not to scale
(A)	5
(B)	10
(C)	20
(D)	25

Q.82	A motorized pulley of diameter 200 mm is used to transfer a block of mass 100 kg from platform 1 to platform 2 using a ramp kept at an inclination of 30° as shown in the figure. The coefficient of static friction between the block and the ramp is 0.2. The acceleration due to gravity is 10 m/s^2. Assume the rope to be parallel to the ramp surface. The minimum torque required by the motor to transport the block uphill is ____ Nm (*rounded off to two decimal places*).  Figure is not to scale
Q.83	The bending moment diagram for a simply supported beam is piecewise linear as shown in the figure. The bending moment $M(x)$ at x = 0.5 m is 5 Nm. The beam has a rectangular cross-section with an area of 1 m^2. The absolute value of the maximum shear stress on the cross-section at x = 0.75 m is _____ N/m^2 (*in integer*).  Figure is not to scale

Q.84	A thin walled cylindrical container of diameter 2 m and wall thickness of 2.5 cm is made of steel whose Young's modulus is 200 GPa and yield stress is 450 MPa. Using von Mises criteria, the maximum permissible pressure is _____MPa (*rounded off to the nearest integer*).
Q.85	A solid axial bar made of steel with Young's modulus, 200 GPa and Poisson's ratio, 0.3, is subjected to uniaxial stress of 50 MPa. The absolute value of the maximum shear strain on the outer surface of the bar is _____$\times 10^{-4}$ (*rounded off to two decimal places*).
Q.86	EFGH (solid lines) is the initial configuration and E′F′G′H′ (dashed lines) is the deformed configuration of an object as shown in the figure. E′ coincides with E and F′ coincides with F. The average normal strain along the line segment OP is _____ (*rounded off to three decimal places*).  Figure is not to scale. All units are in mm.

Q.87	A simply supported beam of length $l = 2$ m is subjected to a concentrated moment $M = 150$ kNm at a distance $l/2$ from the left end as shown in the figure. The elastic-strain energy U of the beam is given by the following expression: $$U = \frac{M^2 l}{48\, EI}$$ The section modulus of the beam is $EI = 25 \times 10^5$ Nm^2. The absolute value of the slope of the beam at a distance $l/2$ from the left end is _____(*rounded off to three decimal places*).  Figure is not to scale

Q.88 – Q.96 Carry ONE mark Each

Q.88	Consider any substance whose mass specific heat capacity at constant pressure and mass specific heat capacity at constant volume are c_P and c_V, respectively. If the gas constant is R, which ONE of the following relations is CORRECT for the substance at all conditions?
(A)	$c_P = c_V$
(B)	$c_P - c_V = R$
(C)	$c_P \geq c_V$
(D)	$c_P > c_V$
Q.89	Consider a mixture of ideal gases, nitrogen (N_2) and carbon-dioxide (CO_2), at 25 °C and 101 kPa. The molar mass of N_2 is 28 kg/kmol and molar mass of CO_2 is 44 kg/kmol. If the molar mass of the mixture is 34 kg/kmol, which ONE of the following mixture compositions is possible?
(A)	62.5% N_2 and 37.5% CO_2 by mass
(B)	62.5% N_2 and 37.5% CO_2 by volume
(C)	37.5% N_2 and 62.5% CO_2 by mass
(D)	37.5% N_2 and 62.5% CO_2 by volume

Q.90	In a mixing chamber hot water enters at a temperature of 80 °C with a flowrate of 0.5 kg/s. From another entry, cold water enters the chamber at 20 °C. The desired temperature after mixing at the exit of the chamber is 40 °C. There is no water leakage and the mixing happens at adiabatic conditions. Assume the specific heat capacity of water is 4.2 kJ/kg-K. For a steady state operation, the mass flow rate (in kg/s) of the cold-water stream is
(A)	2.0
(B)	1.5
(C)	1.0
(D)	0.5
Q.91	Which ONE of the following statements is CORRECT?
(A)	For an ideal gas, specific enthalpy (h) is a function of both temperature and pressure.
(B)	Internal energy (U), entropy (S), and enthalpy (H) are path functions.
(C)	Heat transferred (Q) and work done (W) are state (point) functions.
(D)	Temperature (T), pressure (P), and specific volume (v) are intensive properties.

Q.92	A mixture of carbon-dioxide (CO_2), nitrogen (N_2) and oxygen (O_2) are introduced in a rigid and impermeable tank containing only liquid water (H_2O). Assume that the components are non-reacting and un-dissociated. The system is kept isolated till an equilibrium is achieved, where only two phases are present. The degrees-of-freedom of the equilibrium mixture, as obtained from the phase rule, is
(A)	1
(B)	2
(C)	3
(D)	4
Q.93	A stream of moist air at 101 kPa and 25 °C undergoes a constant pressure process such that its dry bulb temperature increases and specific humidity decreases. For this process, which of the following statements is/are always CORRECT?
(A)	Wet bulb temperature increases.
(B)	Dew point temperature decreases.
(C)	Relative humidity decreases.
(D)	Adiabatic saturation temperature increases.

Q.94	Which of the following is/are example(s) of a pure substance at 25 °C and 101 kPa?
(A)	Gaseous oxygen
(B)	Mixture of liquid water and water vapor
(C)	Mixture of liquid water and gaseous oxygen
(D)	Homogenous mixture of gaseous oxygen and water vapor
Q.95	A house looses heat at a rate of 150 MJ per hour. The temperature outside the house is −3 °C. The minimum power (in kW) required to maintain the temperature inside the house at 25 °C using a heat pump is _____ (*rounded off to two decimal places*).
Q.96	Consider an ideal Otto-cycle with cold-air-standard assumptions to be applicable. The temperature of the working fluid at the start and the end of the compression process is 300 K and 750 K, respectively. For the working fluid take the ratio of the specific heat capacities as 1.4. The thermal efficiency (in %) of the cycle is _____ *(rounded off to two decimal places).*

Q.97 – Q.109 Carry TWO marks Each

Q.97	Consider a real gas, which obeys the following equation-of-state: $v = \frac{RT}{P} + C_1 - \frac{C_2}{Pv}$, where v is the mass specific volume, P is the pressure, T is the temperature and R is the gas constant. C_1 and C_2 are constants. If s is the mass specific entropy, the quantity $\left(\frac{\partial s}{\partial v}\right)_T$ for the gas is given by
(A)	$\frac{R}{v}$
(B)	$\frac{R^2T}{Pv^2}$
(C)	$\frac{R}{v - C_1}$
(D)	$\frac{C_1C_2}{Tv}$

