



GATE 2022 Engineering Sciences XE GATE 2022 General Aptitude

Q.1 – Q.5 Carry ONE mark each.

Q.1	The movie was funny and I
(A)	could help laughing
(B)	couldn't help laughed
(C)	couldn't help laughing
(D)	could helped laughed

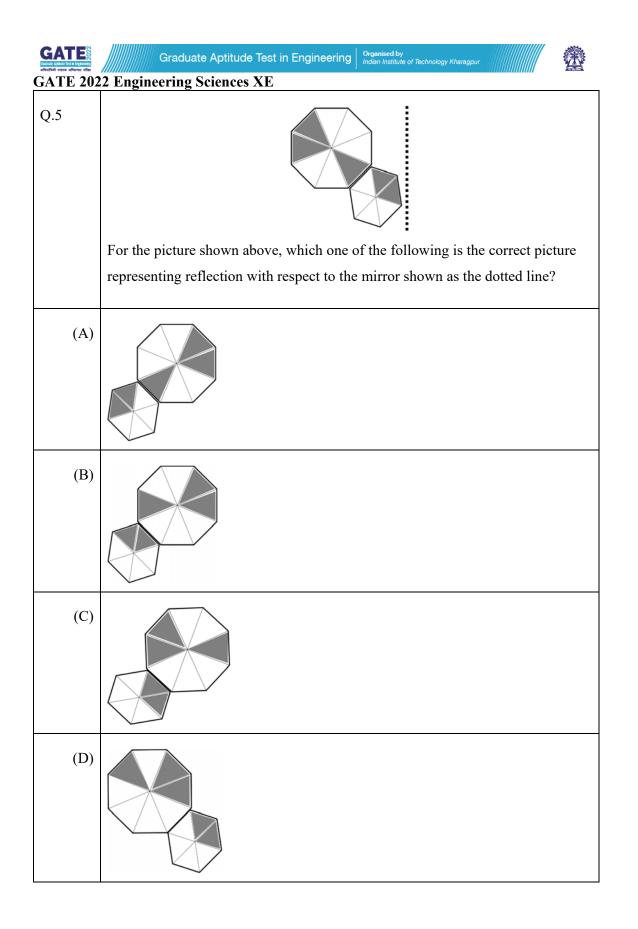
Q.2	$x: y: z = \frac{1}{2}: \frac{1}{3}: \frac{1}{4}.$
	What is the value of $\frac{x+z-y}{y}$?
(A)	0.75
(B)	1.25
(C)	2.25
(D)	3.25

	Graduate Aptitude Test in Engineering Organised by Indian Institute of Technology Kharagpur
Q.3	Both the numerator and the denominator of $\frac{3}{4}$ are increased by a positive integer, x, and those of $\frac{15}{17}$ are decreased by the same integer. This operation results in the same value for both the fractions. What is the value of x?
(A)	1
(B)	2
(C)	3
(D)	4



Q.4	 A survey of 450 students about their subjects of interest resulted in the following outcome. 150 students are interested in Mathematics. 200 students are interested in Physics. 175 students are interested in Chemistry. 50 students are interested in Mathematics and Physics. 60 students are interested in Physics and Chemistry. 40 students are interested in Mathematics and Chemistry. 30 students are interested in Mathematics, Physics and Chemistry. Remaining students are interested in Humanities. Based on the above information, the number of students interested in Humanities is
(A)	10
(B)	30
(C)	40
(D)	45









Q. 6 – Q. 10 Carry TWO marks each.

Q.6	In the last few years, several new shopping malls were opened in the city. The total number of visitors in the malls is impressive. However, the total revenue generated through sales in the shops in these malls is generally low. Which one of the following is the CORRECT logical inference based on the information in the above passage?
(A)	Fewer people are visiting the malls but spending more
(B)	More people are visiting the malls but not spending enough
(C)	More people are visiting the malls and spending more
(D)	Fewer people are visiting the malls and not spending enough





Q.7	In a partnership business the monthly investment by three friends for the first six months is in the ratio 3: 4: 5. After six months, they had to increase their monthly investments by 10%, 15% and 20%, respectively, of their initial monthly investment. The new investment ratio was kept constant for the next six months. What is the ratio of their shares in the total profit (in the same order) at the end of the year such that the share is proportional to their individual total investment over the year?
(A)	22:23:24
(B)	22:33:50
(C)	33:46:60
(D)	63 : 86 : 110



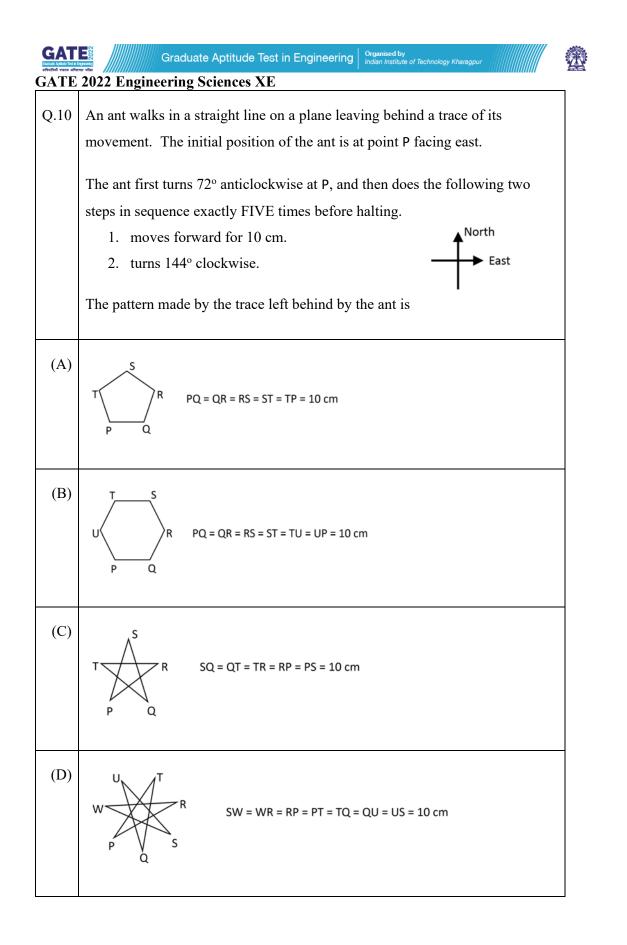


Q.8	Consider the following equations of straight lines:
	Line L1: $2x - 3y = 5$ Line L2: $3x + 2y = 8$ Line L3: $4x - 6y = 5$ Line L4: $6x - 9y = 6$ Which one among the following is the correct statement?
(A)	L1 is parallel to L2 and L1 is perpendicular to L3
(B)	L2 is parallel to L4 and L2 is perpendicular to L1
(C)	L3 is perpendicular to L4 and L3 is parallel to L2
(D)	L4 is perpendicular to L2 and L4 is parallel to L3





Q.9	Given below are two statements and four conclusions drawn based on the statements.
	Statement 1: Some soaps are clean.
	Statement 2: All clean objects are wet.
	Conclusion I: Some clean objects are soaps.
	Conclusion II: No clean object is a soap.
	Conclusion III: Some wet objects are soaps.
	Conclusion IV: All wet objects are soaps.
	Which one of the following options can be logically inferred?
(A)	Only conclusion I is correct
(B)	Either conclusion I or conclusion II is correct
(C)	Either conclusion III or conclusion IV is correct
(D)	Only conclusion I and conclusion III are correct







GATE 2022 Engineering Sciences XE XE-A: Q.11 – Q.17 Carry ONE mark Each

Q.11	The value of $\lim_{x \to 0} \frac{1}{x} \int_{2}^{2+x} \left(t + \sqrt{t^2 + 5}\right) dt$
	is
(A)	0
(B)	4
(C)	5
(D)	6



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Q.12	Let $\mathbb{C} = \{z = x + iy : x \text{ and } y \text{ are real numbers, } i = \sqrt{-1}\}$ be the set of complex numbers. Let the function $f(z) = u(x, y) + i v(x, y)$ for $z = x + iy \in \mathbb{C}$ be analytic in \mathbb{C} , where $u(x, y) = x y^3 - y x^3$ and $v(x, y) = \frac{x^4}{4} + \frac{y^4}{4} - \frac{3}{2} x^2 y^2$. If $f'(z)$ denotes the derivative of $f(z)$, then
(A)	$ f'(-1+i) ^2 = 1$
(B)	$ f'(-1+i) ^2 = 7$
(C)	$ f'(-1+i) ^2 = 8$
(D)	$ f'(-1+i) ^2 = 10$

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GATE 2	022 Engineering Sciences XE
Q.13	If the partial differential equation
	$(x+2)\frac{\partial^2 u}{\partial x^2} + 2(x+y)\frac{\partial^2 u}{\partial x \partial y} + 2(y-1)\frac{\partial^2 u}{\partial y^2} - 3y^2 \frac{\partial u}{\partial y} = 0$
	is parabolic on the circle $(x - a)^2 + (y - b)^2 = r^2$, then the values of a, b and r are given by
(A)	a = 1, b = 2, r = 1
(B)	a = -1, b = 2, r = 1
(C)	a = 1, b = -2, r = 1
(D)	a = -1, b = -2, r = 1

Q.14	Let Γ be the positively oriented circle $x^2 + y^2 = 9$ in the <i>xy</i> -plane. If
	$\oint_{\Gamma} (3y + e^{x \sin x}) dx + (7x + \sqrt{e^y + 2}) dy = \alpha \pi,$
	where α is a real constant, then α is equal to



Q.15 Let $y_1(x)$ and $y_2(x)$ be two linearly independent solutions of $x^2 \frac{d^2y}{dx^2} - 2x \frac{dy}{dx} + 2y = 0, \quad x > 0.$ Let $W(y_1, y_2)(x)$ denote the Wronskian of $y_1(x)$ and $y_2(x)$ at x. If $W(y_1, y_2)(1) = 1$ then $W(y_1, y_2)(2)$ is equal to _____.

Q.16	Let $A = \begin{bmatrix} 2 & 0 & 1 & 1 \\ 1 & 2 & 5 & -5 \\ 0 & 0 & 3 & 0 \\ 0 & 0 & 1 & 3 \end{bmatrix}$. Then the sum of the geometric multiplicities of the distinct eigenvalues of A is equal to

Q.17	In a cosmopolitan city, the population comprises of 30% female and 70% male. Suppose that 5% of female and 30% of male in the population are foreigners. A person is selected at random from this population. Given that the selected person is a foreigner, the probability that the person is a female is (round off to three decimal places).





Q.18 – Q.21 Carry TWO marks Each

Q.18	Let $f: (0, \infty) \to \mathbb{R}$ be the continuous function such that $f(x) = 2 + \frac{g(x)}{x}$ for all $x > 0$, where $g(x) = \int_{1}^{x} f(t) dt$ for all $x > 0$. Then $f(2)$ is equal to
(A)	$2 + \log_e 2$
(B)	$2 - \log_e 2$
(C)	$2 + \log_e 4$
(D)	$2 - \log_e 4$

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	2022 Engineering Sciences XE
Q.19	Let A and B be $n \times n$ matrices with real entries.
	Consider the following statements:
	P: If A is symmetric then $rank(A)$ = Number of nonzero eigenvalues (counting multiplicity) of A.
	Q: If $AB = 0$ then $rank(A) + rank(B) \le n$.
	Then
(A)	both P and Q are TRUE
(B)	P is TRUE and Q is FALSE
(C)	P is FALSE and Q is TRUE
(D)	both P and Q are FALSE

Q.20	Let $f: \mathbb{R}^2 \to \mathbb{R}$ be given by $f(x, y) = 4xy - 2x^2 - y^4 + 1$. The number of critical points where <i>f</i> has local maximum is equal to

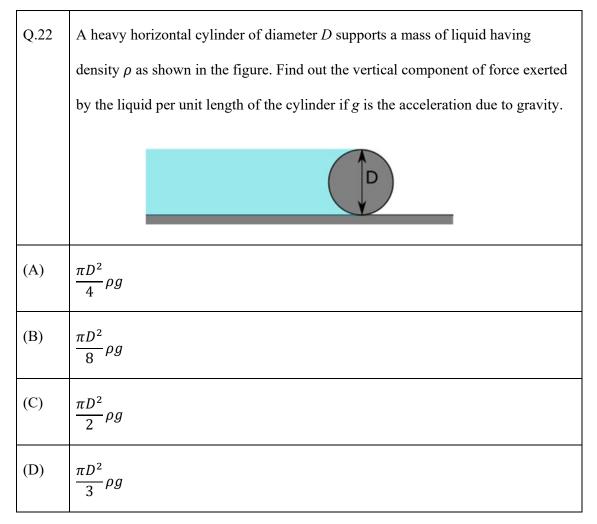


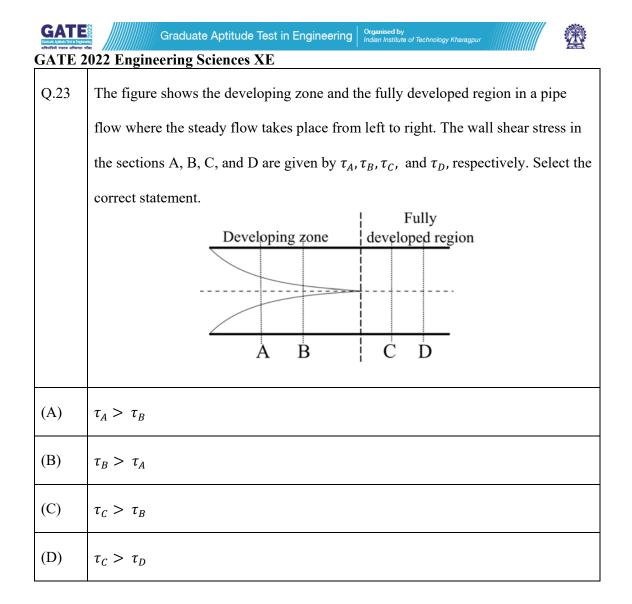
Q.21	If the quadrature rule
	$\int_{-1}^{1} f(x) dx \approx f(\alpha) + \gamma f(\beta),$
	where α, β and γ are real constants, is exact for all polynomials of degree ≤ 3 , then $\gamma + 3(\alpha^2 + \beta^2) + (\alpha^3 + \beta^3)$ is equal to





Fluid Mechanics: XE-B (Q.22 – Q.30 Carry ONE mark Each)





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GATE 2	2022 En	gineeri	ng Scie	ences XE					
Q.24	The let	The left hand column lists some non-dimensional numbers and the right hand							
	colum	n lists s	ists some physical phenomena. Indicate the correct combination						
		1.	Reyno	olds number		i.	Wave drag		
		2.	Froud	le number		ii.	Compressible flow		
		3.	Mach	number		iii.	Viscous drag		
		4.	Webe	r number		iv.	Spray formation		
(A)	1-iii,	2-i,	3-ii,	4-iv					
(B)	1-i,	2-ii,	3-iv,	4-iii					
(C)	1-iv,	2-iii,	3-iv,	4-iii					
(D)	2-iv,	1-iii,	3-ii,	4-i					





Q.25	As temperature increases
(A)	the dynamic viscosity of a gas increases.
(B)	the dynamic viscosity of a liquid decreases.
(C)	the dynamic viscosity of a liquid does not change.
(D)	the dynamic viscosity of a gas decreases.

