General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

Q.1	If '→' denotes increasing order of intensity, then the meaning of the words [dry → arid → parched] is analogous to [diet → fast → ________]. Which one of the given options is appropriate to fill the blank?
(A)	starve
(B)	reject
(C)	feast
(D)	deny
Q.2	If two distinct non-zero real variables x and y are such that $(x + y)$ is proportional to $(x - y)$ then the value of $\frac{x}{y}$
(A)	depends on xy
(B)	depends only on x and not on y
(C)	depends only on y and not on x
(D)	is a constant

Q.3	Consider the following sample of numbers: 9, 18, 11, 14, 15, 17, 10, 69, 11, 13 The median of the sample is
(A)	13.5
(B)	14
(C)	11
(D)	18.7
Q.4	The number of coins of ₹1, ₹5, and ₹10 denominations that a person has are in the ratio 5:3:13. Of the total amount, the percentage of money in ₹5 coins is
(A)	21%
(B)	$14\frac{2}{7}\%$
(C)	10%
(D)	30%

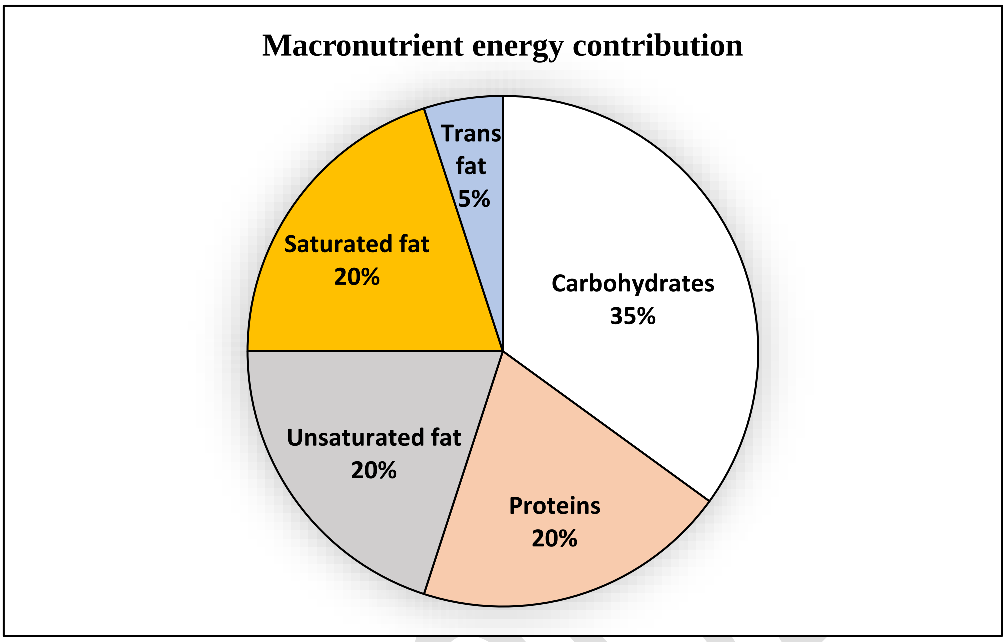
Q.5	For positive non-zero real variables p and q, if $$\log\ (p^2 + q^2) = \log p + \log q + 2\log 3\,,$$ then, the value of $\frac{p^4+q^4}{p^2q^2}$ is
(A)	79
(B)	81
(C)	9
(D)	83

Q.6 – Q.10 Carry TWO marks Each

Q.6	In the given text, the blanks are numbered (i)−(iv). Select the best match for all the blanks. Steve was advised to keep his head ___(i)___ before heading ___(ii)___ to bat; for, while he had a head ___(iii)___ batting, he could only do so with a cool head ___(iv)___ his shoulders.
(A)	(i) down (ii) down (iii) on (iv) for
(B)	(i) on (ii) down (iii) for (iv) on
(C)	(i) down (ii) out (iii) for (iv) on
(D)	(i) on (ii) out (iii) on (iv) for

Q.7	A rectangular paper sheet of dimensions 54 cm × 4 cm is taken. The two longer edges of the sheet are joined together to create a cylindrical tube. A cube whose surface area is equal to the area of the sheet is also taken. Then, the ratio of the volume of the cylindrical tube to the volume of the cube is
(A)	$1/\pi$
(B)	$2/\pi$
(C)	$3/\pi$
(D)	$4/\pi$

Q.8	The pie chart presents the percentage contribution of different macronutrients to a typical 2,000 kcal diet of a person.

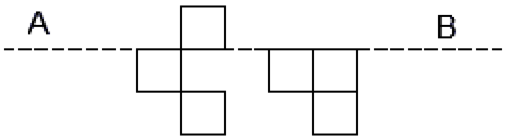


The typical energy density (kcal/g) of these macronutrients is given in the table.