Q.98	M kg of a liquid at a temperature T_1 is mixed with M kg of the same liquid at another temperature T_2 in an isolated tank at constant pressure. The mass specific heat capacity at constant pressure of the liquid is c_P, which is a constant. The total entropy change in the process is
(A)	$Mc_P \ln\left(\frac{T_1+T_2}{2\sqrt{T_1T_2}}\right)$
(B)	$2Mc_P \ln\left(\frac{T_1+T_2}{\sqrt{T_1T_2}}\right)$
(C)	$Mc_P \ln\left(\frac{T_1+T_2}{\sqrt{T_1T_2}}\right)$
(D)	$2Mc_P \ln\left(\frac{T_1+T_2}{2\sqrt{T_1T_2}}\right)$

Q.99	A fluid undergoes a process where its pressure (P), temperature (T) and volume (V) changes from (P_1, T_1, V_1) to (P_2, T_2, V_2). During the process, volume expansivity (β) and isothermal compressibility (κ_T) remains constant. Given that $\beta = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$ and $\kappa_T = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$, the ratio $\left(\frac{V_2}{V_1}\right)$ is
(A)	$\frac{\beta(T_2 - T_1)}{\kappa_T(P_2 - P_1)}$
(B)	$\left[\beta(T_2 - T_1)\right]\left[\kappa_T(P_2 - P_1)\right]$
(C)	$\frac{\exp\left[\beta(T_2 - T_1)\right]}{\exp\left[\kappa_T(P_2 - P_1)\right]}$
(D)	$\beta(T_2 - T_1) - \kappa_T(P_2 - P_1)$

Q.100	Consider an ideal Rankine cycle with fixed conditions at the turbine inlet. If the condenser pressure is lowered, which of the following statements is/are CORRECT?
(A)	Pump work input remains the same.
(B)	Moisture content at turbine exit decreases.
(C)	Heat rejected in the condenser decreases.
(D)	Turbine work output increases.
Q.101	An adiabatic rigid and impermeable tank of volume 10 m^3 contains air at 800 kPa and 70 °C. The air is allowed to leave the tank until the pressure is one-fourth of its original value. During the process, the air in the tank is maintained at 70 °C using an electrical heater. Assume that the air behaves as an ideal gas having gas constant and ratio of specific heat capacities as 287 J/kg-K and 1.4, respectively. The total electrical energy (in MJ) supplied by the heater is _____ *(rounded off to two decimal places).*
Q.102	Two kg of a gas is compressed in a process. Pressure (P) and mass specific volume (v) of the gas during the process follows: $Pv^{1.2}$ = constant. The temperature of the gas before and after compression is 300 K and 600 K, respectively. Assume that the gas behaves as an ideal gas with gas constant and ratio of specific heat capacities equal to 287 J/kg-K and 1.4, respectively. The heat rejected (in kJ) during the process is _____*(rounded off to two decimal places).*

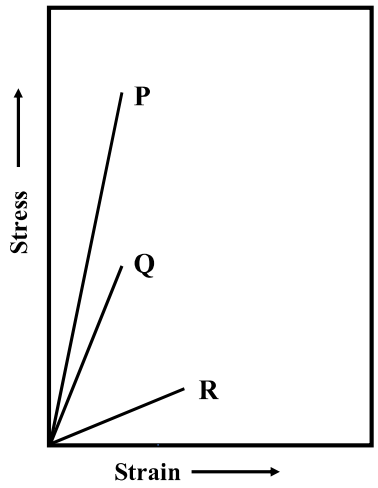
Q.103	Consider a single component fluid at saturation conditions having the following properties. Latent heat of vaporization, $h_{fg} = 39.6 \times 10^3$ kJ/kmol Compressibility factor for the vapor phase, $z_g = \dfrac{v_g}{v_{\text{ideal}}} = \dfrac{P_{\text{sat}} v_g}{R_u T} = 0.95$ P_{sat} is the saturation pressure T is the temperature v_g is the molar specific volume of the vapor phase Assume that $v_{fg} = v_g$, where v_{fg} is the difference in the molar specific volume of the vapor and the liquid phases Universal gas constant, $R_u = 8.314$ kJ/kmol-K Using the Clapeyron equation, the quantity $-\dfrac{d \ln P}{d(1/T)}\Big\|_{\text{saturation}}$ (in K) is _____ *(rounded off to two decimal places).*
Q.104	It is given that: $\left(\dfrac{\partial h}{\partial T}\right)_P = c_p$ and $\left(\dfrac{\partial h}{\partial P}\right)_T = (v - \beta T v)$. Here h is the mass specific enthalpy, v is the mass specific volume, $\beta = \dfrac{1}{v}\left(\dfrac{\partial v}{\partial T}\right)_P$ is the volume expansivity, and c_p is the mass specific heat capacity at constant pressure. T and P represent the temperature and the pressure, respectively. The inversion temperature is the temperature at which the Joule-Thomson coefficient, $\mu_{\text{JT}} = \left(\dfrac{\partial T}{\partial P}\right)_h$, goes to zero. Consider a fluid with properties: $v = 1.03$ m^3/kg, $c_P = 1$ kJ/kg-K, and $\beta = 4.39 \times 10^{-3}$ 1/K; The inversion temperature (in K) for the fluid is _____ *(rounded off to two decimal places).*

Q.105	A stream of moist air enters an adiabatic saturator at 45 °C and 101 kPa and leaves as a saturated mixture at 30 °C. Make-up water to the saturator is supplied at 30 °C. The amount of make-up water (in grams per kg of dry air) supplied is _____ *(rounded off to two decimal places)*. Use the following data: Specific heat capacity of water is 4.2 kJ/kg-K Specific heat capacity of air at constant pressure is 1 kJ/kg-K Saturated water properties: At 30 °C: specific enthalpy of saturated water vapor is 2556 kJ/kg-K, specific enthalpy of saturated liquid water is 125.7 kJ/kg-K, and saturation pressure is 4.25 kPa At 45 °C: specific enthalpy of saturated water vapor is 2582 kJ/kg-K, specific enthalpy of saturated liquid water is 188.4 kJ/kg-K, and saturation pressure is 9.60 kPa
Q.106	A rigid spherical solid ball at 1000 °C is cooled slowly to 200 °C in a surrounding air at 25 °C. The density, specific heat capacity, and diameter of the ball are 8000 kg/m^3, 500 J/kg-K, and 10 mm; respectively. Assuming that the cooling process is quasi-equilibrium, the entropy generated (in J/K) in the process is _____(*rounded off to two decimal places*).
Q.107	Consider an ideal Diesel-cycle with cold-air-standard assumptions to be applicable. The compression ratio is 20 and the cut-off ratio is 1.8. At the end of the compression process, the working fluid is at 1120 K and 6.6 MPa. The ratio of the specific heat capacities is 1.4 for the working fluid. The temperature (in K) at the end of the expansion process is _____(*rounded off to two decimal places*).