Q.26	Which of the following statement(s) regarding a venturimeter is/are correct?
(A)	In the direction of flow, it consists of a converging section, a throat, and a diverging section.
(B)	In the direction of flow, it consists of a diverging section, a throat, and a converging section.
(C)	It is used for flow measurement at a very low Reynolds number.
(D)	Pressure tappings are provided just upstream of the venturimeter and at the throat.





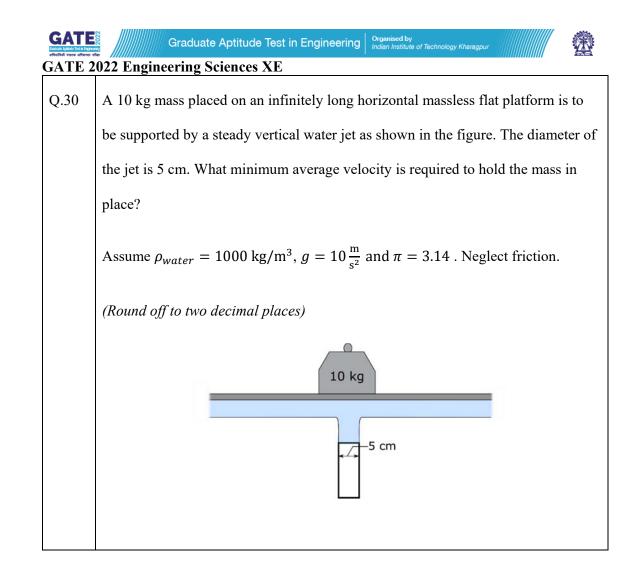
Q.27	Which of the following statement(s) is/are true for streamlines in a steady incompressible flow?
(A)	Two streamlines cannot intersect each other.
(B)	Flow rate increases between two diverging streamlines.
(C)	Flow rate decreases between two diverging streamlines.
(D)	Stream function has a constant value along a streamline.

Q.28	A flow has a velocity potential given by $\phi = Ax^3$ where 'A' is a non-zero constant. Which of the following statement(s) is/are true about the flow?
(A)	The flow is incompressible.
(B)	The flow is irrotational.
(C)	The flow has local acceleration.
(D)	The flow has convective acceleration.





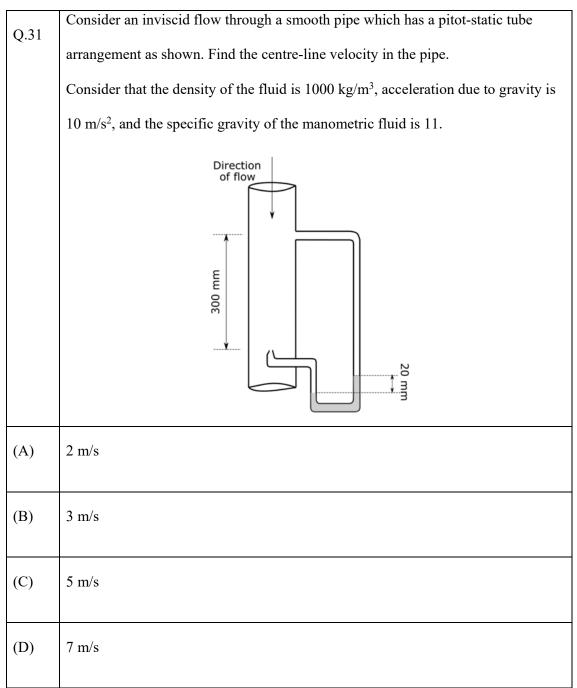
Q.29	A boundary layer develops due to a two-dimensional steady flow over a horizontal				
	flat plate. Consider a vertical line away from the leading edge which extends from				
	the wall to the edge of the boundary layer. Which of the following				
	quantity/quantities is/are not constant along the vertical line? u and v represent				
	the components of velocity in the direction along the plate and normal to it,				
	respectively and x is taken along the length of the plate while p is the pressure.				
	Neglect body forces.				
(A)	u				
(B)	$\frac{\partial u}{\partial x}$				
(C)	ν				
(D)	p				







GATE 2022 Engineering Sciences XE Q.31 – Q.43 Carry TWO marks Each





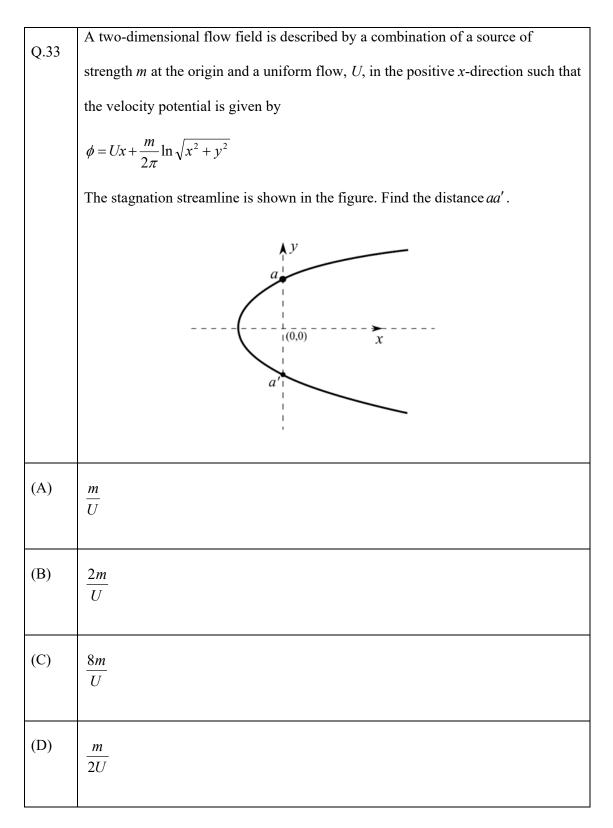


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GATE 2	022 Engineering Science	es XE

Q.32	The speed of propagation, c , of a capillary wave depends on the density of the
	fluid, ρ , the wavelength of the wave, λ , and the surface tension, σ . If the density
	and wavelength remain constant, halving the surface tension would lead to a new
	velocity, c' , given by
(A)	c' = 2c
(B)	$c' = \sqrt{2}c$
(C)	$c' = \frac{c}{\sqrt{2}}$
(D)	<i>c'</i> = <i>c</i>
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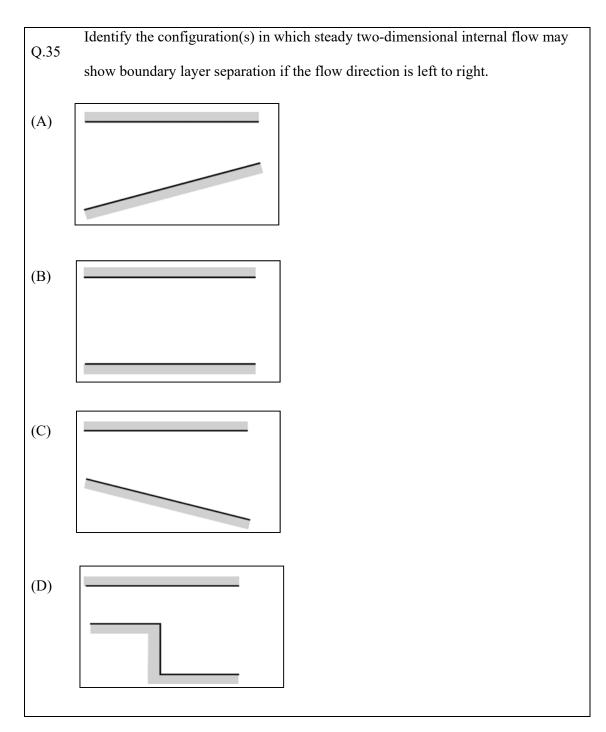




GATE 2	022 Engineering Sciences XE
Q.34	A typical boundary layer over a flat plate has a linear velocity profile with zero
	velocity at the wall and freestream velocity, U_{∞} , at the outer edge of the boundary
	layer. What is the ratio of the momentum thickness to the thickness of the
	boundary layer?
(A)	$\frac{1}{2}$
(B)	$\frac{1}{4}$
	/4
(C)	$\frac{1}{6}$
(-)	
(D)	$\frac{1}{3}$
·	/3











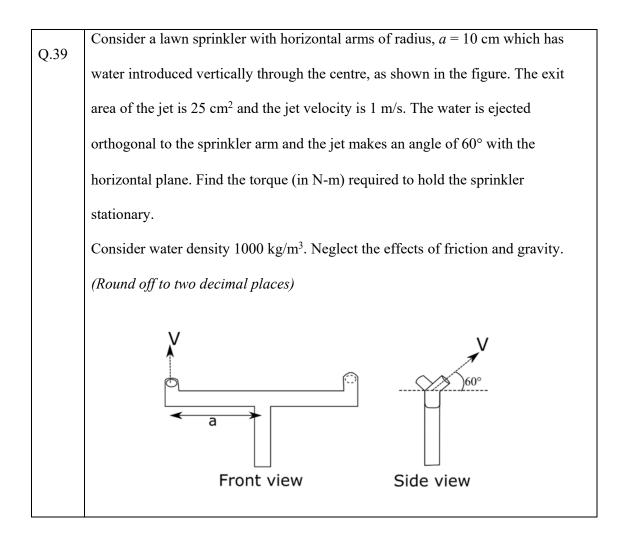
Q.36 Consider steady fully developed flow of a liquid through two large horizo			
	parallel plates separated by a distance of 2 mm. One of the plate is fixed and the		
	other plate moves at a speed of 0.5 m/s. What is the magnitude of the pressure		
	gradient (in Pa/m) in the direction of the flow required to ensure that the net flow		
	through the plates is zero?		
	Dynamic viscosity of the liquid is $5 \times 10^{-4} \text{ Ns/m}^2$		
	(Round off to the nearest integer)		

Q.37	Consider two-dimensional turbulent flow of air over a horizontal flat plate of
	length 1 m. Skin friction coefficient at a length x from the leading edge of the
	plate is obtained as:
	$c_f = \frac{0.06}{\left(\operatorname{Re}_x\right)^{0.2}}$
	where, Re_x is the local Reynolds number.
	Find out the drag force per unit width (in N/m^2) on the plate if the free stream air
	velocity is 10 m/s.
	Density and dynamic viscosity of air are given as 1.2 kg/m^3 and $1.83 \times 10^{-5} \text{ N-s/m}^2$,
	respectively.
	(Round off to three decimal places)





Q.38	For an inviscid fluid with density 1 kg/m ³ , the Cartesian velocity field is given as:
Q.50	$\mathbf{u} = (-2x + y)t\mathbf{i} + (2x + y)t\mathbf{j} \text{ m/s}$
	Neglecting the body forces, find the magnitude of pressure gradient in (Pa/m) at
	(x, y) = (1 m, 1 m) at $t = 1 s$.
	(Round off to two decimal places)

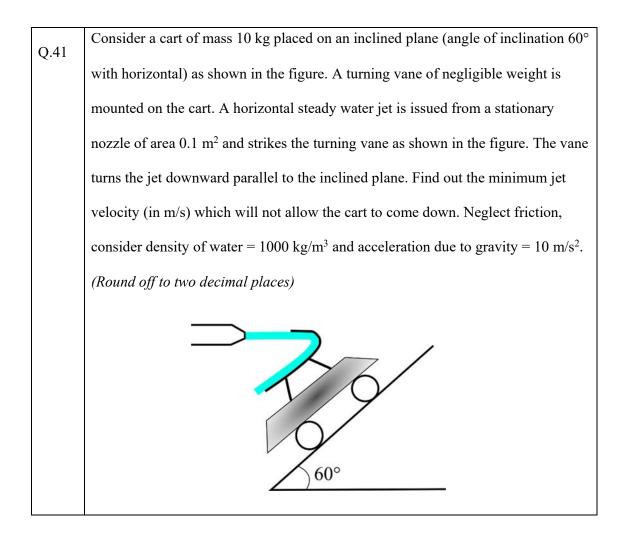


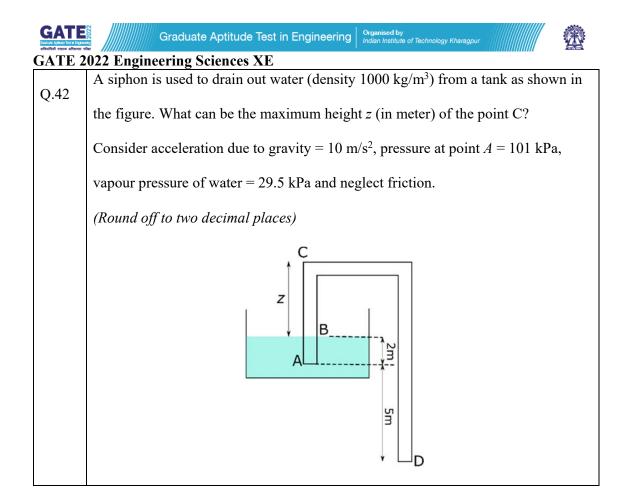


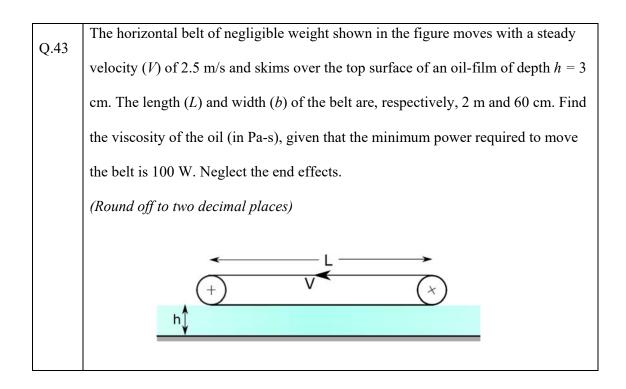


Q.40 A wooden cylinder (specific gravity = 0.6) of length L and diameter D floats in water (density 1000 kg/m³). Find out the minimum value of D/L for which the cylinder floats with its axis vertical.