Macronutrient	Energy density (kcal/g)
Carbohydrates	4
Proteins	4
Unsaturated fat	9
Saturated fat	9
Trans fat	9

The total fat (all three types), in grams, this person consumes is

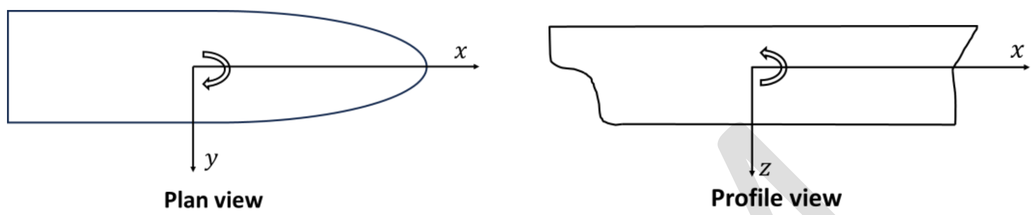
(A)	44.4
(B)	77.8
(C)	100
(D)	3,600

Q.9	A rectangular paper of 20 cm × 8 cm is folded 3 times. Each fold is made along the line of symmetry, which is perpendicular to its long edge. The perimeter of the final folded sheet (in cm) is
(A)	18
(B)	24
(C)	20
(D)	21
Q.10	The least number of squares to be added in the figure to make AB a line of symmetry is 
(A)	6
(B)	4
(C)	5
(D)	7

Q.11 – Q.35 Carry ONE mark Each

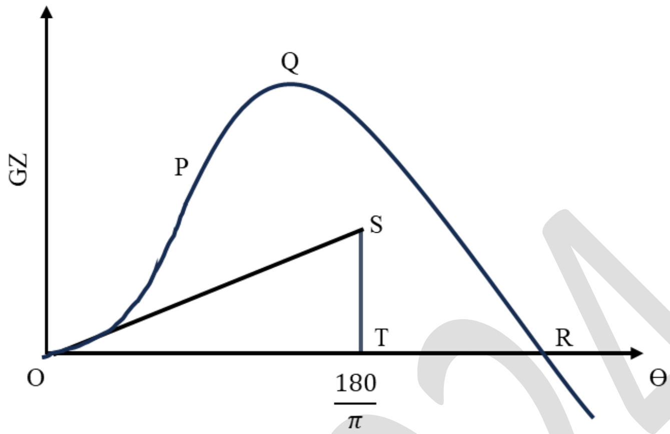
Q.11	The value of the contour integral $\oint \frac{dz}{2z-z^2}$ along the circle $\lvert z \rvert = 1$, oriented in the counterclockwise sense is
(A)	πi
(B)	0
(C)	$2\pi i$
(D)	$4\pi i$
Q.12	The tangent plane to the surface $x^2 + y^2 + z = 9$ at the point (1, 2, 4) is
(A)	$2x + 4y + z = 14$
(B)	$4x + 2y + z = 12$
(C)	$x + 4y + 2z = 17$
(D)	$4x + y + 2z = 14$

Q.13	The value of the line integral $\oint x^2\,dx + 2x\,dy$ along the ellipse $4x^2 + y^2 = 4$ oriented in the counterclockwise sense is
(A)	π
(B)	2π
(C)	4π
(D)	8π
Q.14	The system of linear equations $x + 2y + 3z = 4$ $2x - y - 2z = a^2$ $-x - 7y - 11z = a$ has a solution if the values of a are
(A)	-1 and 5
(B)	-2 and 3
(C)	-5 and 1
(D)	-3 and 4

Q.15	A ship with a standard right-handed coordinate system has positive x, y and z axes respectively pointing towards bow, starboard and down as shown in the figure. If the ship takes a starboard turn, then the drift angle, sway velocity and the heel angle of the ship for a steady yaw rate respectively are
	
(A)	positive, negative and positive
(B)	negative, positive and positive
(C)	negative, positive and negative
(D)	positive, negative and negative

Q.16	A ship with controls fixed, is modeled as a two degrees of freedom system. For the linear maneuvering equations of motion for coupled sway and yaw, if the derived eigenvalues are real and negative, then the ship must possess
(A)	positional motion stability
(B)	directional stability
(C)	straight line stability
(D)	both directional and positional motion stabilities
Q.17	Which one of the following cooling systems is used in large marine diesel engines?
(A)	Thermosyphon
(B)	Forced coolant circulation
(C)	Evaporative
(D)	Air circulation

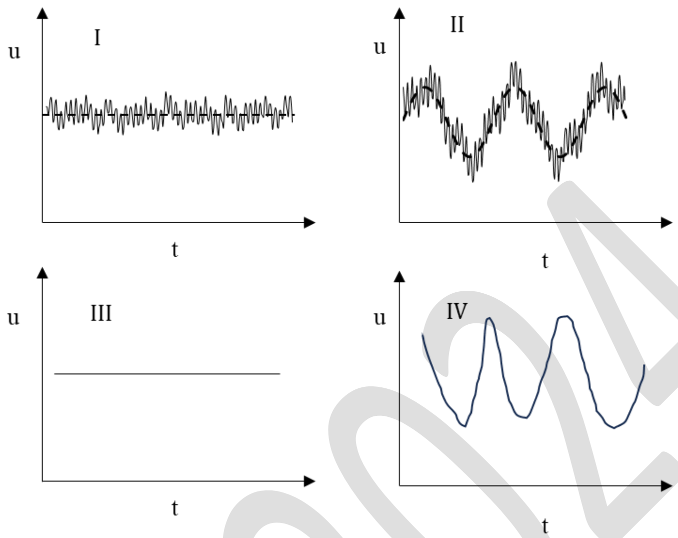
Q.18	Which one of the following reduces the ratio of vibratory response amplitude to the forcing amplitude, in large stationary engine shaft design?
(A)	Reduction in axial vibrations of the rotating shaft
(B)	Increase in the fundamental frequency of the rotating shaft
(C)	Decrease in the rotational speed of shaft
(D)	Operating the shaft at a speed exceeding the critical speed