Q.108	A mixture of helium (He) and nitrogen (N_2) expands in a turbine from 800 kPa to 100 kPa. The mixture composition is 40% He and 60% N_2 by mass. The turbine inlet temperature is 1000 K. The temperature (in K) at the turbine exit is _____*(rounded off to two decimal places).* Assume: The process is isentropic. Kinetic and potential energy changes in the process are negligible. He and N_2 behaves as ideal gases. Specific heat capacities are constant. Use the following data: Ratio of specific heat capacities for He and N_2 are 1.67 and 1.4, respectively. Specific heat capacities at constant pressure for He and N_2 are 5.19 kJ/kg-K and 1.04 kJ/kg-K, respectively.
Q.109	A rigid and impermeable tank has only moist air with a specific humidity of 0.025 $kg_{water\text{-}vapor}/kg_{dry\text{-}air}$ at 30 °C and 101 kPa. The air is heated to 90 °C. Assume moist air to behave as an ideal gas. The relative humidity (in %) of the heated air is _____*(rounded off to two decimal places).* Saturation pressure of water at 30 °C is 4.25 kPa and at 90 °C is 70.18 kPa.

Q.110 – Q.118 Carry ONE mark Each

Q.110	Which one of the following polymerization methods is used for the synthesis of butyl rubber?
(A)	Ring opening polymerization
(B)	Condensation polymerization
(C)	Cationic polymerization
(D)	Anionic polymerization

Q.111	The stress-strain profiles in the figure were obtained following longitudinal tensile loading for a brittle polymer, glass fibre, and a composite lamina consisting of unidirectional continuous glass fibres and the polymer matrix. Assume that the matrix is free of voids, there is perfect bonding between glass fibres and the matrix, and there are no residual stresses in the composite lamina.  Identify the correct stress-strain profile for the polymer matrix, glass fibre, and their composite lamina from the above figure.
(A)	P – Matrix ; Q – Glass fibre ; R – Composite
(B)	P – Glass fibre ; Q – Composite ; R – Matrix
(C)	P – Glass fibre ; Q – Matrix ; R – Composite
(D)	P – Composite ; Q – Glass fibre ; R – Matrix

Q.112	Norrish-Smith effect or Trommsdorff effect during free radical bulk polymerization at high conversion is characterized by_____.
(A)	increase in rate of polymerization with time due to increase in viscosity
(B)	decrease in rate of polymerization with time due to increase in viscosity
(C)	decrease in rate of polymerization with time due to reduction in viscosity
(D)	increase in rate of polymerization with time due to reduction in viscosity
Q.113	For a polydisperse polymer, the viscosity-average molecular weight ($\bar{M}_v$) becomes equal to the weight-average molecular weight ($\bar{M}_w$), when the Mark–Houwink constant a is _____.
(A)	0.1
(B)	0.5
(C)	0.7
(D)	1.0

Q.114	Which one of the following is **NOT** a rotational rheometer?
(A)	Cone and plate rheometer
(B)	Parallel plate rheometer
(C)	Capillary rheometer
(D)	Cylindrical Couette rheometer

Q.115 Select the correct option to match the **Product** with the most appropriate **Processing technique** from the table given below:

Product		**Processing technique**	
P	Fibre-reinforced pressure vessel	I	Rotomoulding
Q	Overhead water tank	II	Thermoforming
R	Blister package for medicine	III	Filament winding
S	Plastic carry bag	IV	Blown film extrusion

(A) P–III ; Q–II ; R–I ; S–IV

(B) P–IV ; Q–III ; R–II ; S–I

(C) P–II ; Q–I ; R–III ; S–IV

(D) P–III ; Q–I ; R–II ; S–IV

Q.116	Which of the following is/are the most appropriate compatibilizer(s) for the polypropylene/Nylon 66 blend?
(A)	Maleic anhydride grafted polystyrene
(B)	Maleic anhydride grafted polypropylene
(C)	Polypropylene-*b*-polystyrene
(D)	Glycidyl methacrylate grafted polypropylene
Q.117	Which of the following polymers is/are prone to hydrolytic degradation?
(A)	Poly(ethylene terephthalate)
(B)	Polypropylene
(C)	Poly(lactic acid)
(D)	Polycaprolactone
Q.118	An insulating polymer is used as a dielectric medium between two capacitor plates. The dielectric constant of the polymer is 5.0 and the permittivity of vacuum is 8.85×10^{-12} F/m. The permittivity of the polymer is _____ $\times 10^{-12}$ F/m (*rounded off to two decimal places*).

Q.119 – Q.131 Carry TWO marks Each

Q.119 Select the correct option to match the **Polymer** to its **Major polymeric constituent** from the table given below:

Polymer		**Major polymeric constituent**	
P	Natural rubber	I	Polyisobutylene
Q	Gutta percha	II	Polychloroprene
R	Neoprene	III	*trans*-1,4-polyisoprene
S	Butyl rubber	IV	*cis*-1,4-polyisoprene

(A) P–IV ; Q–III ; R–I ; S–II

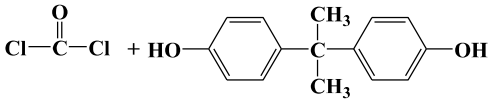
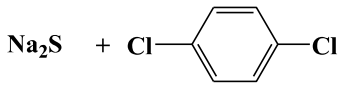
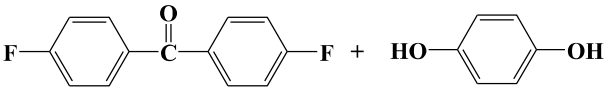
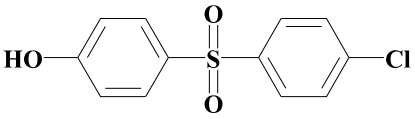
(B) P–IV ; Q–III ; R–II ; S–I

(C) P–II ; Q–IV ; R–I ; S–III

(D) P–II ; Q–IV ; R–III ; S–I

Q.120	Resol is produced by reaction of _____.
(A)	phenol with an excess of formaldehyde in presence of a base catalyst
(B)	formaldehyde with an excess of phenol in presence of a base catalyst
(C)	phenol with an excess of formaldehyde in presence of an acid catalyst
(D)	an equimolar mixture of phenol and formaldehyde at neutral pH

Q.121 Select the correct option to match the **Polymer** to its most suitable **Monomer(s)** from the table given below:

Polymer		**Monomer(s)**	
P	Poly(*p*-phenylene sulfide)	I	
Q	Poly(ether sulfone)	II	
R	Poly(ether ether ketone)	III	
S	Polycarbonate	IV	

(A) P–II ; Q–IV ; R–III ; S–I

(B) P–II ; Q–IV ; R–I ; S–III

(C) P–IV ; Q–III ; R–II ; S–I

(D) P–IV ; Q–I ; R–III ; S–II

Q.122 Select the correct option to match the **Compound/Additive** to its most suitable **Function** from the table given below:

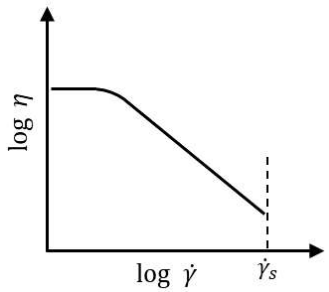
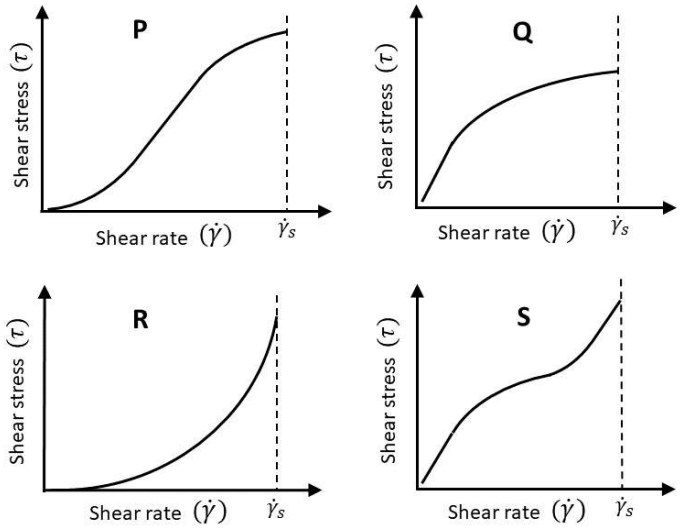
Compound/Additive		**Function**	
P	Azocarbonamide	I	Flame retardant
Q	2-(2-hydroxyphenyl)-benzotriazole	II	Coupling agent
R	(3-Aminopropyl)triethoxysilane	III	Blowing agent
S	Ammonium polyphosphate	IV	UV-absorber

(A) P–IV ; Q–III ; R–II ; S–I

(B) P–III ; Q–IV ; R–II ; S–I

(C) P–I ; Q–III ; R–II ; S–IV

(D) P–III ; Q–IV ; R–I ; S–II

Q.123	The variation of steady shear viscosity (η) of a polymer melt with shear rate ($\dot{\gamma}$) is shown in the figure, where $\dot{\gamma}_s$ is the upper limit of the applied shear rate.  Which one of the following figures, labeled P, Q, R and S, shows the most appropriate variation of shear stress (τ) with shear rate for the same polymer melt? 
(A)	P
(B)	Q
(C)	R
(D)	S

Q.124 Select the correct option to match the **Initiator(s)** with the **Method of polymerization** from the table given below:

Initiator(s)		**Method of polymerization**	
P	BF_3/H_2O	I	Anionic polymerization
Q	*n*-C_4H_9Li	II	Cationic polymerization
R	$FeCl_2/K_2S_2O_8$	III	Coordination addition polymerization
S	Metallocene/methylaluminoxane	IV	Free radical addition polymerization

(A) P–II ; Q–III ; R–IV ; S–I

(B) P–IV ; Q–I ; R–II ; S–III

(C) P–III ; Q–II ; R–IV ; S–I

(D) P–II ; Q–I ; R–IV ; S–III

Q.125 Select the correct option to match the **Characterization technique** with the **Information** that is obtained using these techniques.

Characterization technique		**Information**	
P	Differential scanning calorimetry	I	Spherulite size
Q	Infrared spectroscopy	II	Loss modulus
R	Dynamic mechanical thermal analysis	III	Functional groups
S	Optical microscopy	IV	Enthalpy of crystallization

(A) P–IV ; Q–III ; R–I ; S–II

(B) P–III ; Q–IV ; R–I ; S–II

(C) P–IV ; Q–III ; R–II ; S–I

(D) P–III ; Q–IV ; R–II ; S–I

Q.126	Which of the following options is/are used to plasticize poly(vinyl chloride) (PVC)?
(A)	Addition of vinyl acetate comonomer during the synthesis of PVC
(B)	Chlorination of PVC
(C)	Addition of di-iso-octyl phthalate during processing of PVC
(D)	Addition of dicumyl peroxide during processing of PVC
Q.127	A certain amount of plasticizer with a glass transition temperature (T_g) of –50 °C was added to a polymer to reduce its T_g from 70 °C to 30 °C. Using the Fox equation, the weight fraction of the plasticizer used is _____ (*rounded off to two decimal places*).
Q.128	A rectangular plastic specimen with a cross-sectional area of 240 mm^2 is subjected to tension with a force of 15000 N resulting in elastic deformation. If the Young's modulus of the specimen is 34.55 MPa, the value of strain is _____ (*rounded off to two decimal places*).
Q.129	Equimolar mixture of terephthalic acid and butylene glycol was taken to synthesize a polyester. The reaction was stopped at 99.6% conversion of the acid monomer. The weight-average molecular weight ($\bar{M}_w$) of the synthesized polyester is _____ g/mol (*rounded off to the nearest integer*).
Q.130	A viscoelastic polymer is subjected to a constant strain of 0.3. The behaviour of the polymer follows Maxwell model of linear viscoelasticity. Elastic modulus of the polymer is 5 MPa and the relaxation time is 200 days. The stress in the polymer after 100 days from the initial application of the strain is _____ MPa (*rounded off to two decimal places*).

Q.131	A single-screw extruder is operated at 12 rpm under open discharge condition (i.e., without a die). The screw has a diameter of 10 cm, a distance of 2.5 cm between the adjacent flights, a gap of 0.25 cm between the screw and the inner wall of the barrel, and a helix angle (i.e., angle between the flights and the plane perpendicular to the screw axis) of 8°. If the flow of the molten polymer in the metering zone through the extruder is assumed isothermal, Newtonian and incompressible, the volumetric flow rate of the polymer melt is _____ cm^3/min (*rounded off to the nearest integer*).