(Round off to three decimal places)











GATE 2022 Engineering Sciences XE (Materials Science XE-C) Q.44 – Q.52 Carry ONE mark Each

<u>MCQ</u>

Q.44	Number of atoms per unit area of the (110) plane of a body centered cubic crystal, with lattice parameter ' a ', is
(A)	$\frac{1}{a^2}$
(B)	$\frac{\sqrt{2}}{a^2}$
(C)	$\frac{1}{\sqrt{3}a^2}$
(D)	$\frac{1}{\sqrt{2}a^2}$





GATE	2022 Engineering Sciences XE					
Q.45	Match the following materials with their corresponding bonding types.					
	Material	Bonding				
	P: Cu _{0.5} Al _{0.5}	1: Ionic				
	Q: ZnS	2: Covalent				
	R: Na ₂ O	3: Metallic				
	S: Li4SiO4	4: Mixed				
(A)	P - 4; Q - 2; R - 3; S - 1					
(B)	P - 3; Q - 4; R - 2; S - 1					
(C)	P - 3; Q - 2; R - 1; S - 4					
(D)	P - 3; Q - 1; R - 4; S - 2					





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GATE 2	022	Engin	eering	Sciences	XE

Q.46	In an ideal rubber, the primary factor responsible for elasticity up to small strains is				
(A)	Change in both enthalpy and entropy				
(B)	Change in enthalpy, but no change in the entropy				
(C)	No change in enthalpy, but change in the entropy				
(D)	Neither a change in enthalpy, nor a change in the entropy				





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Q.47	Which one of the following statements is true for an intrinsic semiconductor?	
(A)	Electrical conductivity increases with increasing temperature and pressure	
(B)	Electrical conductivity increases with increasing temperature and decreasing pressure	
(C)	Electrical conductivity increases with decreasing temperature and increasing pressure	
(D)	Electrical conductivity increases with decreasing temperature and pressure	



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GATE 2	2022 Engineering Sciences XE
Q.48	A differential scanning calorimetry (DSC) experiment tracks the heat flow into or out of a system as a function of temperature. If the experiments given in the options below are performed at 1 atmospheric pressure, then in which case will the DSC thermogram exhibit a spike, either upward or downward?
(A)	Heating 10 mg of pure Cu from 323 K to 673 K
(B)	Cooling pure water from 323 K to 278 K
(C)	Heating pure ice from 263 K to 284 K
(D)	Cooling a Pb-Sn alloy at the eutectic composition from 323 K to 273 K





GATE 2	GATE 2022 Engineering Sciences XE	
Q.49	Which one of the following solvent environments will likely result in swelling of solid polystyrene?	
(A)	0.1 M NaOH in H2O	
(B)	HCl (aq.) of pH = 6	
(C)	Distilled water	
(D)	Benzene	





GATE 2022 Engineering Sciences XE MSQ

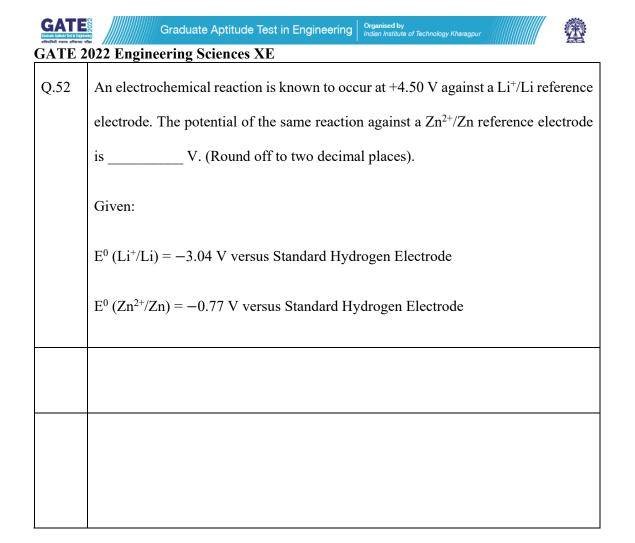
Q.50	Vickers microhardness (HV) of a ductile material A is higher than another ductile
	material B. Which of the following is/are true?
(A)	Young's modulus of A is greater than B
(B)	Yield strength of A is greater than B
(C)	Scratch resistance of A is greater than B
(D)	Ductility of A is greater than B





GATE 2022 Engineering Sciences XE NAT

Q.51	The enthalpy required to create an oxygen vacancy in CeO ₂ is 4 eV. The number
	of oxygen vacancies present per mole of CeO ₂ at 1000 K is
	(Round off to the nearest integer)
	Given:
	N_A : Avogadro's number = 6.02×10^{23} mole ⁻¹
	k_B : Boltzmann's constant = 8.62×10 ⁻⁵ eV/K







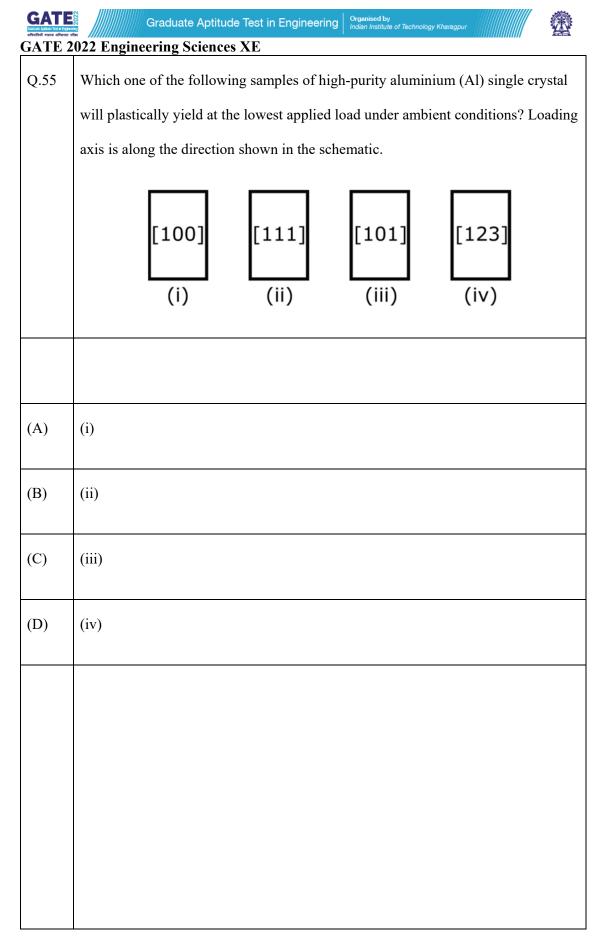
GATE 2022 Engineering Sciences XE Q.53 – Q.65 Carry TWO marks Each

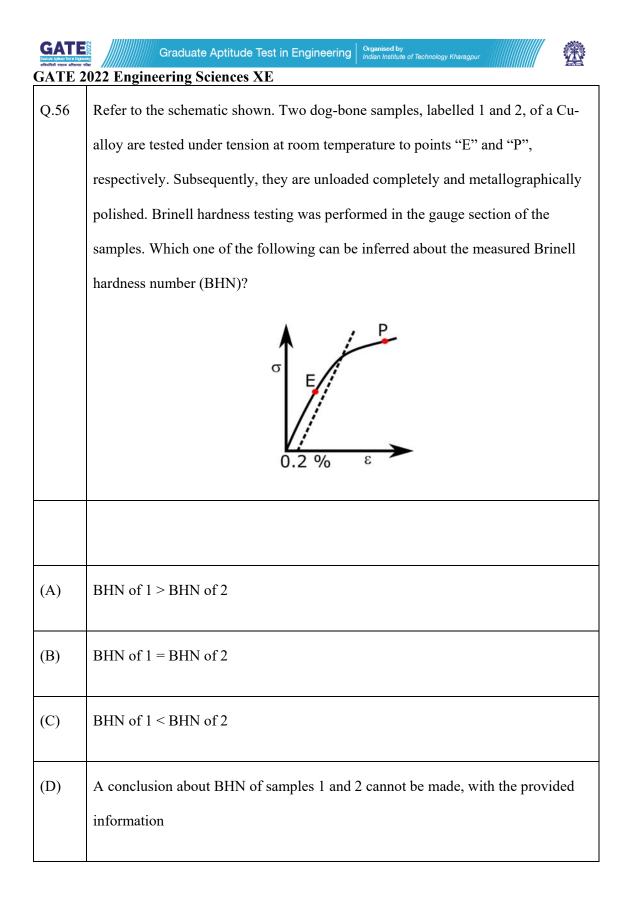
Q.53	For a binary system at constant pressure, there are two types of invariant reactions: (i) $\alpha \leftrightarrow \beta + \gamma$ (ii) $\alpha + \beta \leftrightarrow \gamma$
	Analogously, how many different types of invariant reactions may exist under variable temperature and pressure, for a binary system?
(A)	1
(B)	2
(C)	3
(D)	4





GATE 2	GATE 2022 Engineering Sciences XE		
Q.54	For a glass marginally below its glass transition temperature, which one of the following statements is true?		
(A)	Glass has higher enthalpy than both the corresponding crystalline and liquid phases		
(B)	Glass has lower enthalpy than both the corresponding crystalline and liquid phases		
(C)	Glass has higher entropy than the corresponding crystalline phase and lower entropy than the corresponding liquid phase		
(D)	Glass has lower entropy than the corresponding crystalline phase and higher entropy than the corresponding liquid phase		









GATE 2	2022 Engineering Sciences XE
Q.57	During the ageing of a homogenized Al-Cu alloy (1 to 4 wt.% Cu) below the GP zone solvus, hardness of the alloy:
(A)	increases monotonically
(B)	decreases monotonically
(C)	first increases and then decreases
(D)	first decreases and then increases





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GATE 2	GATE 2022 Engineering Sciences XE	
Q.58	A student aims to deposit a thin metallic film on SiO ₂ substrate, with an adhesion layer between the metal film and substrate, in a contiguous planar fashion. Island	
	type of growth must be avoided. The student performs an extensive optimization	
	exercise. Which one of the following steps is in the right direction?	
(A)	Choose a metallic adhesion layer with very low interfacial energy with the	
	deposited thin film	
(B)	Choose a metallic adhesion layer with very low interfacial energy with SiO ₂ ,	
	irrespective of its interaction with metal film to be deposited	
(C)	Increase the substrate temperature and decrease the deposition rate	
(D)	Use intermittent stages of deposition followed by annealing	





GATE 2022 Engineering Sciences XE MSQ

Q.59	For a diffusional transformation (i.e., growth of β precipitates in an α matrix),
	which of the following is/are true with increasing degree of undercooling?
(A)	Rate of transformation first increases and then decreases
(B)	Rate of transformation first decreases and then increases
(C)	Thermodynamic driving force increases monotonically
(D)	Mobility of atoms in α matrix remains unchanged





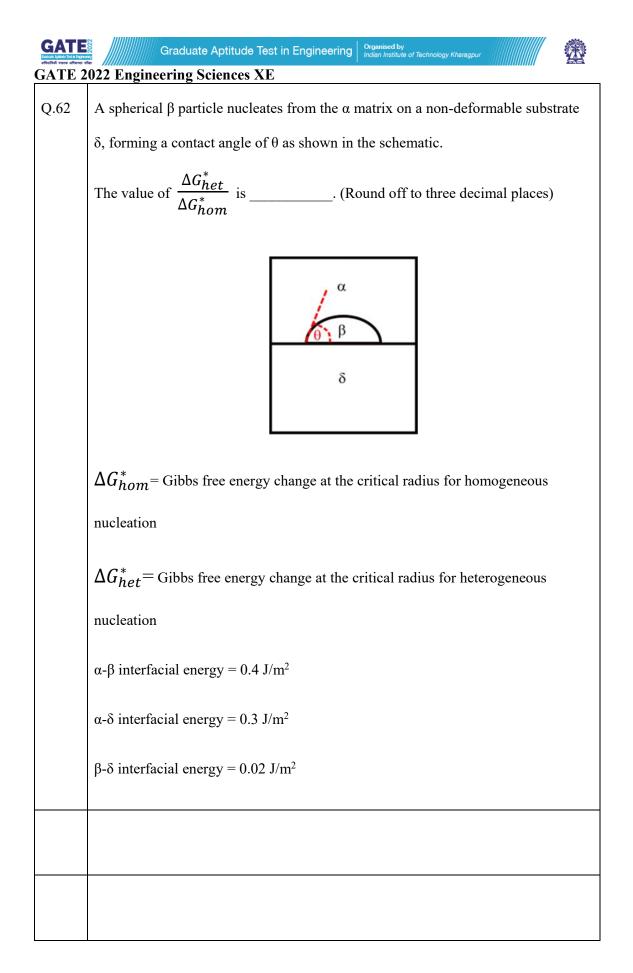
GATE 2022 Engineering Sciences XE NAT

Q.60	A two-phase $(\alpha + \beta)$ mixture of an A-B binary system has the following properties:
	(i) Phase α has equal weight percentages of A and B.
	(ii) Phase β has twice the mole fraction of A compared to B.
	(iii) The two-phase mixture has equal amounts of α and β .
	(iv) Atomic mass of A is twice that of B.
	The mole fraction of A in the resultant two-phase mixture is
	(Round off to one decimal)





GATE 2	2022 Engineering Sciences XE
Q.61	It is known that component A diffuses into a solid to a depth of 10 μ m in 1 hour at
	300 K. Treat diffusion in one dimension. The time taken for A to diffuse to the same
	depth at 600 K is seconds. (Round off to 1 decimal).
	Diffusivity of A in the solid is given by
	$D_A = D_A^0 \exp\left(-\frac{E_a}{k_B T}\right)$
	D_A^0 : Diffusivity coefficient
	E_a : Activation energy = 0.3 eV
	k_B : Boltzmann's constant = 8.62×10 ⁻⁵ eV/K
	<i>T</i> : Absolute temperature
1	