Q.19	The GZ curve for a stable ship is shown in the figure, where P is a point of inflection on the curve. Match the labels in **Column 1** with the corresponding descriptions in **Column 2**.
	 **Column 1** / **Column 2** P — I: Angle of vanishing stability ST — II: Maximum GZ R — III: Initial GM Q — IV: Deck edge immersion
(A)	R - I; Q - II; ST - III; P - IV
(B)	P - I; Q - II; ST - III; R - IV
(C)	ST - I; Q - II; R - III; P - IV
(D)	R - I; Q - II; P - III; ST - IV

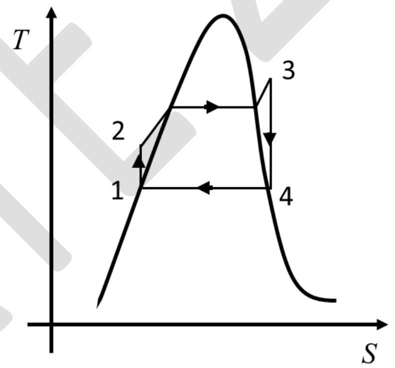
Q.20	Consider an initially perfectly straight elastic column with pinned supports at both ends. If E is the Young's modulus of the material, L is the length of the column between the supports, and I is the least moment of inertia of the constant cross-sectional area of the column, then the Euler load is given by
(A)	$\frac{\pi^2 EI}{L^2}$
(B)	$\frac{\pi^2 EI}{4L^2}$
(C)	$\frac{\pi^2 EI}{\sqrt{2}L^2}$
(D)	$\frac{2\pi^2 EI}{L^2}$
Q.21	For a plane strain problem in the *x-y* plane, it is necessary that
(A)	normal stress σ_z is zero
(B)	normal strain ε_z is zero
(C)	both the normal stresses σ_x and σ_y are zero
(D)	shear strain γ_{xy} is equal to $\frac{(\varepsilon_x - \varepsilon_y)}{2}$

Q.22	How many independent material constants in solids are required to define isotropic materials?
(A)	2
(B)	3
(C)	9
(D)	21

Q.23	Which one of the following is the mass conservation equation?
(A)	$\frac{D}{Dt}\iiint_V \rho\, \vec{v}.\hat{n}\, dV = 0$
(B)	$\frac{\partial}{\partial t}\iiint_V \rho dV = 0$
(C)	$-\frac{\partial}{\partial t}\iiint_V \rho dV = \iint_S \rho\vec{v}.\hat{n}\, ds$
(D)	$-\frac{D}{Dt}\iiint_V \rho dV = \iint_S \rho\vec{v}.\hat{n}\, ds$

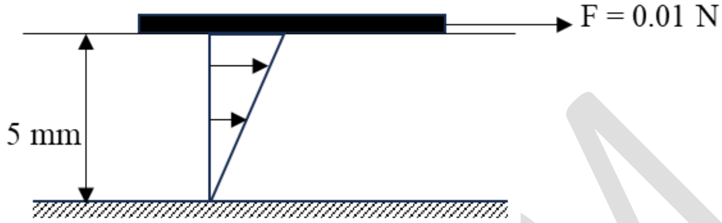
Q.24	Identify the type of flow from the time series plots of instantaneous fluid velocity (u) at a point.
	
(A)	I - unsteady turbulent flow; II - steady turbulent flow; III - steady laminar flow; IV - unsteady laminar flow
(B)	I - steady turbulent flow; II - unsteady turbulent flow; III - unsteady laminar flow; IV - steady laminar flow
(C)	I - steady turbulent flow; II - unsteady turbulent flow; III - steady laminar flow; IV - unsteady laminar flow
(D)	I - steady turbulent flow; II - unsteady laminar flow; III - unsteady turbulent flow; IV - steady laminar flow

Q.25	Which of the following hull distortion(s) is/are resisted by a ship's transverse bulkhead?
(A)	Racking
(B)	Torsion
(C)	Longitudinal bending
(D)	Horizontal bending
Q.26	Which of the following boiler(s) is/are **NOT** used in a nuclear propulsion system for ships?
(A)	Water tube boiler
(B)	Cochran boiler
(C)	Double evaporation boiler
(D)	Boiled water reactor boiler

Q.27	Which of the following statement(s) is/are correct about strip theory?
(A)	It can be used to calculate the surge added mass
(B)	It is a two-dimensional theory
(C)	It can be used to calculate the pitch added mass
(D)	It can be used to calculate the coupled sway, roll and yaw added mass
Q.28	Consider an ideal Rankine cycle as shown in the figure, where *T* and *S* represent the temperature and entropy respectively. The overall efficiency of the cycle can be improved by
	