Q.132 – Q.140 Carry ONE mark Each

Q.132	Ergotism is caused by ingestion of grains infected with
(A)	*Clostridium perfringens*
(B)	*Rhizopus stolonifer*
(C)	*Lactococcus lactis*
(D)	*Claviceps purpurea*

Q.133 Match the bacteria in **Column I** with their respective characteristic features in **Column II.**

Column I	Column II
(P) *E. coli*	(1) Gram-positive, round-shaped and non-spore formers
(Q) *B. subtilis*	(2) Gram-negative, rod-shaped and non-spore formers
(R) *S. aureus*	(3) Gram-positive, rod-shaped and spore formers
(S) *L. monocytogenes*	(4) Gram-positive, rod-shaped and non-spore formers

(A) P-1; Q-4; R-2; S-3

(B) P-2; Q-1; R-3; S-4

(C) P-2; Q-3; R-1; S-4

(D) P-2; Q-4; R-1; S-3

Q.134	Carmine, a food colorant, is derived from
(A)	*Curcuma longa*
(B)	*Dactylopius coccus*
(C)	*Beta vulgaris*
(D)	*Monascus purpureus*
Q.135	Which one of the following carbohydrates is **NOT** a storage polysaccharide?
(A)	Starch
(B)	Glycogen
(C)	Chitin
(D)	Dextran

Q.136	Which one of the following statements is true for a high-pressure homogenizer?
(A)	Homogenization takes place only due to uniform mixing of solid and liquid
(B)	Solid particles in the suspension are disintegrated due to the high shear rate exerted by the liquid
(C)	High pressure steam is injected to dissolve the solids
(D)	Solid particles in the suspension are compressed into a cake under high pressure
Q.137	Coconut oil contains a small fraction of unsaturated fatty acids, but still has a low melting point due to the presence of
(A)	large amounts of long chain saturated fatty acids
(B)	mostly medium chain saturated fatty acids such as lauric acid
(C)	few hydrogen bonds per fatty acid chain
(D)	higher cholesterol content

Q.138	Which of the following amines, produced as a result of protein degradation, is/are foul smelling?
(A)	Histamine
(B)	Cadaverine
(C)	Tyramine
(D)	Putrescine
Q.139	Water is flowing at 100 litres/min through a pipe with a diameter of 5 cm. Assume the coefficient of viscosity of water to be 0.001 Pa.s and the density to be 1000 kg/m^3. The Reynolds number for this flow is _____ (*Round off to nearest integer*)
Q.140	A wet solid, fed to a dryer at a rate of 5 kg/s, is dried using hot air. In this process its moisture content is reduced from 25% to 15%. The rate of moisture removal is _____ kg/s. (*Round off to two decimal places*)

Q.141 – Q.153 Carry TWO marks Each

Q.141 Match the toxins in **Column I** with their respective sources in **Column II.**

Column I	Column II
P. Aflatoxin	1. *Fusarium verticilloides*
Q. Nisin	2. Enterohemorrhagic *E. coli*
R. Fumonisin	3. *Lactococcus lactis*
S. Shiga-like toxin	4. *Aspergillus flavus*

(A) P-1; Q-2; R-3; S-4

(B) P-4; Q-1; R-2; S-3

(C) P-4; Q-3; R-1; S-2

(D) P-1; Q-3; R-2; S-4

Q.142 Match the vitamins in **Column I** with their respective coenzyme forms listed in **Column II.**

Column I	Column II
P. Vitamin B_1	1. Tetrahydrofolate
Q. Vitamin B_2	2. Methylcobalamin
R. Pantothenic acid	3. Thiamine pyrophosphate
S. Vitamin B_{12}	4. Flavin adenine dinucleotide
T. Folic acid	5. Coenzyme A

(A) P-3; Q-4; R-5; S-2; T-1

(B) P-4; Q-3; R-1; S-5; T-2

(C) P-1; Q-5; R-4; S-2; T-3

(D) P-5; Q-2; R-4; S-3; T-1

Q.143	Which one of the following proteins brings about the coagulation of milk in the stomach of calves?
(A)	Rennin
(B)	Alpha-lactalbumin
(C)	Beta-lactoglobulin
(D)	Lactoferrin

Q.144	Match the class of additives used for food preservation listed in **Column I** with their specific examples in **Column II.** **Column I** P. Antioxidants Q. Anti-foaming agent R. Anti-caking agent S. Glazing agent **Column II** 1. Rice bran wax 2. Tricalcium phosphate 3. Mineral oil 4. Butylated hydroxy anisole (BHA)
(A)	P-3; Q-4; R-2; S-1
(B)	P-4; Q-3; R-1; S-2
(C)	P-4; Q-3; R-2; S-1
(D)	P-2; Q-3; R-1; S-4

Q.145	Match the food items listed in C**olumn I** with their respective flavoring agents in C**olumn II.** **Column I**: P. Cloves; Q. Butter; R. Orange; S. Lemon; T. Garlic **Column II**: 1. Diacetyl; 2. Limonene; 3. Eugenol; 4. Diallyl disulfide; 5. Citral
(A)	P-1; Q-3; R-2; S-4; T-5
(B)	P-3; Q-2; R-1; S-5; T-4
(C)	P-4; Q-2; R-5; S-1; T-3
(D)	P-3; Q-1; R-2; S-5; T-4

Q.146	Vegetable oils resist oxidation and maintain their quality for a long period due to the presence of
(A)	tocopherols
(B)	hydrolytic enzyme such as lipases
(C)	microorganisms such as molds and yeast
(D)	carbohydrates
Q.147	For a given temperature difference between the top and bottom surfaces of a flat metal plate, Fourier's law of heat conduction implies that
(A)	temperature gradient increases with increase in heat transfer area
(B)	heat flux is proportional to the thermal conductivity of the metal
(C)	heat flux increases with increase in thickness of the metal plate
(D)	temperature gradient decreases with increase in thickness of the metal plate

Q.148	Xylooligosaccharides can be produced by
(A)	hydrolytic degradation of xylan by hydrochloric acid
(B)	hydrolysis of starch
(C)	enzymatic hydrolysis of lactose
(D)	enzymatic hydrolysis of xylan containing lignocellulosic material
Q.149	In a α-helix, the R-groups on the amino acid residues
(A)	are found on the outside of the helix
(B)	participate in the backbone H-bonding that stabilize the helix
(C)	allow formation of right-handed helices
(D)	allow formation of left-handed helices