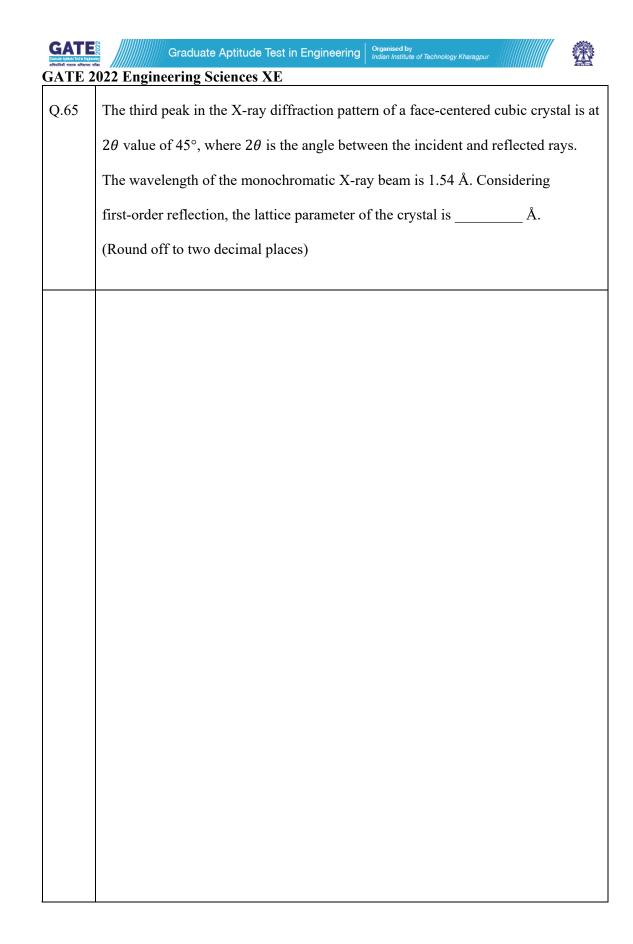




022 Engineering Sciences XE
The resistivity of a pure semiconductor at 298 K is 3000 $\Omega m.$ Assume that the
number of electrons excited (n_e) across the band gap is given by the relation
$n_e = N_A \exp\left(-\frac{E_g}{k_B T}\right)$
N_A : Avogadro's number = 6.02×10^{23} mole ⁻¹
k_B : Boltzmann's constant = 8.62×10 ⁻⁵ eV/K
<i>T</i> : Absolute temperature
Mobility of electrons in the semiconductor = $0.14 \text{ m}^2/(\text{V s})$
Mobility of holes in the semiconductor = $0.06 \text{ m}^2/(\text{V s})$
Absolute charge of an electron = 1.60×10^{-19} C
The band gap (E_g) of the semiconductor is eV.
(Round off to two decimals)



Q.64 A new glass material is developed to minimize the transmission of the light
through the window with glass panel of thickness 5 mm. The refractive index of
the glass material is 1.5 and the absorption coefficient can be changed from
0.3 cm⁻¹ to 1 cm⁻¹. In the given range of absorption coefficients, the ratio of the
maximum to the minimum fraction of the light coming out of the other side of the
glass panel is _____. (Round off to two decimal places)







GATE 2022 Engineering Sciences XE Solid Mechanics XE-D (Q.66 – Q.74 Carry ONE mark Each)

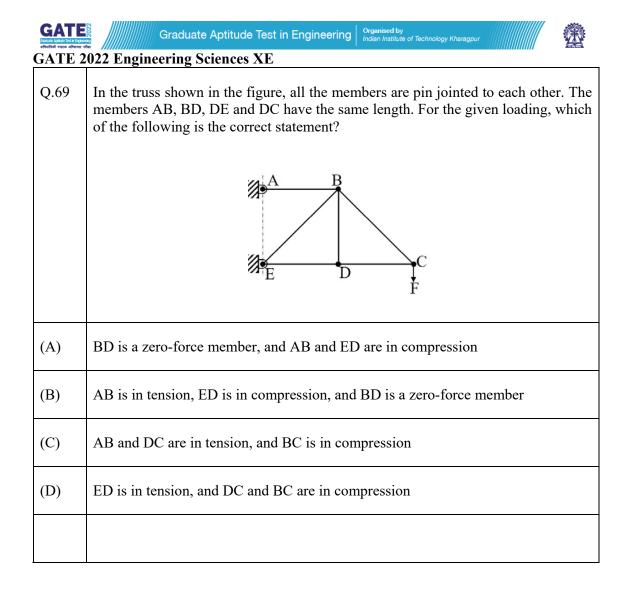
Q.66	A force F is applied at an angle $\theta = 30^{\circ}$ on an elastic column as shown in the figure. E and I are respectively the Young's modulus and area moment of inertia. The smallest magnitude of F needed to cause buckling is
(A)	$\frac{2}{\sqrt{3}}\frac{\pi^2 EI}{L^2}$
(B)	$\frac{\sqrt{3}}{2}\frac{\pi^2 EI}{L^2}$
(C)	$\frac{\pi^2 EI}{2L^2}$
(D)	$\frac{2\pi^2 EI}{L^2}$



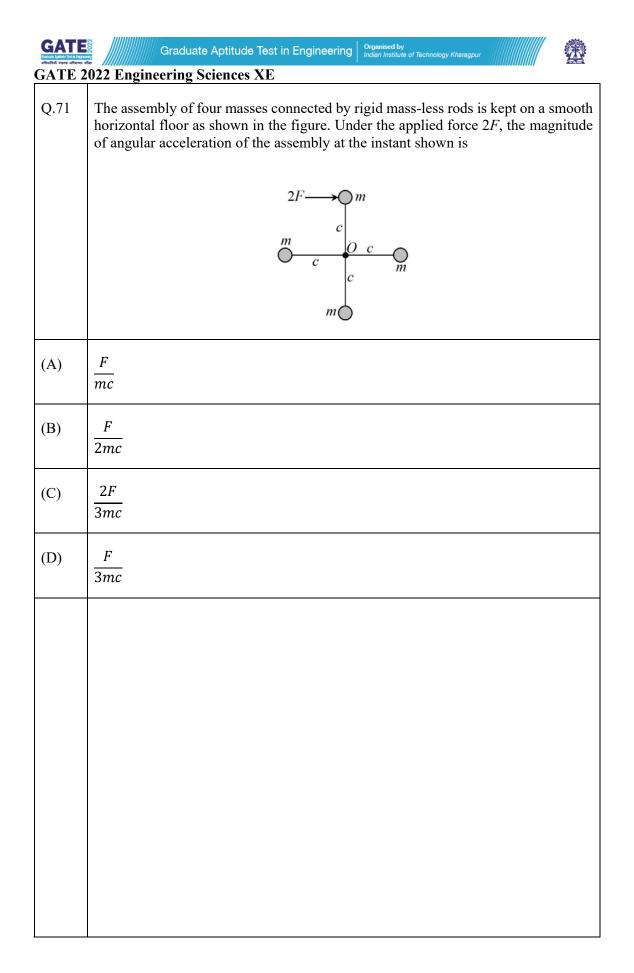


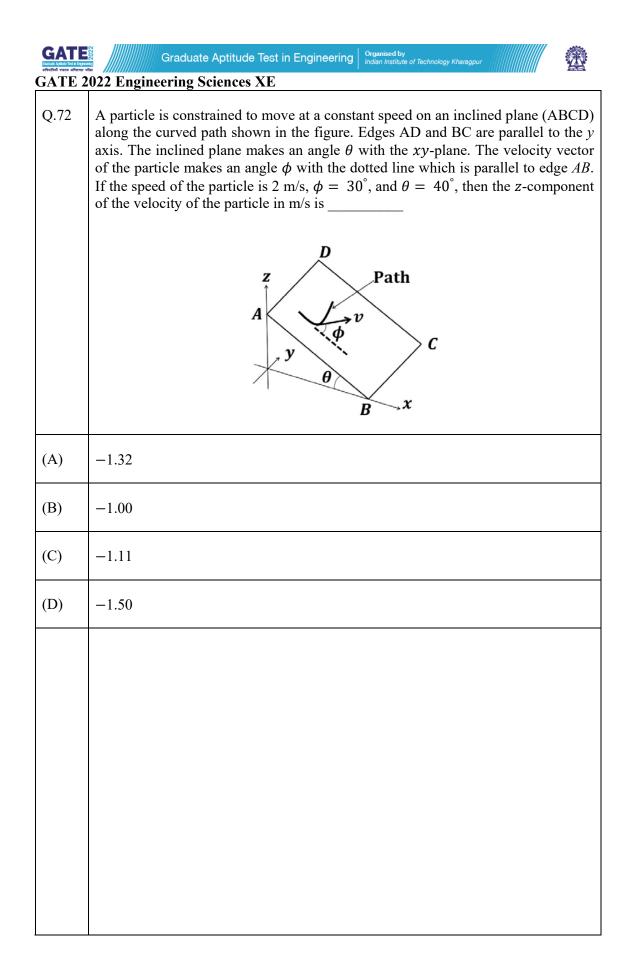
Q.67	The shear stress due to a transverse shear force in a linear elastic isotropic beam of rectangular cross-section
(A)	varies linearly along the depth in the transverse direction of the beam
(B)	is zero at the neutral axis
(C)	is maximum at the neutral axis
(D)	remains constant along the depth in the transverse direction of the beam

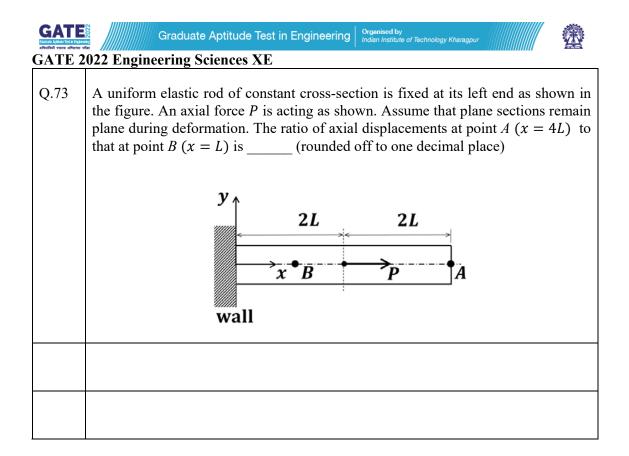
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Q.68	A massless semicircular rod held fixed at end A is in the xy -plane, as shown in the figure. A force P along the negative z direction is acting at point B on the rod. The unit vectors along x , y and z directions are denoted respectively as i , j and k . Due to the applied force P , the cross-section of the rod at point D will be subjected to
	$A \bullet O \\ C \to x$
(A)	a twisting moment $PR(1 - \cos \theta)$ i , a bending moment $PR \sin \theta$ j , and a shear force $-P$ k
(B)	a twisting moment $PR(1 - \sin \theta)$ i , a bending moment $PR \cos \theta$ j , and a shear force P k
(C)	a twisting moment $PR(\cos \theta - 1)$ i, a bending moment $-PR \sin \theta$ j, and a shear force $-P$ k
(D)	a twisting moment <i>PR</i> sin θ i , a bending moment <i>PR</i> (1 - cos) θ j , and a shear force <i>P</i> k



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Q.70	End <i>B</i> of the 2 m long rigid rod <i>AB</i> is constrained to move horizontally in the slot as shown in the figure and has a velocity of 1.0 i m/s. The angular velocity of the rod at the instant shown is 2 rad/s. The unit vectors along <i>x</i> and <i>y</i> directions are denoted respectively as i and j. The velocity of point <i>A</i> in m/s is then given by $\frac{y}{\omega} = 2 \text{ rad/s}$ Slot
(A)	$(1-2\sqrt{3})\mathbf{i}+2\mathbf{j}$
(B)	$(1+2\sqrt{3})\mathbf{i}-2\mathbf{j}$
(C)	$-2\sqrt{3}\mathbf{i} + 2\mathbf{j}$
(D)	$2\sqrt{3}i - 2j$







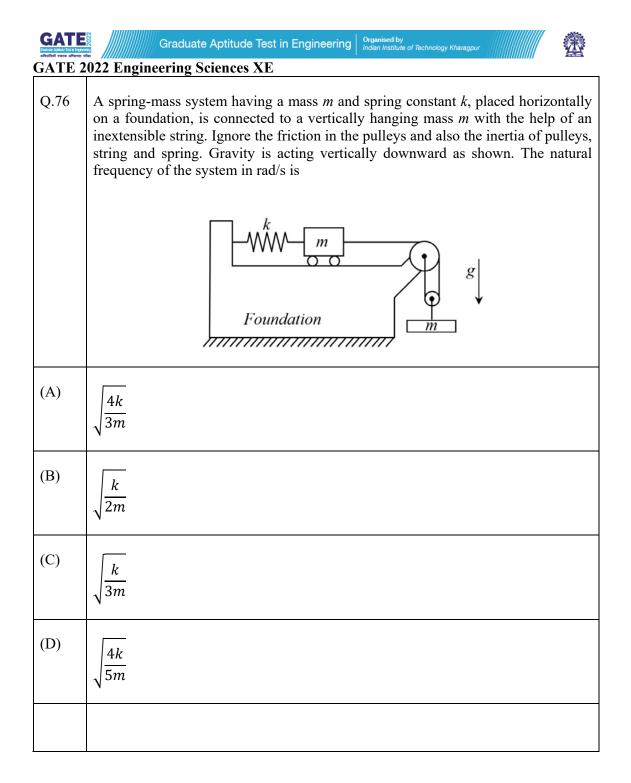
Q.74	A thin-walled spherical pressure vessel has a mean radius of 500 mm and wall thickness of 10 mm. The yield strength of the material is 500 MPa. The internal pressure in MPa at which the spherical pressure vessel will yield according to the Tresca criterion is (rounded off to one decimal place)	