(A)	increasing the pressure at which heat is added
(B)	decreasing the pressure at which heat is rejected
(C)	employing an intercooler
(D)	superheating the steam

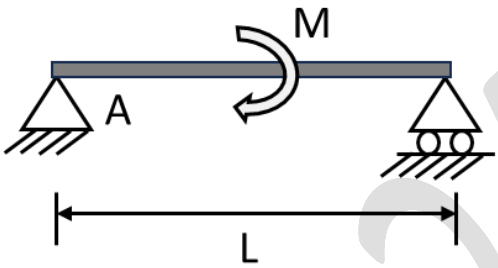
Q.29	Which of the following statement(s) is/are correct for a thermodynamic closed system?
(A)	The entropy change is positive for a reversible adiabatic process
(B)	The entropy change is positive for a reversible cycle
(C)	The entropy change is positive for a reversible isothermal heat addition process
(D)	The entropy change is negative for a reversible isothermal heat rejection process
Q.30	The arc length of the one arch of the cycloid given by $x = t - \sin t$ and $y = 1 - \cos t$ is ________.
Q.31	A 10 m long pipe with inlet and outlet diameters of 40 cm and 20 cm respectively, is carrying an incompressible fluid with a flow rate of 0.04 m^3/s. The ratio of the velocity at the outlet to that at the inlet is _____ (rounded off to one decimal place)

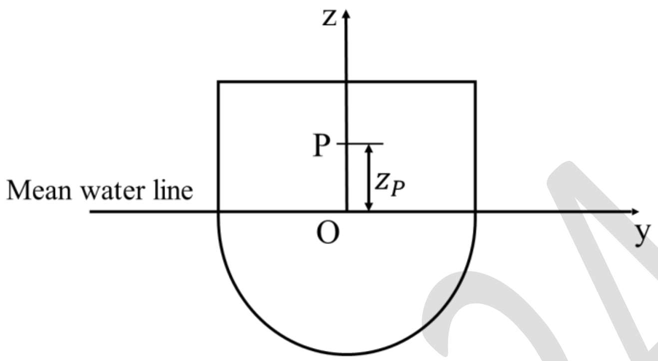
Q.32	An 80 m long barge with rectangular cross-section of 12 m beam and 4 m draft floats at even keel. The transverse metacenter (KM) above the keel is ________ m.
Q.33	A 100 m long ship has a cruising speed of 25 knots. A geometrically similar model of 4 m length is used for resistance prediction in a towing tank. The corresponding speed of the model is ____________ knots.
Q.34	A cube-shaped pontoon with 200 tonnes of mass placed on it, floats with a freeboard of 1 m in fresh water. When the mass is removed, the pontoon floats with a freeboard of 3 m. The length of the pontoon is ______ m (rounded off to two decimal places).

Q.35	Consider a fluid between two horizontal parallel flat plates 5 mm apart as shown in the figure. The top plate of dimensions 0.5 m × 2 m is towed with an applied horizontal force F of 0.01 N, while the infinitely long bottom plate is kept fixed. The horizontal velocity profile between the plates is assumed to be linear. If the dynamic viscosity (μ) of the fluid is 0.89×10^{-3} N-s/m^2, then the towing velocity of the top plate is ________ m/s (rounded off to three decimal places).
	