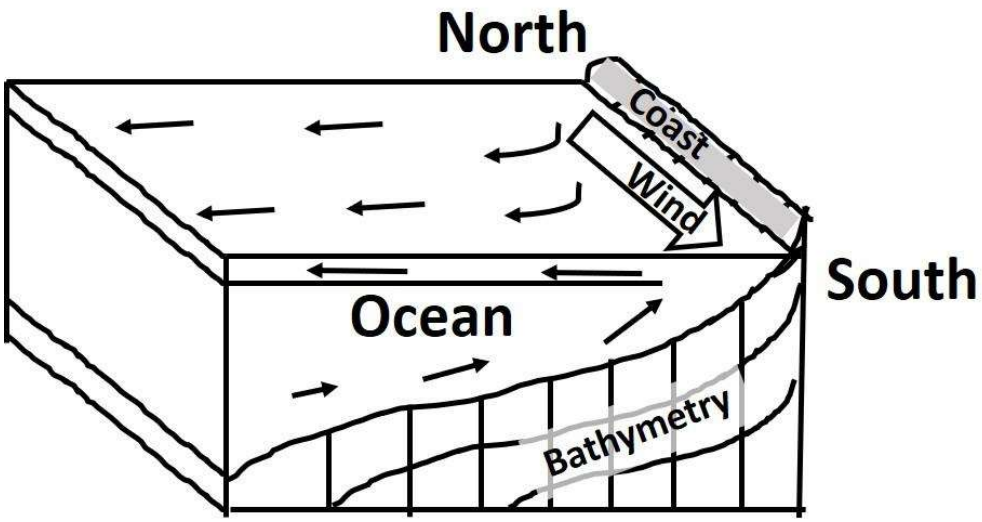
Q.150	During constant pressure cake filtration, for an incompressible cake deposited uniformly over a constant filter surface area,
(A)	the cake resistance remains constant
(B)	the cake resistance increases in proportion to the cake thickness
(C)	the filtration rate remains constant
(D)	the filtration rate decreases with time
Q.151	Hot oil is being cooled in a countercurrent, double-pipe heat exchanger from 410 K to 340 K by chilled water entering at 290 K and exiting the exchanger at 330 K. The Log Mean Temperature Difference (LMTD) for this heat transfer is _____K. (*Round off to one decimal place*)
Q.152	A cold-storage room has a double-layered wall. The inner layer is 10 cm thick, made of fiber insulation board (k = 0.048 W m^{-1} K^{-1}), and the outer layer is 15 cm thick, made of concrete (k = 0.762 W m^{-1} K^{-1}). The surface temperature of the wall inside the cold room is 260 K and the ambient temperature outside is 300 K. The steady state heat flux into the cold room is _____ W/m^2. (*Round off to two decimal places*)

Q.153	A tubular centrifuge separates 5 micron particles of density 1500 kg/m^3 from a slurry. The slurry is fed at a volumetric flow rate of 0.5 m^3/s. The equivalent clarification area of the centrifuge is _____m^2. (*Answer in integer*) Assume g = 10 m/s^2 and for water, density = 1000 kg/m^3, coefficient of viscosity (μ) = 10^{-3} Pa-s

Q.154 – Q.162 Carry ONE mark Each

Q.154	Which of the following is **TRUE** for the 'summer solstice' in the Northern Hemisphere?
(A)	Longest night of the year
(B)	Equal duration of daylight and night
(C)	Longest duration of daylight of the year
(D)	Shortest duration of daylight of the year
Q.155	Which of the following options are parts of the atmospheric boundary layer?
(A)	Benthic boundary layer, Internal boundary layer
(B)	Mixed layer, Entrainment layer
(C)	Mixed layer, Internal boundary layer
(D)	Mixed layer, Benthic boundary layer

Q.156	What is the approximate value of annual-mean pH of seawater at the surface in the northern Indian Ocean?
(A)	4.5
(B)	5.0
(C)	8.0
(D)	11.0
Q.157	Which of the following weather systems has the shortest duration of lifecycle?
(A)	Tropical Cyclones
(B)	Thunderstorms
(C)	Western Disturbance
(D)	Winter Monsoon

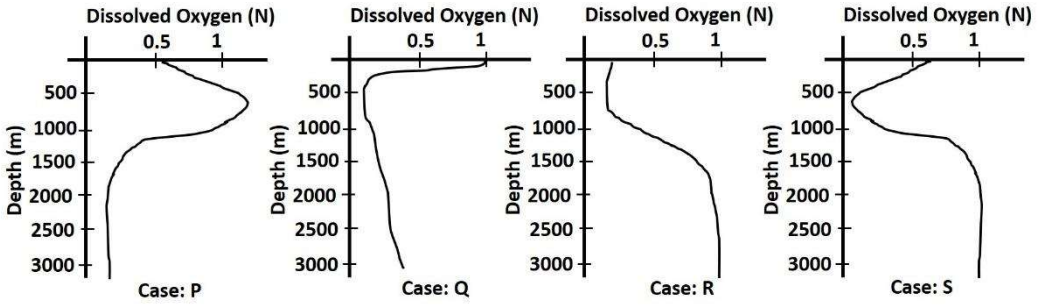
Q.158	Which of the following statements based on the given figure is / are **TRUE** with respect to the upwelling process in the ocean? 
(A)	Wind is northerly.
(B)	Wind is southerly.
(C)	Event occurs in the southern hemisphere.
(D)	Event occurs in the northern hemisphere.

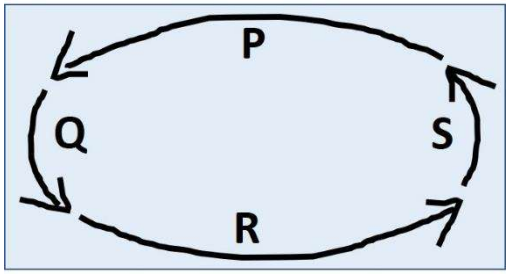
Q.159	In a stable atmosphere, the change in pressure (in *kilo Pascal*) at a height of 100 m from the mean sea level is _____. (*rounded off to three decimal places*) [Density of air is 1.029 $kg\ m^{-3}$ and acceleration due to gravity is 9.81 $m\ s^{-2}$]
Q.160	If 20 wave crests pass a fixed point in an interval of 5 *minutes*, then the frequency of the wave (in *Hertz*) is _____. (*rounded off to three decimal places*)
Q.161	The required magnitude of heat transfer to reduce the temperature of 10 *kg* of dry air by 5 °C is _____ *kilo Joules*. (*rounded off to one decimal place*) [Specific heat capacity of dry air is 1004 $J\ kg^{-1}K^{-1}$]
Q.162	The mass (in *kg*) of dry air in a room, measuring 10 m × 7 m × 3 m, is _____. (*rounded off to two decimal places*) [Density of dry air is 1.029× $10^{-3}\ g\ cm^{-3}$]