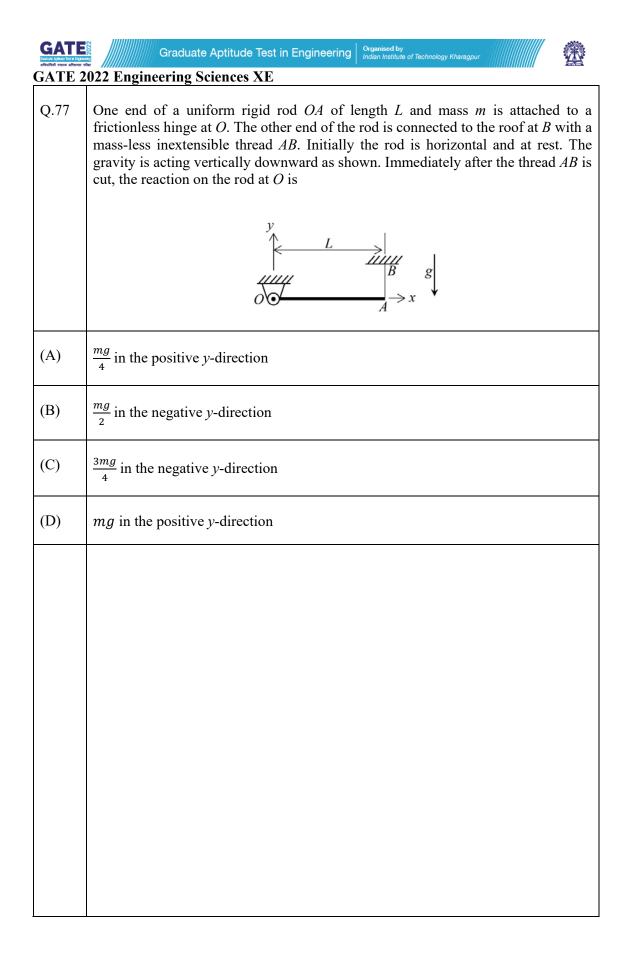


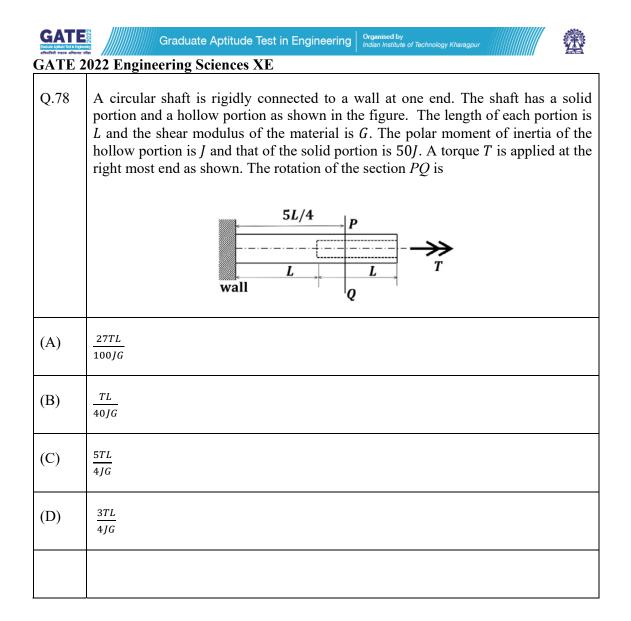


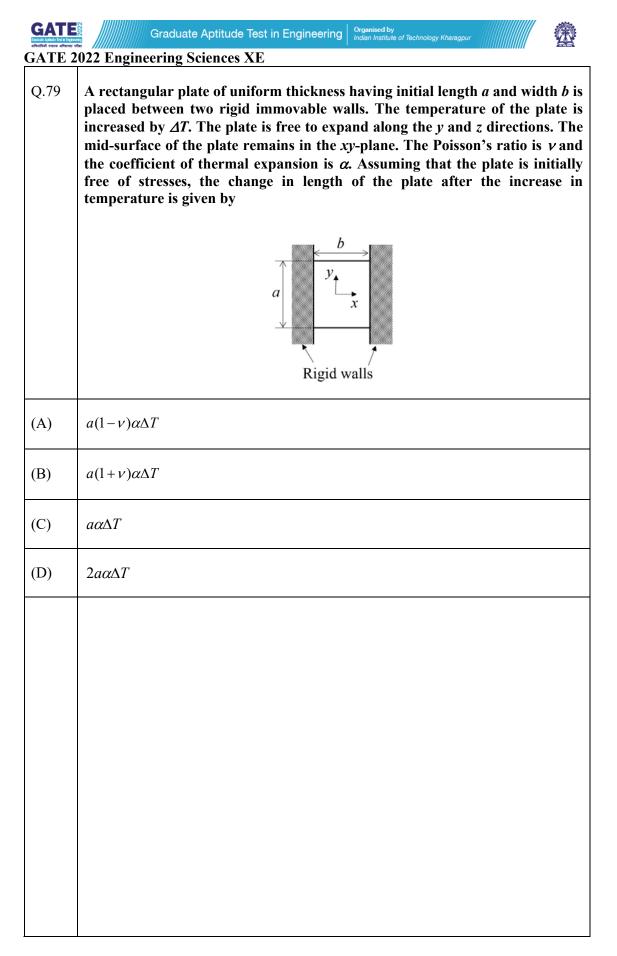
GATE 2022 Engineering Sciences XE Q.75 – Q.87 Carry TWO marks Each

Q.75	The beam in the figure is subjected to a moment M_0 at mid span as shown. Which of the following is the vertical reaction at B?
	$A \xrightarrow{L/2} B \xrightarrow{L/2} B$
(A)	$\frac{9M_0}{8L}$
(B)	$\frac{15M_0}{8L}$
(C)	$\frac{3M_0}{4L}$
(D)	$\frac{9M_0}{4L}$

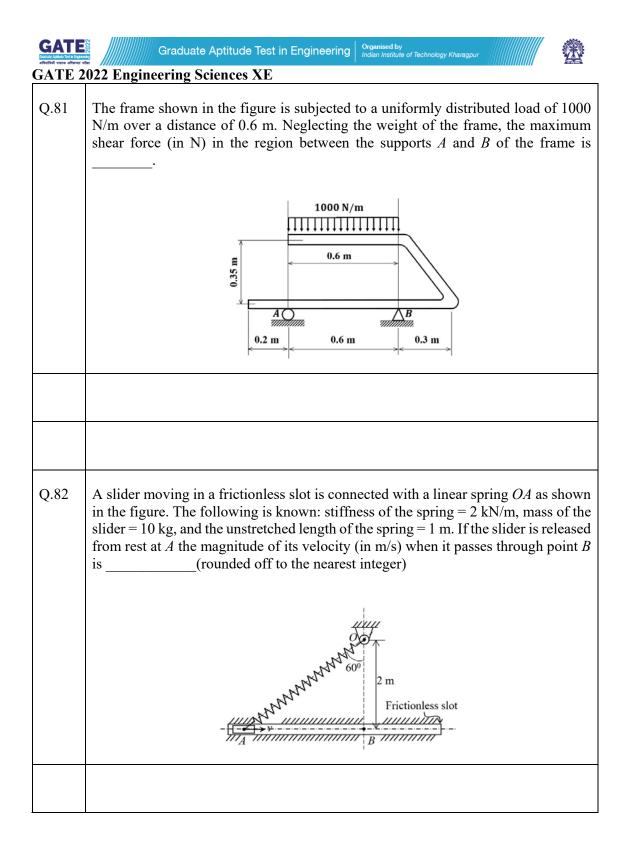








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GATE 2	GATE 2022 Engineering Sciences XE	
Q.80	A mass $m = 10$ kg is attached to a spring as shown in the figure. The coefficient of friction between the mass and the inclined plane is 0.25. Assume that the acceleration due to gravity is 10 m/s ² and that static and kinematic friction coefficients are the same. Equilibrium of the mass is impossible if the spring force is	
	$\begin{array}{c} k \\ m \\$	
(A)	30 N	
(B)	45 N	
(C)	60 N	
(D)	75 N	



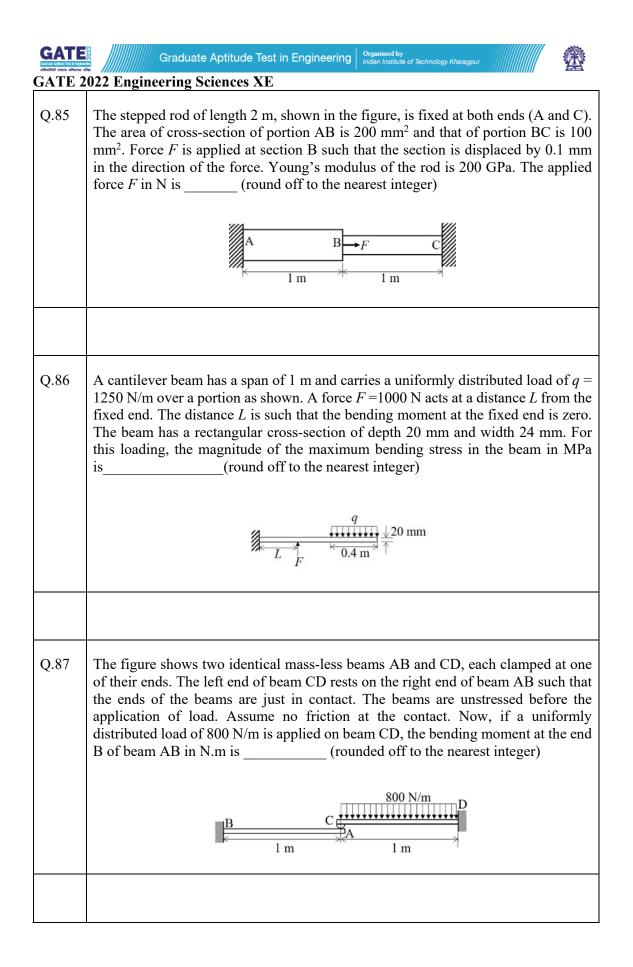




GATE 2022 Engineering Sciences XE

Q.83	A sphere A of mass m is thrown into the air at 50 m/s along a direction $\tan^{-1}(3/4)$ up from the horizontal. At the topmost point of its trajectory, it has a central (non-oblique) collision with another sphere B which is at rest on top of a vertical pole. Sphere B has a mass of 3m. Acceleration due to gravity is 10 m/s ² . Neglect contact friction and air-resistance. If the coefficient of restitution is 0.3, then the speed (in m/s) of sphere A immediately after the collision is (rounded off to one decimal place)

Q.84	The truck shown in the figure is moving on a horizontal road at a speed of 20 m/s. It is carrying a box of mass 1000 kg, which is simply placed on the truck platform. The coefficient of friction between the truck platform and the box is 0.25. Take acceleration due to gravity as 10 m/s ² . Assume uniform deceleration during braking, and the coefficients of static and kinetic friction to be the same. The shortest distance in meters in which the truck can be brought to rest without the box slipping is(round off to the nearest integer)
	Box 20 m/s







GATE 2022 Engineering Sciences XE Thermodynamics XE (E) Q.88 – Q.96 Carry ONE mark each

Q.88	The energy equation for a reversible non-flow process can be expressed as $\delta q = du + pdv$, where q is the heat transfer per unit mass, u is the internal energy per unit mass, p is the pressure, and v is the mass specific volume. This energy equation is not in exact differential form. It can be made exact differential by multiplying with the following integrating factor: (T is the absolute temperature)
(A)	$\frac{1}{p}$
(B)	$\frac{1}{v}$
(C)	$\frac{1}{T}$
(D)	$\frac{1}{uT}$

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GATE 2	2022 Engineering Sciences XE
Q.89	An air standard Diesel cycle consists of four processes: 1-2 (isentropic compression), 2-3 (constant pressure heat addition), 3-4 (isentropic expansion) and 4-1 (constant volume heat rejection). T_4 is the temperature (in K) attained at the end of isentropic expansion (3-4) before constant volume heat rejection. The constant volume heat rejection process (4-1) is replaced by a constant pressure heat rejection process (4a-1) such that T_{4a} is the temperature (in K) reached at the end of isentropic expansion (3-4a), and the state point 1 remains the same. Then
(A)	$T_{4a} < T_4$
(B)	$T_{4a} > T_4$
(C)	$T_{4a} = T_4$
(D)	$T_{4a} = 2T_4$





2022 Engineering Sciences XE
Gas in a cylinder-piston device expands from state 1 (p_1, V_1, T_1) to state 2 (p_2, V_2, T_2) . The expansion process is polytropic, i.e., $pV^n = \text{constant}, n \neq 1$. Assuming the ideal gas behaviour, the expression for the work done, W by the system is given by
$W = p_1 V_1 \ln\left(\frac{T_2}{T_1}\right)$
$W = \frac{p_2 V_2 - p_1 V_1}{1 - n}$
$W = p_1 V_1 \ln\left(\frac{V_1}{V_2}\right)$
$W = p_2 V_2 \ln\left(\frac{p_2}{p_1}\right)$



GATE 2	2022 Engineering Sciences XE
Q.91	The temperature of the working fluid in a real heat engine cycle changes during heat addition and heat rejection processes. The maximum and minimum temperatures of the cycle are T_{max} and T_{min} , respectively. If η_c is the thermal efficiency of a Carnot engine operating between these temperature limits, then the thermal efficiency, η of the real heat engine satisfies the relation
(A)	$\eta > \eta_c$
(B)	$\eta < \eta_c$
(C)	$\eta = \eta_c$
(D)	$\eta = 1 + \eta_C$
Q.92	A 1.2 m ³ rigid vessel contains 8 kg of saturated liquid-vapor mixture at 150 kPa. The specific enthalpy of this mixture is kJ/kg (<i>round off to 2 decimal places</i>).
	At 150 kPa: $v_f = 0.001053 \text{ m}^3/\text{kg}$, $v_g = 1.1594 \text{ m}^3/\text{kg}$
	$h_f = 467.13 \text{ kJ/kg}, h_g = 2693.1 \text{ kJ/kg}$
Q.93	Air in a closed system undergoes a thermodynamic process from an initial temperature of 300 K to the final temperature of 400 K. The specific heat of air at constant volume, c_v varies linearly with the temperature, T (in K) as
	$c_v = (0.7 + 0.27 \times 10^{-3} T) \text{ kJ/(kg K)}.$
	Change in the specific internal energy of the air in the system is kJ/kg (<i>round off to 2 decimal places</i>).





Q.94	A vertical cylinder-piston device contains a fixed mass of gas in equilibrium. The cross-sectional area of the piston is 0.05 m^2 . For 150 kPa pressure of the gas in the cylinder, the mass of the piston is kg (<i>round off to 2 decimal places</i>). Assume that the atmospheric pressure is 100 kPa and the acceleration due to gravity is 9.81 m/s ² .
Q.95	A steam power plant operates on Rankine cycle. At certain operating condition of the plant, there is a reduction of 20% net work output (kJ/kg) as compared to 100% capacity. This reduction will cause the specific steam consumption (kg/kJ) to increase by% (<i>in integer</i>).
Q.96	A Carnot heat pump extracts heat from the environment at 250 K, and supplies 6 kW of heat to a room which is maintained at a constant temperature T_H . The heat pump requires a power input of 1 kW for its operation. Then, the temperature of the room T_H is K (round off to nearest integer).