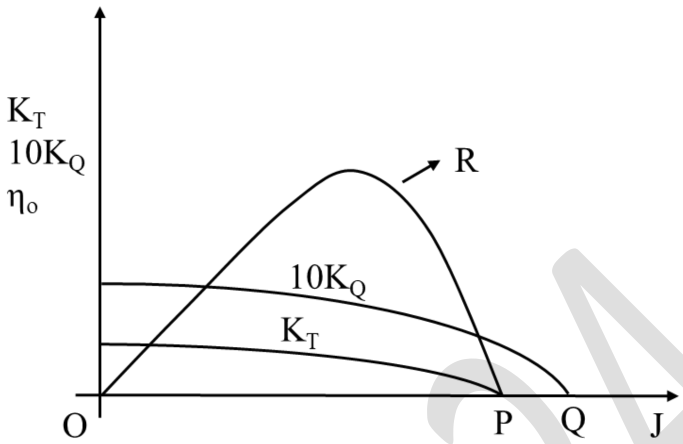
Q.36 – Q.65 Carry TWO marks Each

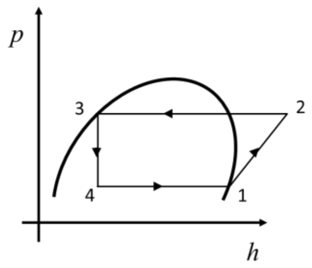
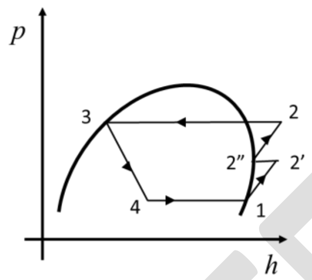
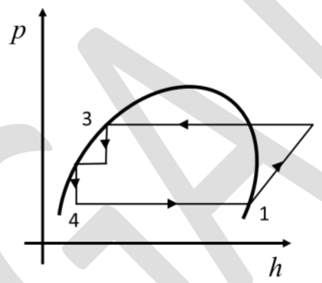
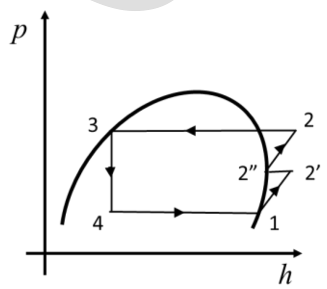
Q.36	Consider the matrices $M = \begin{pmatrix} 2 & 1 \\ 0 & 2 \end{pmatrix}$ and $N = \begin{pmatrix} 1 & 0 & 0 \\ 1 & 2 & 0 \\ 1 & 1 & 0 \end{pmatrix}$. Which one of the following is true?
(A)	M is not diagonalizable but N is diagonalizable
(B)	Both M and N are not diagonalizable
(C)	Both M and N are diagonalizable
(D)	M is diagonalizable but N is not diagonalizable

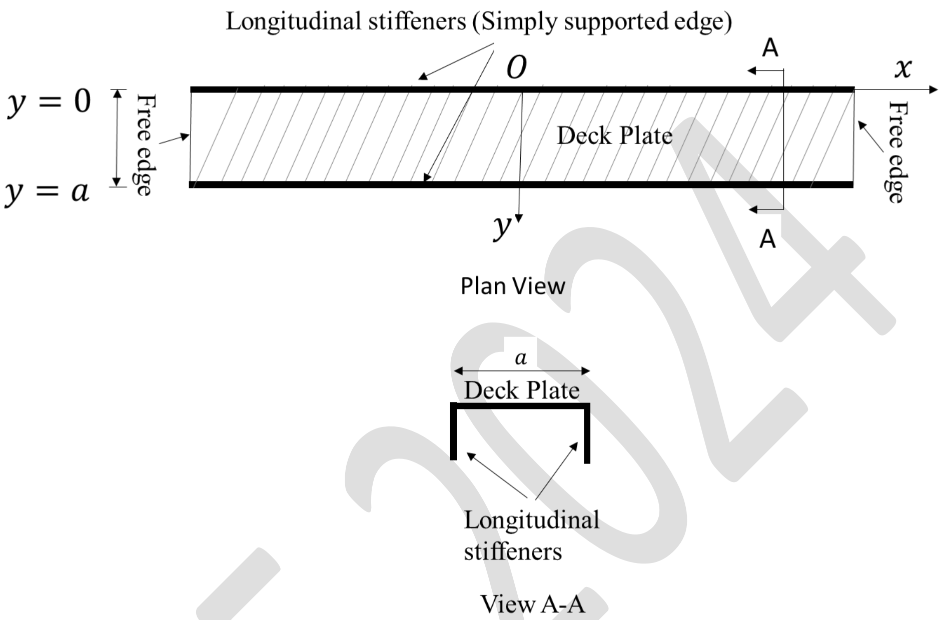
Q.37	A simply supported beam is subjected to a concentrated moment M at the mid span as shown in the figure. The magnitude of the bending moment at a distance of L/4 from the left support A is equal to
	
(A)	M
(B)	$\frac{ML}{4}$
(C)	$\frac{M}{4}$
(D)	$\frac{M}{2}$

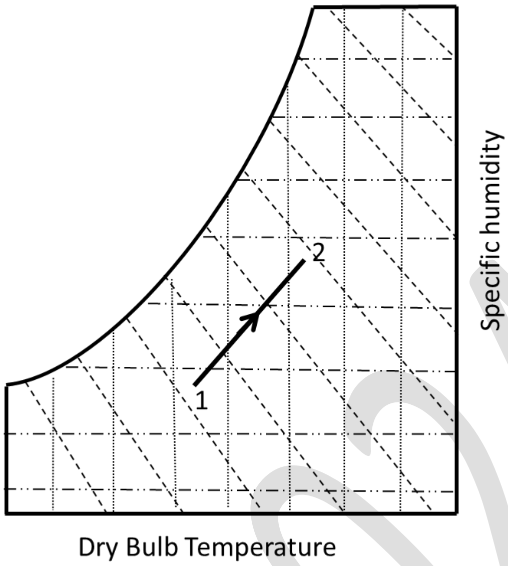
Q.38	Consider a two-dimensional ship section as shown in the figure. About the point O, let the sway added mass components be a_{22} and a_{24} and roll added moment of inertia be a_{44}. The clockwise roll angle is considered positive. The roll added mass due to roll, about P which is at a distance z_P above O is given by
	
(A)	$a_{44} - a_{24}z_P$
(B)	$a_{44} - a_{22}z_P - a_{24}z_P$
(C)	$a_{44} - a_{22}z_P + a_{24}z_P$
(D)	$a_{22} + a_{24} + a_{44}$