Q.163 – Q.175 Carry TWO marks Each

Q.163	In a two-layered fluid system, temperature and salinity values are given for cases P, Q and R. Which of the following options indicates that the process of 'salt fingering' is likely to occur? $T_1 = 30\,℃, S_1 = 35\,psu$ $T_2 = 31\,℃, S_2 = 35.5\,psu$ **Case: P** $T_1 = 30\,℃, S_1 = 35\,psu$ $T_2 = 29\,℃, S_2 = 34\,psu$ **Case: Q** $T_1 = 30\,℃, S_1 = 35\,psu$ $T_2 = 29.5\,℃, S_2 = 36\,psu$ **Case: R**
(A)	Only P
(B)	Only Q
(C)	Q and R
(D)	P and R

Q.164	A body radiates heat at a rate of 5 $cal\ m^{-2}\ s^{-1}$, when its temperature is 227 °C. Which of the following is the correct value of the heat (in $cal\ m^{-2}\ s^{-1}$) radiated by the same body at a temperature of 727 °C?
(A)	25
(B)	80
(C)	150
(D)	625

Q.165	From the given cases (P, Q, R and S), which represents the annual mean profile of dissolved oxygen in the Bay of Bengal?  *N = Normalized value wth respect to its maximum value*
(A)	P
(B)	Q
(C)	R
(D)	S

Q.166	The given figure illustrates a subtropical gyre in the Southern Indian Ocean. Identify the currents in the correct sequence of P, Q, R and S, respectively from the following options. 
(A)	South Equatorial Current, West Australian Current, Madagascar Current and South Indian Ocean Current
(B)	South Equatorial Current, Madagascar Current, West Australian Current and South Indian Ocean Current
(C)	South Equatorial Current, Madagascar Current, South Indian Ocean Current and West Australian Current
(D)	South Equatorial Current, South Indian Ocean Current, Madagascar Current and West Australian Current

Q.167	Which of the following is/are generally associated within a cyclonic eddy in the northern Indian Ocean?
(A)	Upwelling
(B)	Positive sea level anomaly
(C)	Negative sea level anomaly
(D)	Downwelling
Q.168	Which of the following combinations of forces is/are balanced in a cyclostrophic motion?
(A)	Pressure Gradient, Coriolis, and Centrifugal
(B)	Pressure Gradient and Centrifugal
(C)	Centrifugal and Coriolis
(D)	Pressure Gradient and Coriolis

Q.169	Which of the following statements is/are correct for the Equatorial Indian Ocean during a positive Indian Ocean Dipole event?
(A)	Strong surface westerly winds
(B)	Weak surface westerly winds
(C)	Positive Sea Surface Temperature anomaly in the western region
(D)	Negative Sea Surface Temperature anomaly in the western region

Q.170	The temperature of a dry air parcel is 20 °C at a height of 150 *m* with atmospheric pressure of 1000 *hPa*. If the air parcel rises adiabatically to a height of 2 *km* where atmospheric pressure is 800 *hPa*, then the temperature (in °C) of the air parcel at that height will be _____. (*rounded off to three decimal places*) [Gas constant and specific heat capacity for the dry air are 287 $J\ kg^{-1}\ K^{-1}$ and 1004 $J\ kg^{-1}\ K^{-1}$, respectively.]
Q.171	For an incompressible fluid, the velocity components (u, v, and w) are given as: $u(x, y, z) = 2x + y + 2z$ $v(x, y, z) = ax + by + cz$ $w(x, y, z) = -6z$ The value of b is _____. (*Answer in integer*)
Q.172	A steady westerly wind is blowing over the ocean surface at a latitude of 30°N and exerting a wind stress of 0.8 $N\ m^{-2}$. The magnitude of net volume transport (in $m^2\ s^{-1}$) per unit width is _____. (*rounded off to three decimal places*) [Density of seawater is 1025 $kg\ m^{-3}$, angular velocity of the Earth is $7.29 \times 10^{-5}\ s^{-1}$.]

Q.173	In a free atmosphere without friction, if the pressure increases by one *kilo Pascal* eastward across a distance of 200 *km*, the magnitude of geostrophic flow (in $m\ s^{-1}$) is _____. (*rounded off to two decimal places*) [Density of air is 1.029 $kg\ m^{-3}$and the Coriolis parameter is $10^{-4}\ s^{-1}$.]
Q.174	Using the dispersion relation for deep water small amplitude wave, the wavelength (in *m*) for a 20 second gravity wave is _____. (*Answer in integer*) [Take acceleration due to gravity as 9.81 $m\ s^{-2}$]
Q.175	A two-layered fluid system in an estuarine environment has a total water depth of 10 *m*. The difference in densities between the two layers is 15 $kg\ m^{-3}$ and thickness of the less dense upper layer is 3 *m*. If complete mixing occurs in 3 *hours*, then intensity (in $W\ m^{-2}$) of mixing process is _____. (*rounded off to three decimal places*) [Acceleration due to gravity is 9.81 $m\ s^{-2}$]

Q.176 – Q.184 Carry ONE mark Each

Q.176	The luminous efficacy of an electric light bulb is measured in which one of the following units?
(A)	lumen W^{-1}
(B)	lumen W^{-1} h^{-1}
(C)	lumen m^{-2}
(D)	candela W^{-1}
Q.177	Which one of the following biomass treatment processes occurs in an oxygen limited condition approximately between 450 °C and 600 °C, and produces biochar and bio-oil as primary products?
(A)	Gasification
(B)	Pyrolysis
(C)	Anaerobic Digestion
(D)	Steam Reforming

Q.178	For a fixed thermal output, which one of the following is the major advantage offered by a concentrated collector over a flat plate collector?
(A)	Utilization of diffuse solar radiation
(B)	Reduction of capital cost of the system
(C)	Operation at higher temperature
(D)	Reduction in aperture area of the collector
Q.179	A part of the blowdown energy losses in a boiler can be recovered by which one of the following ways?
(A)	Completely avoiding the blowdown
(B)	Recycling the blowdown to the steam drum
(C)	Flashing the blowdown to generate low-pressure steam
(D)	Mixing the blowdown with the boiler feedwater

Q.180	Which of the following is/are greenhouse gas(es), as identified by the Intergovernmental Panel on Climate Change (IPCC)?
(A)	Nitrogen dioxide (NO_2)
(B)	Nitrous oxide (N_2O)
(C)	Sulphur hexafluoride (SF_6)
(D)	Carbon monoxide (CO)
Q.181	Which of the following is/are step(s) followed in energy audit?
(A)	Walkthrough
(B)	Collection of past energy consumption data
(C)	Evaluation of energy conservation measures
(D)	Preparation of historic profit and loss statement

Q.182	An energy conservation project requires an initial investment of ₹ 50,000 with an expected annual operation and maintenance cost of ₹ 5,000. This project is expected to reduce the monthly energy cost by ₹ 1,250. The simple payback period (in years) is_____. (Answer in integer)
Q.183	The open circuit voltage, short circuit current, and the fill factor of a solar photovoltaic module are 45 V, 9 A, and 0.8, respectively. The maximum output power (in Watt) of the solar photovoltaic module is_____. (Answer in integer)
Q.184	Energy is extracted from a fully charged supercapacitor bank and the voltage of this system drops to 25 % of its initial value. The energy extracted with respect to initial energy (in %, rounded off to two decimal places) is_____.