GATE 2022 Engineering Sciences XE Q.97 – Q.109 Carry TWO marks each

Q.97	One of the Maxwell equations is expressed as $\left(\frac{\partial s}{\partial v}\right)_T = \left(\frac{\partial p}{\partial T}\right)_v$, where <i>s</i> is the entropy per unit mass, <i>v</i> is the mass specific volume, <i>p</i> is the pressure, and <i>T</i> is the temperature. In this expression, <i>s</i> is a continuous function of <i>T</i> and <i>v</i> . The derivatives of <i>s</i> are also continuous. Let c_v be specific heat capacity at constant volume for a gas. Then, $\left(\frac{\partial c_v}{\partial v}\right)_T$ can be written as
(A)	$\frac{p}{T} \left(\frac{\partial^2 p}{\partial T^2} \right)_{\nu}$
(B)	$\frac{v}{T} \left(\frac{\partial^2 p}{\partial v^2} \right)_T$
(C)	$T\left(\frac{\partial^2 p}{\partial T^2}\right)_{v}$
(D)	$\frac{1}{T} \left(\frac{\partial^2 p}{\partial v^2} \right)_T$

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GATE 2	022 Engineering Sciences XE
Q.98	The general relation among the properties x, y and z at any state point can be expressed as $\left(\frac{\partial x}{\partial y}\right)_z \left(\frac{\partial y}{\partial z}\right)_x \left(\frac{\partial z}{\partial x}\right)_y = -1$. If p, T and h are continuous functions and
	$c_p = \left(\frac{\partial h}{\partial T}\right)_p$, μ is the Joule-Thomson coefficient, then $\left(\frac{\partial h}{\partial p}\right)_T$ is
(A)	$-\mu c_p$
(B)	c _p T
(C)	$-\frac{c_p}{T}$
(D)	μc_p

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GATE 2	022 Engineering Sciences XE
Q.99	An air-conditioning system consists of an insulated rigid mixing chamber designed to supply air at 24 °C to a building. The mixing chamber mixes two air streams: (i) a cold air stream at 10 °C and mass flow rate \dot{m}_c (kg/s), and (ii) a stream of fresh ambient air at 30 °C and mass flow rate \dot{m}_a (kg/s). Assume air to be an ideal gas with constant specific heat ($c_p = 1.005$ kJ/(kg K), $\gamma = c_p / c_v = 1.4$). Neglect change in kinetic and potential energies as compared to change in enthalpy. Under the steady state condition, the ratio of the mass flow rates of the two streams (\dot{m}_c / \dot{m}_a) is
(A)	$\frac{7}{3}$
(B)	$\frac{3}{7}$
(C)	$\frac{2}{7}$
(D)	$\frac{4}{7}$





Q.100	An ideal gas mixture consists of 80% N_2 and 20% O_2 on mass basis. If the total pressure is 300 kPa, then the partial pressure of N_2 (in kPa) is
	(Molecular weights of $N_2 = 28 \text{ kg/kmol}$ and $O_2 = 32 \text{ kg/kmol}$)
(A)	246.15
(B)	230.34
(C)	254.78
(D)	213.54
Q.101	On the basis of the ideal gas equation and van der Waals equation, the temperatures of a gas at pressure 10 MPa and specific volume 0.005 m ³ /kg would be, respectively
	(Assume gas constant $R = 0.3$ kJ/(kg K), $a = 0.18$ m ⁶ kPa/kg ² and $b = 0.0014$ m ³ /kg)
	(Assume gas constant $R = 0.3$ kJ/(kg K), $a = 0.18$ m ⁶ kPa/kg ² and $b = 0.0014$ m ³ /kg)
(A)	(Assume gas constant $R = 0.3$ kJ/(kg K), $a = 0.18$ m ⁶ kPa/kg ² and $b = 0.0014$ m ³ /kg) 166.67 K and 235.89 K
(A) (B)	
	166.67 K and 235.89 K
(B)	166.67 K and 235.89 K 166.67 K and 206.40 K
(B) (C)	166.67 K and 235.89 K 166.67 K and 206.40 K 166.67 K and 267.21 K





Q.102	An ideal Brayton cycle operates between maximum and minimum temperatures of T_3 and T_1 , respectively. For constant values of T_3 and T_1 , the pressure ratio (r_p) for maximum work output is $(\gamma \text{ is the specific heat ratio of air})$
	(γ is the specific heat ratio of air)
(A)	$\left(\frac{T_3}{T_1}\right)^{\frac{\gamma}{(\gamma-1)}}$
(B)	$\left(\frac{T_3}{T_1}\right)^{\frac{2\gamma}{(\gamma-1)}}$
(C)	$\left(\frac{T_3}{T_1}\right)^{\frac{\gamma}{2(\gamma-1)}}$
(D)	$\left(\frac{T_3}{T_1}\right)^{\frac{2}{(\gamma-1)}}$
Q.103	An insulated rigid tank of volume 10 m ³ contains air initially at 1 MPa and 600 K. A valve connected to the tank is opened, and air is allowed to escape until the temperature inside the tank drops to 400 K. The temperature of the discharged air can be approximated as the average of the initial and final temperatures of the air in the tank. Neglect kinetic and potential energies of the discharged air. Assume that air behaves as an ideal gas with constant specific heat so that internal energy $u = c_v T$ and enthalpy $h = c_p T$. Then, the final pressure of the air in the tank is MPa (<i>round off to 2 decimal places</i>). Assume $c_p = 1.005 \text{ kJ/(kg K)}$, $\gamma = c_p / c_v = 1.4$

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GATE 2	022 Engineering Sciences XE
Q.104	Steam enters a steam turbine at 5 MPa and 600 °C, and exits as saturated vapor at 50 kPa. Under steady state condition, the turbine loses heat to the surroundings at the rate of 50 kJ per kilogram of steam flowing through the turbine. The ambient temperature is 300 K, and the heat transfer to the surroundings takes place at the outer surface of the turbine at a temperature of 450 K. The irreversibility per unit mass of steam flowing through the turbine is kJ/kg (<i>round off to 2 decimal places</i>).
	following property values:
	Superheated steam at 5 MPa, 600 °C $v = 0.07870 \text{ m}^3/\text{kg}, u = 3273.3 \text{ kJ/kg}, h = 3666.9 \text{ kJ/kg}, s = 7.2605 \text{ kJ/(kg K)}$
	Saturated vapour at 50 kPa
	$v_g = 3.2403 \text{ m}^3/\text{kg}, u_g = 2483.2 \text{ kJ/kg}, h_g = 2645.2 \text{ kJ/kg}, s_g = 7.5931 \text{ kJ/(kg K)}$
Q.105	A heat engine receives heat at 1000 K and rejects heat to the environment at 300 K. The efficiency of the heat engine is half of the efficiency of a Carnot engine operating between the above mentioned temperature limits. The work output from the heat engine is completely used to drive a refrigerator that steadily removes heat from a cold space at 260 K at a rate of 5.2 kW, and rejects the heat to the same environment at 300 K. The COP (coefficient of performance) of the refrigerator is half of the COP of the Carnot refrigerator operating between the same temperature limits as that of the refrigerator. Then, rate of heat supplied to the heat engine is <u>kW</u> (<i>round off to 2 decimal places</i>).
Q.106	A room contains air at 25 °C, 100 kPa and 80% relative humidity. If the saturation pressure of water vapor at 25 °C is 3.1698 kPa, then the specific humidity of air is kg of water vapor / kg of dry air (<i>round off to 4 decimal places</i>).

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GATE 2	022 Engineering Sciences XE
Q.107	An insulated rigid container is divided into two parts by a thin partition. One part of the container contains 6 kg of saturated liquid-vapor mixture with a dryness fraction of 0.7 at 0.3 MPa. The other part contains 12 kg of saturated liquid at 0.6 MPa of the same substance. When the partition is removed and the system attains equilibrium, the final specific volume of the mixture is m ³ /kg (<i>round off to 2 decimal places</i>).
	Use the following property values:
	At 0.3 MPa : $v_f = 0.001073 \text{ m}^3/\text{kg}$, $v_g = 0.60582 \text{ m}^3/\text{kg}$
	At 0.6 MPa : $v_f = 0.001101 \text{ m}^3/\text{kg}$, $v_g = 0.31560 \text{ m}^3/\text{kg}$
Q.108	During a steady state air-conditioning process, air enters a heating section at 15 °C with 40% relative humidity and leaves at 30 °C. Assuming the heating process takes place at 100 kPa, the relative humidity of the air at exit is% (<i>round off to nearest integer</i>). Saturation pressures of water vapor at 15 °C and 30 °C are 1.7057 kPa and 4.2469 kPa respectively.
Q.109	Steam enters a steam turbine at 10 MPa and 600 °C with a mass flow rate of 16 kg/s. The steam exits the turbine as saturated vapor at 10 kPa. Under steady state condition, the turbine generates 16.2 MW power. If the ambient temperature is 25 °C, the rate of entropy generation in the turbine is kW/K (<i>round off to 2 decimal places</i>).
	Neglect the change in kinetic and potential energies of the steam, and use the following property values:
	Superheated steam at 10 MPa, 600 °C $v = 0.03837 \text{ m}^3/\text{kg}, u = 3241.68 \text{ kJ/kg}, h = 3625.34 \text{ kJ/kg}, s = 6.9028 \text{ kJ/(kg K)}$
	<u>Saturated vapour at 10 kPa</u> $v_g = 14.67355 \text{ m}^3/\text{kg}, u_g = 2437.89 \text{ kJ/kg}, h_g = 2584.63 \text{ kJ/kg}, s_g = 8.1501 \text{ kJ/(kg K)}$





Polymer Science and Engineering XE-F (Q.110 – Q.118 Carry ONE mark Each)

Q.110	Interfacial polymerization can be used to prepare	
(A)	Nylon 6	
(B)	Nylon 66	
(C)	Polyacrylonitrile	
(D)	Poly(butyl acrylate)	
Q.111	In a rubber sample with a Mooney viscosity of 60 ML(1+4) 100 °C, the number 4 signifies	
(A)	Applied shear rate in s ⁻¹	
(B)	Number of samples tested	
(C)	Time in minutes after starting the motor when the measurement is taken	
(D)	Preheating time in minutes	
Q.112	The initiator system which can be used for free radical polymerization at 5 °C is	
(A)	FeSO ₄ + <i>t</i> -butyl hydroperoxide	
(B)	Azobisisobutyronitrile	
(C)	Potassium persulfate	
(D)	Benzoyl peroxide	





GATE 2	022 Engineering Sciences XE		
Q.113	Weather resistance of high impact polystyrene can be improved by blending polystyrene with		
(A)	Styrene butadiene rubber		
(B)	Natural rubber		
(C)	Ethylene propylene rubber		
(D)	Nitrile rubber		
Q.114	Which of the following is a discontinuous polymer processing operation?		
(A)	Calendering		
(B)	Extrusion		
(C)	Film blowing		
(D)	Thermoforming		
Q.115	The blend of polyethylene and polypropylene is		
(A)	Immiscible due to enthalpic constraints		
(B)	Immiscible due to entropic constraints		
(C)	Miscible as they are polyolefins		
(D)	Miscible due to comparable solubility parameters		





GATE 2	0022 Engineering Sciences XE	
Q.116	Toughness in a polymer can be inferred from	
(A)	Izod impact strength	
(B)	Depth of indentation	
(C)	Area under the stress-strain curve	
(D)	Charpy impact strength	
Q.117	Which of the following polymers are polyesters?	
(A)	Poly(acrylic acid)	
(B)	Poly(lactic acid)	
(C)	Polyhydroxybutyrate	
(D)	$Poly(\varepsilon$ -caprolactone)	
Q.118	The functionality of adipic acid for condensation reaction with glycerol is (<i>in integer</i>).	





GATE 2022 Engineering Sciences XE Q.119 – Q.131 Carry TWO marks Each

Q.119	From the dynamic mechanical analysis of a polymer sample with a phase angle of 30°, the relationship between storage modulus (E') and loss modulus (E'') can be expressed as	
(A)	$E' = \sqrt{3} E''$	
(B)	$2E' = \sqrt{3} E''$	
(C)	$E'' = \sqrt{3} E'$	
(D)	$2E'' = \sqrt{3} E'$	
Q.120	Match the properties in Column A with their re	espective unit in Column B
	Column A	Column B
	P. Surface resistivity	1. Ohm-cm
	Q. Volume resistivity	2. S cm ⁻¹
	R. Coefficient of thermal expansion	3. Ohm
	S. Electrical conductivity	4. K ⁻¹
(A)	P-1; Q-3; R-4; S-2	
(B)	P-2; Q-3; R-1; S-4	
(C)	P-3; Q-1; R-4; S-2	
(D)	P-3; Q-1; R-2; S-4	





GATE 2	GATE 2022 Engineering Sciences XE		
Q.121	Match the following polymer product technique	with its most appropriate processing	
	Polymer product	Processing technique	
	P. Bottle	1. Extrusion	
	Q. Blister packaging	2. Pultrusion	
	R. Reinforced electric poles	3. Injection blow molding	
	S. Sewage pipes	4. Thermoforming	
(A)	P-3; Q-4; R-1; S-2		
(B)	P-3; Q-4; R-2; S-1		
(C)	P-4; Q-3; R-2; S-1		
(D)	P-3; Q-2; R-4; S-1		





GATE 2022 Engineering Sciences XE		
Q.122	Match the following additives to their respective functions	
	Additive Function	
	P. <i>p</i> -phenylenediamine	1. Flame retardant
	Q. Trixylyl phosphate	2. Impact modifier
	R. Polybutadiene rubber	3. Nucleating agent
	S. Talc	4. Antiozonant
(A)	P-4; Q-2; R-1; S-3	
(B)	P-3; Q-1; R-2; S-4	
(C)	P-4; Q-1; R-3; S-2	
(D)	P-4; Q-1; R-2; S-3	





GATE 2022 Engineering Sciences XE		
Q.123		
	Polymer	IR stretch (cm ⁻¹)
	P. Polyurethane	1.~2234
	Q. Polyethylene	2.~1151
	R. Polysulfone	3.~1720
	S. Acrylonitrile-butadiene-styrene copolymer	4. ~2914
(A)	P-4; Q-3; R-2; S-1	
(B)	P-3; Q-4; R-2; S-1	
(C)	P-3; Q-4; R-1; S-2	
(D)	P-3; Q-2; R-4; S-1	





GATE 2	2022 Engineering Sciences XE	Indian Institute of Technology Kharagpur	
Q.124			
	Polymer	Product	
	P. Expanded polystyrene	1. Motor bearings	
	Q. Polyether ether ketone	2. TV cabinet	
	R. Polycarbonate	3. Sound proof walls	
	S. Poly(butylene terephthalate)	4. Safety glass	
(A)	P-2; Q-1; R-4; S-3		
(B)	P-2; Q-4; R-1; S-3		
(C)	P-3; Q-1; R-2; S-4		
(D)	P-3; Q-1; R-4; S-2		





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Q.125	Match the polymers to the polymerization method used for their synthesis		
	Polymer	Polymerization method	
	P. Linear low density polyethylene	1. Ring opening	
	Q. Nylon 6	2. Ziegler-Natta	
	R. Styrene-butadiene rubber	3. Condensation	
	S. Aromatic polyamide	4. Emulsion	
(A)	P-2; Q-1; R-4; S-3		
(B)	P-2; Q-1; R-3; S-4		
(C)	P-2; Q-3; R-4; S-1		
(D)	P-2; Q-4; R-1; S-3		
Q.126	If 5 g of a monodisperse polystyrene sample of molecular weight 10,000 g mol ⁻¹ is mixed with 15 g of another monodisperse polystyrene sample of molecular weight 20,000 g mol ⁻¹ , then the polydispersity of the resulting mixture is (<i>rounded off to two decimal places</i>).		
Q.127	For a polymer sample with a viscosity of 6×10^{11} poise, if the apparent plateau modulus of 3×10^6 dyne cm ⁻² drops to zero above a certain temperature, the relaxation time of the polymer is days (<i>rounded off to one decimal place</i>).		