Q.39	A ship with a displacement of 10000 tonnes has the center of gravity at 4 m above the keel and 1.5 m forward of midship. If 2000 tonnes of cargo is placed at 10 m above the keel and 1.5 m aft of midship, then the new position of the center of gravity is
(A)	5 m above the keel and 1 m aft of midship
(B)	6 m above the keel and 1 m forward of midship
(C)	6 m above the keel and 1 m aft of midship
(D)	5 m above the keel and 1 m forward of midship
Q.40	The waterplane area of a ship floating in sea water is 2000 m^2. The density of seawater is 1025 kg/m^3. If a mass of 246 tonnes is added to the ship, then the TPC (Tonnes Per Centimeter immersion) and increase in draft (in cm) respectively are
(A)	20.50 and 12
(B)	20 and 12.3
(C)	20.50 and 24
(D)	10.25 and 24.6

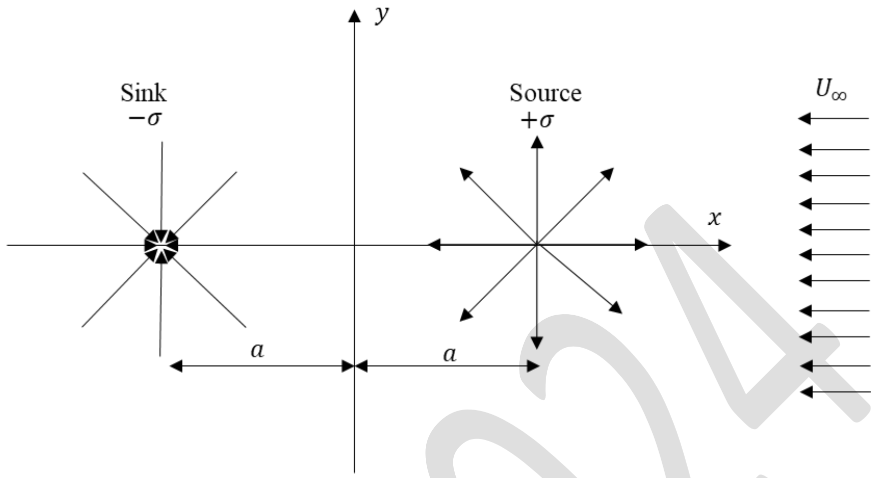
Q.41	The open water characteristics of a propeller is shown in the figure. Match the labels in **Column 1** with the corresponding descriptions in **Column 2.**
	 **Column 1** / **Column 2** R — I: Bollard pull condition Q — II: Feathering condition P — III: Wind milling condition O — IV: Efficiency curve
(A)	O - I; P - II; Q - III; R - IV
(B)	O - I; Q - II; P - III; R - IV
(C)	O - I; R - II; Q - III; P - IV
(D)	P - I; Q - II; O - III; R - IV

Q.42	Which one of the following *p*-*h* plots represents the ideal vapour compression cycle with intercooling? Here, *p* and *h* denote pressure and specific enthalpy respectively.
(A)	
(B)	
(C)	
(D)	

Q.43	A steel deck plate of a tanker is supported by two longitudinal stiffeners as shown in the figure. The width of the plate is a and its length is 5 times the width. Assume that the long edge is simply supported, and the short edge is free. The plate is loaded by a distributed pressure, $p = p_0 \sin\left(\frac{\pi y}{a}\right)$, where p_0 is the pressure at $y = a/2$. The flexural rigidity of the plate is D. The plate equation is given by
	
(A)	$\frac{\partial^4 w}{\partial y^4} = \frac{p_0}{D} \sin\left(\frac{\pi y}{a}\right)$
(B)	$\frac{\partial^2 w}{\partial x^2} = \frac{p_0}{D} \sin\left(\frac{\pi y}{a}\right)$
(C)	$\frac{\partial^2 w}{\partial y^2} = \frac{p_0}{D} \sin\left(\frac{\pi y}{a}\right)$
(D)	$\frac{\partial^4 w}{\partial x^4} = \frac{p_0}{D} \sin\left(\frac{\pi y}{a}\right)$

Q.44	Which one of the following psychrometric processes is represented by the line 1-2 in the figure?
	
(A)	Cooling and humidification
(B)	Cooling and dehumidification
(C)	Heating and humidification
(D)	Heating and dehumidification

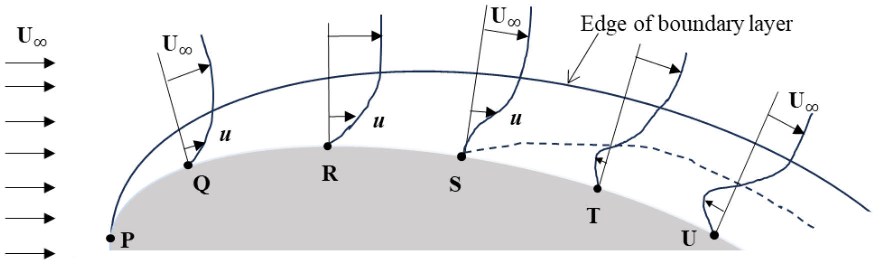
Q.45	Consider model testing where λ is the prototype to model length scale ratio. Let ν_p and ν_m denote the corresponding fluid kinematic viscosities. If Froude and Reynolds similarities are maintained between the prototype and model, then which one of the following is correct?
(A)	$\nu_m = \lambda^{-3/2}\nu_p$
(B)	$\nu_m = \lambda^{3/2}\nu_p$
(C)	$\nu_m = \lambda^{2/3}\nu_p$
(D)	$\nu_m = \lambda^{-2/3}\nu_p$