Q.185 – Q.197 Carry TWO marks Each

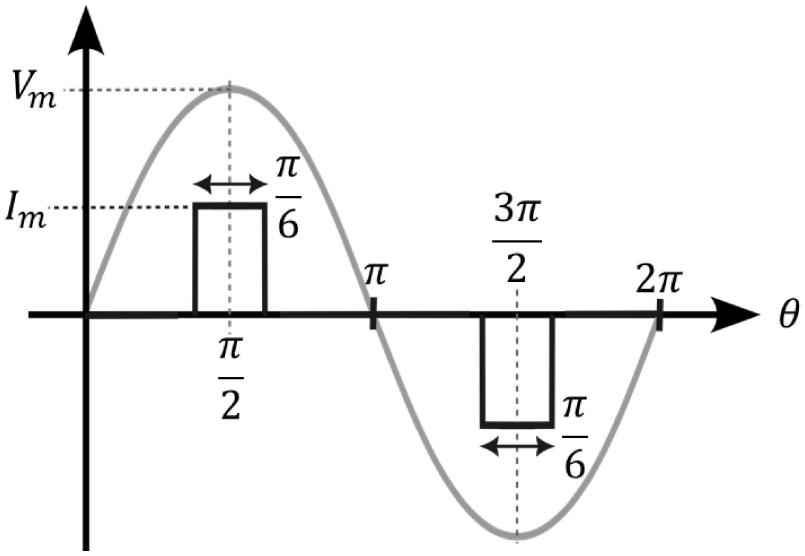
Q.185	A grid-connected induction generator is used to generate electricity from a wind turbine. Which one of the following statements is true while the generator is feeding power to the grid?
(A)	The slip of the induction generator is zero
(B)	The slip of the induction generator is one
(C)	The slip of the induction generator is less than zero
(D)	The slip of the induction generator is greater than one
Q.186	A hydro turbine works under a head of 20 m and has a maximum volume flow rate of 4 $m^3 s^{-1}$ and a speed of 750 rpm. Determine the speed (in rpm) in order to operate the same turbine at approximately the same efficiency under a head of 5 m.
(A)	375.0
(B)	187.5
(C)	750.0
(D)	524.5

Q.187	Which one of the following defines the angle made by the line joining the centers of the sun and the earth with its projection on the equatorial plane?
(A)	Declination
(B)	Latitude
(C)	Azimuth angle
(D)	Zenith angle
Q.188	Which one of the following is the major environmental problem associated with the production of coal-bed methane?
(A)	Contamination of water
(B)	Emission of Carbon dioxide
(C)	Generation of Nitrogen oxides
(D)	Generation of Sulphur oxides

Q.189	A radioactive isotope sample has a decay constant $\lambda = 2.31 \times 10^{-4}$ year^{-1}. Initially the sample contains 8000×10^{15} atoms. The sample decays to 25% of its initial value. The number of years it takes to decay to this stage is closest to _____
(A)	3000
(B)	6000
(C)	900
(D)	2600

Q.190	A fuel with composition by mass is given as 78 % carbon (C), 16 % hydrogen (H_2), 3.2 % sulphur (S), 1.6 % oxygen (O_2), and ash. The fuel is fired in a boiler with excess air for the complete combustion and no carbon monoxide (CO) is detected in the flue gases. The dry flue gas contains 0.2 % sulphur dioxide (SO_2) by volume. Which one of the following options is closest to the amount of excess air provided (in % by mass)? Assume molar masses (g mol^{-1}) of C, H_2, S, and O_2 are 12, 2, 32, and 32, respectively, and the volumetric ratio of nitrogen (N_2) and oxygen (O_2) in the air as 3.76:1.
(A)	14.8
(B)	7.4
(C)	22.2
(D)	3.1

Q.191	Which of the following statements is/are FALSE concerning a wind turbine generation system?
(A)	The rotor power coefficient, C_p, of a multi-blade turbine is a monotonically increasing function of tip-speed ratio
(B)	Maximum power point tracking algorithms are typically employed in wind turbine generators for enhancing energy yield
(C)	The theoretical maximum value of rotor power coefficient, C_p, is 0.65
(D)	Speed control of wind turbine generator is carried out to ensure rotor speed varies in response to wind speed
Q.192	Which of the following options is/are true regarding the behaviour of a typical solar photovoltaic cell?
(A)	Ideal current source
(B)	Current limited voltage source
(C)	Voltage limited current source
(D)	Ideal power source

Q.193	A 75 kWh electric vehicle battery pack made of lithium-ion batteries has 4,800 individual cells in a series-parallel combination, with 120 cells in series. The nominal voltage of the individual cell is 3.7 V. The capacity in Ah (rounded off to two decimal places) of the individual cell is_____.
Q.194	A nonlinear load connected to a sinusoidal voltage source (of peak value V_m and 50 Hz frequency) draws a quasi-square wave shaped current (of maximum value I_m) as shown in the figure below. The power factor of the nonlinear load (rounded off to two decimal places) is_____. 
Q.195	A resident has ₹ 50,000 to purchase a 5-star rated air conditioner with a life of 10 years. The annual energy cost savings (in ₹) needed to recover this investment in 6 years assuming a discount rate of 10 % per annum is_____. (Answer in integer)
Q.196	A country's annual crude oil production in the year 2024 was 150 million tons and that in 2022 was 141 million tons. The proven crude oil resources in 2024 of the country are 12,000 million tons. Consider an exponential growth rate model with a growth rate as compound annual growth rate during 2022-2024. The crude oil reserve will last for _____ years. (rounded off to nearest integer)

Q.197	The useful heat gain in Watt (rounded off to one decimal place) of a solar flat plate collector using Hottel-Whillier-Bliss equation is_____. Assume: Collector heat removal factor = 0.85 Absorber plate area = 1.5 m^2 Absorbed solar flux by the absorber plate = 600 Wm^{-2} Overall loss coefficient = 4 $Wm^{-2}K^{-1}$ Water inlet temperature = 60 °C Ambient temperature = 25 °C