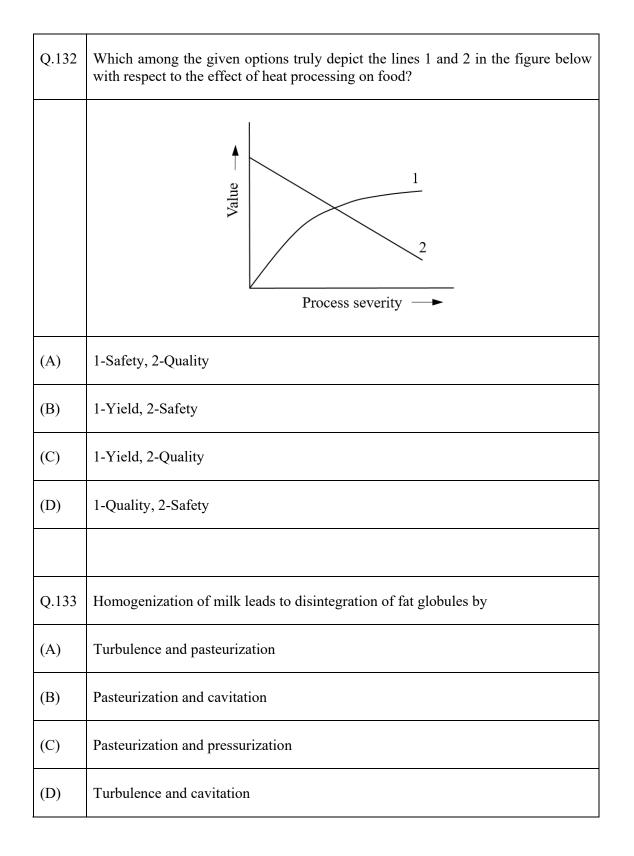


GATE 2	022 Engineering Sciences XE
Q.128	The thermal conductivity values of glass fiber and epoxy resin are 1.05 W m ⁻¹ K ⁻¹ and 0.25 W m ⁻¹ K ⁻¹ , respectively. The thermal conductivity of a glass fiber reinforced epoxy composite with a fiber content of 60% by volume along the fiber direction is W m ⁻¹ K ⁻¹ (<i>rounded off to two decimal places</i>).
Q.129	The tensile modulus of a thermosetting polyester resin and glass fiber are 3 GPa and 80 GPa, respectively. If a tensile stress of 110 MPa is applied along the fiber direction on a continuous uniaxially aligned glass fiber reinforced thermosetting polyester composite with a fiber content of 60% by volume, the resulting strain will be×10 ⁻³ (rounded off to one decimal place).
Q.130	The amount of low molecular weight plasticizer with a T_g of -60 °C that must be added to nylon 6 to reduce its T_g from 50 °C to 30 °C is % (rounded off to nearest integer).
Q.131	The enthalpy of fusion for a polymer is found to decrease from 135.6 J g ⁻¹ to 120 J g ⁻¹ after five years of use. If the enthalpy of fusion of the same polymer with 100% crystallinity is 290 J g ⁻¹ , then the loss in crystallinity after five years is% (<i>rounded off to one decimal place</i>).













Q.134	The lowest water activity (a _w) supporting the growth of <i>Staphylococcus aureus</i> in food under aerobic condition is
(A)	0.98
(B)	0.91
(C)	0.89
(D)	0.86
Q.135	Cultures used in industrial production of yogurt are
(A)	Lactococcus lactis subsp. lactis
(B)	Streptococcus thermophilus
(C)	Leuconostoc mesenteroides subsp. cremoris
(D)	Lactobacillus delbrueckii subsp. bulgaricus





GATE 2	SATE 2022 Engineering Sciences XE		
Q.136	In a dairy plant, spray drying technology is used to produce whey powder. The rate of spray drying depends on		
(A)	Temperature of the incoming air		
(B)	Shape of the cyclone separator		
(C)	Diameter of the whey droplet		
(D)	Heat transfer coefficient of hot air		
Q.137	The parboiling of paddy results into		
(A)	Increase in the milling losses		
(B)	Increase in the nutritional value of rice		
(C)	Increase in the head rice recovery		
(D)	Increase in the broken rice percentage		
Q.138	One hundred kg paddy is dried from 18% wet basis to 13% wet basis moisture content. The amount of water removed (in kg) from the paddy is (round off to one decimal place).		
Q.139	The radius of a centrifuge bowl is 0.1 m and is rotating at 850 revolutions per minute. The centrifugal force developed in terms of gravity force (g-force) is (round off to two decimal places).		
	Given: Acceleration of gravity (g) = 9.81 m s ⁻² and π = 3.14		





GATE 2022 Engineering Sciences XE

Q.140	In a canning industry, the total process time (F_0) was calculated as 3 min. If each can contains 20 spores having decimal reduction time of 1.6 min, the probability of spoilage would be in 100 cans (<i>round off to the nearest integer</i>).

Q.141 – Q.153 Carry TWO marks Each

Q.141	Match the edible oil refining stages giver functions in Column II	n in Column I with their respective
	Column I	Column II
	P. Degumming	1. Separation of waxes
	Q. Neutralization	2. Removal of pigments
	R. Bleaching	3. Removal of phosphatides
	S. Winterization	4. Removal of free fatty acids
(A)	P-3, Q-2, R-1, S-4	
(B)	P-2, Q-1, R-3, S-4	
(C)	P-3, Q-4, R-2, S-1	
(D)	P-3, Q-1, R-2, S-4	





	022 Engineering Sciences XE		
Q.142	Make the correct pair of food packaging technology given in Column I with operating principle or description in Column II.		
	Column I	(Column II
	P. Aseptic packaging	1.	Control of the concentration of O ₂ and CO ₂ inside the package
	Q. Active packaging	2.	Create a skin tight package wall
	R. Modified atmosphere packaging	3.	Independent sterilization of food and packaging material and packaging under sterile environment
	S. Vacuum packaging	4.	Makes non-passive contribution to product development
(A)	P-3, Q-4, R-1, S-2		
(B)	P-3, Q-2, R-1, S-4		
(C)	P-1, Q-4, R-3, S-2		
(D)	P-3, Q-1, R-4, S-2		





GATE 2	022 Engineering Sciences XE	inolan institute of rechnology kharagpur
Q.143	Which of the following is not a caramel flavour producing compound?	
(A)	3-Hydroxy-2-methylpyran-4-one	
(B)	2H-4-Hydroxy-5-methylfuran-3-one	
(C)	3-Hydroxy-2-acetylfuran	
(D)	p-Amino benzoicacid	
Q.144	Match the size reduction equipment in Column I with the method of operation in Column II.	
	Column I	Column II
	P. Hammer mill	1. Compression
	Q. Burr mill	2. Impact
	R. Crushing rolls	3. Cutting
	S. Rotary knife	4. Attrition
(A)	P-2, Q-4, R-1, S-3	
(B)	P-3, Q-1, R-2, S-4	
(C)	P-4, Q-1, R-2, S-3	
(D)	P-3, Q-4, R-2, S-1	





afterfield wares affected to a	2022 Engineering Sciences XE
Q.145	Most commonly used refrigerant in direct immersion freezing of food is
(A)	Monochlorodifluoromethane
(B)	Dichlorodifluoromethane
(C)	Liquid nitrogen
(D)	Freon
Q.146	Which among the following are ω -6 poly unsaturated essential fatty acids?
(A)	18:2 Linoleic acid
(B)	18:3 α-Linolenic acid
(C)	18:3 γ-Linolenic acid
(D)	20:4 Arachidonic acid
Q.147	Which among the following statements are true with respect to protein denaturation?
(A)	There may be an increase in α -helix and β -sheet structure
(B)	It is an irreversible process
(C)	When fully denatured, globular proteins resemble a random coil
(D)	The peptide bonds are broken





Q.148	Identify the correct pair(s) of milling equipment and the grain for which it is used.	
(A)	Mist polisher–Rice	
(B)	Break roll–Wheat	
(C)	Rubber roll–Pigeon pea	
(D)	Beall degermer-Maize	
Q.149	Which among the following expression(s) is/are correct?	
(A)	Reynolds number = $\frac{Density \times Velocity \times Characteristic dimension}{Viscosity}$	
(B)	Nusselt number = $\frac{Convective heat transfer coefficient \times Characteristic dimension}{Thermal conductivity of solid}$	
(C)	Schmidt number = $\frac{Kinematic viscosity of fluid}{Diffusivity}$	
(D)	Biot number = <u>Convective heat transfer coefficient × Characteristic dimension</u> <u>Thermal conductivity of fluid</u>	





Q.150	In sieve analysis of coffee nowder th	e particle size distribution is given below
Q.150		
	Number of particles	Mean particle size (μ m)
	5	40
	8	30
	50	20
	90	17.5
	148	12.5
	10	10
	The Sauter mean diameter (in μ m) of the coffee powder is (round off to one decimal place).	
Q.151	In a dairy processing plant, milk enters a 30 m long and 2 cm diameter tube a 60 °C and leaves at 57 °C. The total heat loss over the tube length is 381.15 W. Th specific heat capacity, density, and viscosity of milk are 3.85 kJ kg ⁻¹ K ⁻¹ 1020 kg m ⁻³ , and 1.20 cP, respectively. The Reynolds number for the flow is (round off to the nearest integer).	
	Given: $\pi = 3.14$	
Q.152	50 W m ⁻¹ K ⁻¹ . The outer surface of p inside diameter and thickness of the overall heat transfer coefficient based convective heat transfer coefficient is	tel pipe having thermal conductivity of pipe is exposed to ambient environment. The pipe are 3 cm and 1.5 cm, respectively. The on inside area is 25 W m ⁻² K ⁻¹ . If the internal s 30 W m ⁻² K ⁻¹ , the external convective heat ill be (round off to two decimal



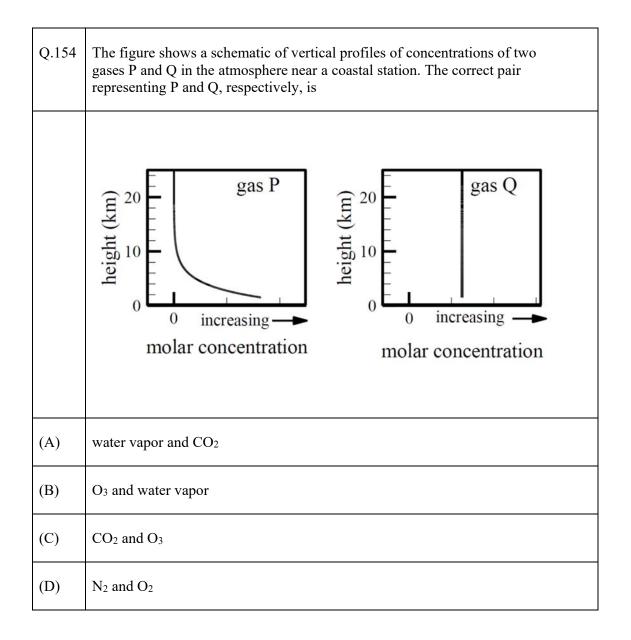
Q.153 The dry bulb temperature and relative humidity of air inside a storage chamber are 37 °C and 50%, respectively. The saturation pressure of water vapour at 37 °C and barometric pressure are 6.28 kPa and 101.32 kPa, respectively. The humidity ratio of air inside the chamber is _____ kg water (kg dry air)⁻¹ (*round off to three decimal places*).

Given: Molecular weight of water vapour and dry air are 18.02 g mol⁻¹ and 28.97 g mol⁻¹, respectively.





Atmospheric and Oceanic Sciences XE-H (Q.154 – Q.162 Carry ONE mark Each)







Q.155	A form of momentum equation for an incompressible fluid is	
	$\rho \frac{DV}{Dt} = -\nabla p + \mu \nabla^2 V + B$ (i) (ii) (iii) (iv)	
	where ρ is density, V is velocity, t is time, p is pressure, μ is viscosity and B represents body force per unit volume. The dimension of term (iii) is (M, L and T stand for mass, length and time, respectively).	
(A)	[L] ¹ [T] ⁻²	
(B)	$[M]^1 [L]^{-2} [T]^{-2}$	
(C)	$[M]^1 [L]^1 [T]^{-2}$	
(D)	$[M]^1 [L]^1 [T]^{-1}$	





Graduate Applicate Text in Engineer अभियांत्रिकी स्थातक अभियागत क	Graduate Aptitude lest in Engineering Indian Institute of Technology Kharagpur			
GATE 2	GATE 2022 Engineering Sciences XE			
Q.156	Tropical cyclones usually do not form close to the Equator primarily because			
(A)	sea surface temperature at the Equator is too cold.			
(B)	beta effect dissipates clouds.			
(C)	Coriolis force is too weak.			
(D)	vertical shear of the zonal wind is weak.			

Q.157	Which one of the following statements regarding equatorial under current (EUC) in the Pacific Ocean is correct?
(A)	EUC flows from west to east.
(B)	EUC flows from east to west.
(C)	EUC flows from north to south.
(D)	EUC flows from south to north.





GATE 2022 Engineering Sciences XE		
Q.158	Which one of the following statements is correct regarding the dominant energy balance in the troposphere in a tropical convergence zone?	
(A)	Shortwave heating balances longwave radiative cooling.	
(B)	Compressional heating balances radiative cooling.	
(C)	Radiative cooling balances heating due to viscous dissipation of kinetic energy.	
(D)	Condensational heating balances adiabatic cooling.	