Q.46	A uniform flow, a point source of strength $+\sigma$ at $(a, 0)$ and a point sink of strength $-\sigma$ at $(-a, 0)$ are shown in the figure. The velocity potential ϕ resulting from the superposition of these flow fields is given by
	
(A)	$\phi = -U_\infty x + \frac{\sigma}{2\pi} ln\sqrt{(x+a)^2 + y^2} - \frac{\sigma}{2\pi} ln\sqrt{(x-a)^2 + y^2}$
(B)	$\phi = -U_\infty x + \frac{\sigma}{2\pi} ln\sqrt{(x-a)^2 + y^2} - \frac{\sigma}{2\pi} ln\sqrt{(x+a)^2 + y^2}$
(C)	$\phi = U_\infty x + \frac{\sigma}{2\pi} ln\sqrt{(x-a)^2 + y^2} - \frac{\sigma}{2\pi} ln\sqrt{(x+a)^2 + y^2}$
(D)	$\phi = U_\infty x + \frac{\sigma}{2\pi} ln\sqrt{(x+a)^2 + y^2} - \frac{\sigma}{2\pi} ln\sqrt{(x-a)^2 + y^2}$

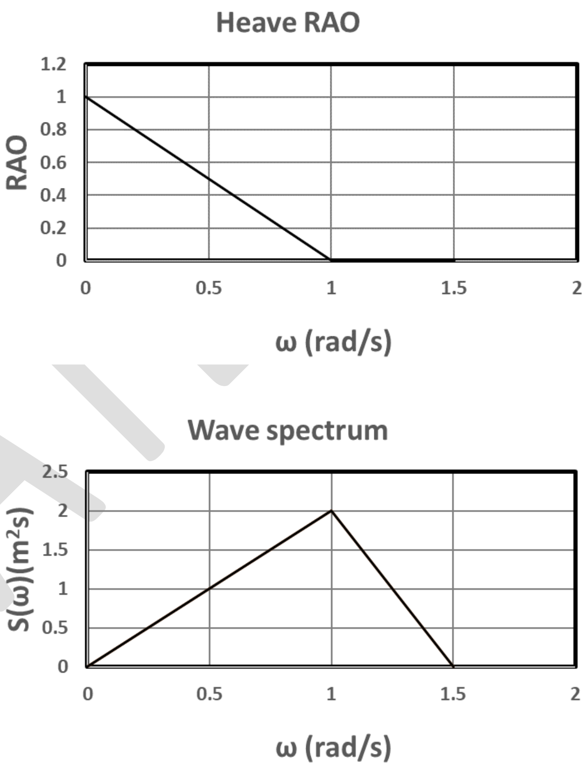
Q.47	In the solution of statically indeterminate problems, Castigliano's second theorem employs the
(A)	principle of virtual work
(B)	virtual displacement method
(C)	virtual force method
(D)	principle of least work
Q.48	Consider the function $f(x, y) = x^4 + y^4 - 4xy + 1$. Which of the following is/are correct?
(A)	The minimum value of f occurs at $(0, 0)$
(B)	The point $(0, 0)$ is a point of inflection
(C)	f has three critical points
(D)	The minimum value of f is -1

Q.49	Consider the 2π – periodic function defined by $$f(x) = \begin{cases} -1 & if\ -\pi < x \leq 0 \\ 1 & if\ \ 0 < x < \pi \end{cases}$$ Which of the following is/are correct about its Fourier series expansion, $\frac{a_0}{2} + \sum_{n=1}^{\infty} a_n \cos nx + b_n \sin nx$?
(A)	$a_n = \frac{1}{n}\ \forall\ n = 1, 2, ...$
(B)	$a_0 = 0$
(C)	$b_n = \frac{4}{n\pi}$ if n is odd
(D)	$b_n = -\frac{4}{n\pi}$ if n is even

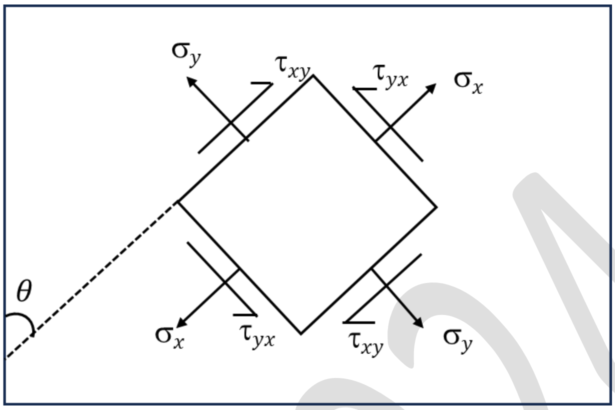
Q.50	Consider the following momentum equation. Let A, B and C denote the first, second and third term on the left-hand side respectively and, D and E denote the first and second term on the right-hand side respectively. Which of the following statement(s) is/are correct?
	$$\rho\left[\frac{\partial \boldsymbol{V}}{\partial t} + grad\left\|\frac{\boldsymbol{V}^2}{2}\right\| + (curl\,\boldsymbol{V}) \times \boldsymbol{V}\right] = -grad(P + \rho g z) + \mu \nabla^2 \boldsymbol{V}$$
(A)	If terms A, C and E vanish, then the flow is irrotational.
(B)	If term A vanishes, then the flow is steady.
(C)	If term D vanishes, then it leads to the Euler's equation.
(D)	If terms A, B, C and E vanish, then it leads to the hydrostatic equation.

Q.51	Consider the flow past a curved wall as shown in the figure. Which of the following statement(s) is/are correct?
	
(A)	P is the separation point.
(B)	Between T and U, the pressure gradient in the streamwise direction at the wall is positive.
(C)	U is the stagnation point.
(D)	Between T and U, the streamwise-velocity gradient in the normal direction at the wall is negative.
Q.52	If X is a Poisson random variable with mean $\mu = 1$, then the conditional probability of the event $\{X \geq 2\}$ given that the event $\{X \geq 4\}$ has occurred, is ________ (rounded off to two decimal places).

Q.53	The value of the triple integral $\iiint (xy^2 + yz^3)\, dx\, dy\, dz$ over the region given by $-1 \le x \le 1,\ 3 \le y \le 4,\ 0 \le z \le 2$, is ________.
Q.54	A 4-cylinder, 4-stroke diesel engine operating at 3000 rpm has a compression ratio r of 12 and cut-off ratio r_c of 2.5. The temperature rise during the heat addition process is 2400 K. The efficiency of an air-standard diesel cycle is given by $\eta = 1 - \frac{1}{r^{\gamma-1}}\left(\frac{1}{\gamma}\frac{r_c^{\gamma}-1}{r_c-1}\right)$. Assume the working fluid as air with a mass flow rate of 0.05 kg/s, $\gamma = 1.4$, and $C_p = 1.004$ kJ/kg-K. The power output of the engine is ________ kW (rounded off to the nearest integer).
Q.55	A ship travelling in head seas experiences a bending moment of 200 MN-m. The ship's cross section is assumed to be a box girder of 30 m beam and 10 m depth with a 10 mm plate thickness. The maximum bending stress is ________ MPa (rounded off to the nearest integer).

Q.56	A single degree of freedom system has a mass, stiffness and damping of 200 kg, 20 N/m and 62 N-s/m respectively. For a forced oscillation system, if the excitation frequency is equal to the undamped natural frequency, then the dynamic magnification factor is ________ (rounded off to three decimal places).
Q.57	The wave spectrum and the ship heave Response Amplitude Operator (RAO) are shown in the figure. The variance of the heave motion is ______ m^2 (rounded off to three decimal places).
	

Q.58	Consider a thin-walled closed cylindrical steel vessel with an internal pressure of 2 N/mm^2. The inner diameter is 1 m, and the thickness of the wall is 10 mm. The hoop stress is _______ N/mm^2 (rounded off to one decimal place).
Q.59	A propeller disc of diameter 2 m produces a thrust of 88 kN while advancing at a speed of 5 m/s in fresh water of density 1000 kg/m^3. Based on the axial momentum theory, the propeller efficiency is _____________ % (rounded off to one decimal place).

Q.60	Consider a rectangular plate with in-plane loads. The state of the stress at an arbitrary angle θ is defined by σ_x, σ_y and τ_{xy} as shown in the figure. If the principal plane is at θ = 45°, and the principal stresses are $\sigma_x = 8$ N/mm² and $\sigma_y = 3$ N/mm², then the corresponding τ_{xy} = ________ N/mm².
	
Q.61	A ship of 5000 tonnes displacement has a rectangular tank 6 m long and 10 m wide, half-filled with oil of relative density 0.8. The virtual reduction in the transverse metacentric height of the ship due to free surface effect of the oil in the tank is _______ cm.

Q.62	An ocean wave of period 8 s and height 2 m is propagating in the Indian Ocean from south to north. According to linear wave theory, for the wave to be considered as a deep-water wave, the minimum water depth should be ______ m (rounded off to the nearest integer).
Q.63	Consider a gas turbine combustor with air as the working fluid. The flow enters the device at 500 K and leaves at 1400 K with a mass flow rate of 0.1 kg/s. The changes in kinetic energy and potential energy of the flow are neglected. Assuming $C_v = 0.717$ kJ/kg-K and R = 0.287 kJ/kg-K, the rate of heat addition is ______ kW (rounded off to the nearest integer).
Q.64	Consider a circular cylinder of diameter 0.5 m and length 2 m, rotating in clockwise direction at a speed of 100 rpm in a flow of velocity 2 m/s. Assume the density of the fluid as 1.225 kg/m^3 and $\pi = 3.14$. By Kutta-Joukowski theorem, the lift force on the cylinder is _______ N (rounded off to the nearest integer).

Q.65	A new absolute temperature scale is proposed based on a Carnot engine operating between hot and cold reservoirs of temperatures T_L and T_H respectively. Let Q_L and Q_H be the respective heat transfers, with the relation given by $\frac{T_L}{T_H} = \frac{Q_L}{Q_H}$. On the new scale, the difference between the steam and ice points of water is 500 units and the efficiency of the engine is 0.268. The steam point of water on this scale is ________ units (rounded off to the nearest integer).