Q.159	Which one of the following processes is primarily responsible for the poleward transport of energy in the midlatitude troposphere?
(A)	atmospheric tides
(B)	baroclinic waves
(C)	gravity waves
(D)	turbulence in the boundary layer





GATE 2022 Engineering Sciences XE		
Q.160	Which of the following feature(s) characterize the seasonal mean flow in the upper troposphere near 200 hPa level over the Tibetan Plateau during the boreal summer?	
(A)	cyclonic	
(B)	anticyclonic	
(C)	irrotational	
(D)	divergent	

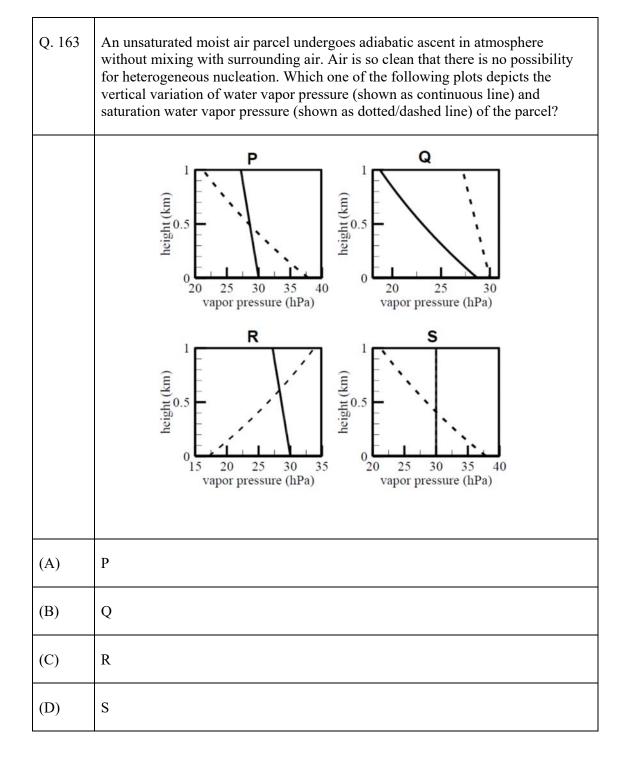
	The Rossby number of a synoptic system with a length scale of 1000 km, characteristic velocity scale of 10 m s ⁻¹ at a latitude where the Coriolis parameter equals 10^{-4} s ⁻¹ , is (Round off to two decimal places)
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	The ratio of scattering efficiency of red light of wavelength 0.65 μ m to blue light of wavelength 0.45 μ m by air molecules in the atmosphere is (Round off to two decimal places)
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GATE 2022 Engineering Sciences XE Q.163 – Q.175 Carry TWO marks Each







রণিয়ারিকী পরাচক রণিরগয়া য	noian institute or technology kharagpur
GATE 2	022 Engineering Sciences XE
Q.164	A fluid is in solid body rotation in a cylindrical container of radius <i>R</i> rotating with an angular velocity $\mathbf{\Omega} = (0, 0, \Omega)$. The circulation per unit area around a circular loop in the horizontal plane of radius <i>r</i> (<i>r</i> < <i>R</i>), whose center coincides with the axis of rotation is
(A)	2 Ω
(B)	Ω^2
(C)	$\Omega/2$
(D)	$\Omega/4$
Q.165	Consider a layer of atmosphere where temperature increases with height. If the concentration of a vertically well-mixed greenhouse gas suddenly increases in this layer, then an immediate consequence is that
(A)	infrared radiation leaving the top of the layer decreases.
(B)	infrared radiation leaving the top of the layer increases.
(C)	infrared radiation leaving the top of the layer remains unchanged.
(D)	the layer becomes optically thinner to infrared radiation.





GATE 2022 Engineering Sciences XE		
Q.166	Consider an atmosphere where the mole fractions of N_2 , Ar and CO_2 are 7.81×10^{-1} , 9.34×10^{-3} and 4.05×10^{-4} , respectively. This atmosphere exchanges gases with sea water below having temperature and salinity of 20 °C and 35 psu, respectively. In the absence of biological and chemical activity, relative concentrations of dissolved gases in the surface sea water at equilibrium are ordered as	
(A)	$[N_2] > [Ar] > [CO_2]$	
(B)	$[CO_2] > [N_2] > [Ar]$	
(C)	$[N_2] > [CO_2] > [Ar]$	
(D)	$[Ar] > [CO_2] > [N_2]$	
Q.167	Gravitational forces exerted by the Sun and the Moon are mainly responsible for ocean tides. Which of the following statement(s) regarding ocean tides is/are correct?	
(A)	Tidal amplitude corresponding to diurnal period is larger than that of the semi-diurnal period.	
(B)	Diurnal time period of lunar forced tides is longer than that of the solar forced tides.	
(C)	Tidal amplitudes are larger during a solar eclipse compared to that during a lunar eclipse.	
(D)	Tides are absent during equinoxes.	





GATE 2022 Engineering Sciences XE		
Q.168	Which of the following statement(s) is/are true about northern hemisphere tropical cyclones?	
(A)	They have a warm core.	
(B)	Their low-level flow is cyclonic.	
(C)	Strong wind shear in the vertical is required for their intensification.	
(D)	They are characterized by upper-level divergence.	
Q.169	In gradient wind balance, which of the following statement(s) is/are true for flow around a region of low pressure in the northern hemisphere?	
(A)	The flow is clockwise.	
(B)	The flow is anti-clockwise.	
(C)	The wind speed is faster than the geostrophic wind.	
(D)	The wind speed is slower than the geostrophic wind.	





Q. 170	Which of the following statement(s) is/are true regarding biogeochemical cycle in the ocean?
(A)	Shutdown of the biological pump in the ocean would have resulted in higher CO ₂ concentration in the atmosphere compared to present-day.
(B)	If atmospheric CO ₂ concentration increases, solubility pump would lead to a decrease in dissolved inorganic carbon in the ocean.
(C)	All carbon sequestered by marine photosynthesis settles down on the ocean floor as organic matter.
(D)	Calcification (the process of making shells and skeletons) by marine organisms in the surface ocean layer would lead to an increase in the surface ocean CO ₂ .

Q.171	Consider the atmosphere to be a heat engine, which converts absorbed radiation to kinetic energy of winds. Let the global mean radiation absorbed be 200 Wm ⁻² . In steady-state, if the global mean kinetic energy dissipation is 10 Wm ⁻² , then the efficiency of the atmospheric heat engine is%. (Round off to one decimal place)
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	A drifter on the surface of the ocean performs inertial oscillation. The speed of the drifter is 2 m s ⁻¹ and the Coriolis parameter at the latitude is 2×10^{-4} s ⁻¹ . The radius
	of the inertial oscillation is km. (Round off to the nearest integer)





Q.173	Consider a tornado in cyclostrophic balance. The tangential wind speed at a radial
	distance of 500 m from the center of the tornado is $m s^{-1}$, if the pressure
	gradient at that location in the radial direction is 5 N m^{-3} . Assume the density of
	air to be 1 kg m ⁻³ . (Round off to the nearest integer)

Ç		Consider two weather stations A and B having the same altitude. Station B is 5 km north of Station A and is always 2 K warmer than Station A. A steady northerly wind blows at 1 m s ⁻¹ . The change in temperature at Station A in 2 hours is K. (Round off to one decimal place)	
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Q. 175	Assume the Earth is in radiative equilibrium with effective radiative temperature of 255 K. If the planetary albedo increases by 0.05, then the effective radiative temperature of the planet will be K. (Round off to the nearest integer)
	Given: Solar constant = 1370 Wm ⁻² Stefan Boltzmann constant = 5.67×10^{-8} Wm ⁻² K ⁻⁴





Q.No.	Session	Question	Section	Key/Range	Mark
		Туре	Name		
1	6	MCQ	GA	С	1
2	6	MCQ	GA	В	1
3	6	MCQ	GA	С	1
4	6	MCQ	GA	D	1
5	6	MCQ	GA	A	1
6	6	MCQ	GA	В	2
7	6	MCQ	GA	D	2
8	6	MCQ	GA	D	2
9	6	MCQ	GA	D	2
10	6	MCQ	GA	С	2
11	6	MCQ	XE-A	С	1
12	6	MCQ	XE-A	С	1
13	6	MCQ	XE-A	В	1
14	6	NAT	XE-A	36 to 36	1
15	6	NAT	XE-A	4 to 4	1
16	6	NAT	XE-A	2 to 2	1
17	6	NAT	XE-A	0.066 to 0.068	1
18	6	MCQ	XE-A	С	2
19	6	MCQ	XE-A	A	2
20	6	NAT	XE-A	2 to 2	2
21	6	NAT	XE-A	3 to 3	2
22	6	MCQ	XE-B	В	1
23	6	MCQ	XE-B	A	1
24	6	MCQ	XE-B	A	1
25	6	MSQ	XE-B	А, В	1
26	6	MSQ	XE-B	A, D	1
27	6	MSQ	XE-B	A, D	1
28	6	MSQ	XE-B	B, D	1
29	6	MSQ	XE-B	А, В, С	1
30	6	NAT	XE-B	6.95 to 7.20	1
31	6	MCQ	XE-B	A	2
32	6	MCQ	XE-B	С	2
33	6	MCQ	XE-B	D	2
34	6	MCQ	XE-B	С	2
35	6	MSQ	XE-B	C, D	2
36	6	NAT	XE-B	374 to 376	2
37	6	NAT	XE-B	MTA	2
38	6	NAT	XE-B	5.60 to 5.70	2
39	6	NAT	XE-B	0.24 to 0.26	2
40	6	NAT	XE-B	1.380 to 1.390	2
41	6	NAT	XE-B	0.74 to 0.78	2
42	6	NAT	XE-B	5.1 to 5.2	2
43	6	NAT	XE-B	0.39 to 0.41	2
44	6	MCQ	XE-C	В	1





45	6	MCQ	XE-C	C	1
46	6	MCQ	XE-C	C	1
47	6	MCQ	XE-C	A	1
48	6	MCQ	XE-C	C	1
49	6	MCQ	XE-C	D	1
50	6	MSQ	XE-C	В, С	1
51	6	NAT	XE-C	4232 to 4249	1
52	6	NAT	XE-C	2.20 to 2.30	1
53	6	MCQ	XE-C	С	2
54	6	MCQ	XE-C	C	2
55	6	MCQ	XE-C	D	2
56	6	MCQ	XE-C	С	2
57	6	MCQ	XE-C	С	2
58	6	MCQ	XE-C	A	2
59	6	MSQ	XE-C	A, C	2
60	6	NAT	XE-C	0.5 to 0.5	2
61	6	NAT	XE-C	9.7 to 11.2	2
62	6	NAT	XE-C	0.057 to 0.062	2
63	6	NAT	XE-C	0.45 to 0.47	2
64	6	NAT	XE-C	1.40 to 1.43	2
65	6	NAT	XE-C	5.64 to 5.73	2
66	6	MCQ	XE-D	A	1
67	6	MCQ	XE-D	С	1
68	6	MCQ	XE-D	A	1
69	6	MCQ	XE-D	В	1
70	6	MCQ	XE-D	A	1
71	6	MCQ	XE-D	В	1
72	6	MCQ	XE-D	С	1
73	6	NAT	XE-D	1.9 to 2.1	1
74	6	NAT	XE-D	19 to 21	1
75	6	MCQ	XE-D	A	2
76	6	MCQ	XE-D	D	2
77	6	MCQ	XE-D	A	2
78	6	MCQ	XE-D	A	2
79	6	MCQ	XE-D	В	2
80	6	MCQ	XE-D	A	2
81	6	NAT	XE-D	295 to 305	2
82	6	NAT	XE-D	39 to 41	2
83	6	NAT	XE-D	0.9 to 1.1	2
84	6	NAT	XE-D	79 to 81	2
85	6	NAT	XE-D	5990 to 6010	2
86	6	NAT	XE-D	123 to 127	2
87	6	NAT	XE-D	148 to 152	2
88	6	MCQ	XE-E	C	1
89	6	MCQ	XE-E	A	1
90	6	MCQ	XE-E	B	1
50	U	INICQ		0	1





91	6	MCQ	XE-E	В	1
92	6	NAT	XE-E	750.00 to 756.00	1
93	6	NAT	XE-E	79.00 to 80.00	1
94	6	NAT	XE-E	254.00 to 255.00	1
95	6	NAT	XE-E	25 to 25	1
96	6	NAT	XE-E	300 to 300	1
97	6	MCQ	XE-E	C	2
98	6	MCQ	XE-E	A	2
99	6	MCQ	XE-E	В	2
100	6	MCQ	XE-E	A	2
101	6	MCQ	XE-E	В	2
102	6	MCQ	XE-E	С	2
103	6	NAT	XE-E	0.20 to 0.24	2
104	6	NAT	XE-E	132.00 to 134.00	2
105	6	NAT	XE-E	4.50 to 4.65	2
106	6	NAT	XE-E	0.0160 to 0.0165	2
107	6	NAT	XE-E	0.13 to 0.15	2
108	6	NAT	XE-E	15 to 17	2
109	6	NAT	XE-E	21.00 to 22.00	2
110	6	MCQ	XE-F	В	1
111	6	MCQ	XE-F	С	1
112	6	MCQ	XE-F	А	1
113	6	MCQ	XE-F	С	1
114	6	MCQ	XE-F	D	1
115	6	MCQ	XE-F	В	1
116	6	MSQ	XE-F	A, C, D	1
117	6	MSQ	XE-F	B, C, D	1
118	6	NAT	XE-F	2 to 2	1
119	6	MCQ	XE-F	A	2
120	6	MCQ	XE-F	С	2
121	6	MCQ	XE-F	В	2
122	6	MCQ	XE-F	D	2
123	6	MCQ	XE-F	В	2
124	6	MCQ	XE-F	D	2
125	6	MCQ	XE-F	A	2
126	6	NAT	XE-F	1.04 to 1.14	2
127	6	NAT	XE-F	2.1 to 2.5	2
128	6	NAT	XE-F	0.71 to 0.75	2
129	6	NAT	XE-F	2.1 to 2.4	2
130	6	NAT	XE-F	12 to 14	2
131	6	NAT	XE-F	5.2 to 5.6	2
132	6	MCQ	XE-G	A	1
133	6	MCQ	XE-G	D	1
134	6	MCQ	XE-G	D	1
135	6	MSQ	XE-G	B, D	1
136	6	MSQ	XE-G	A, C, D	1





407			N/5 0		
137	6	MSQ	XE-G	B, C	1
138	6	NAT	XE-G	5.5 to 6.0	1
139	6	NAT	XE-G	79.50 to 81.50	1
140	6	NAT	XE-G	25 to 28	1
141	6	MCQ	XE-G	C	2
142	6	MCQ	XE-G	A	2
143	6	MCQ	XE-G	D	2
144	6	MCQ	XE-G	A	2
145	6	MCQ	XE-G	C	2
146	6	MSQ	XE-G	A, C, D	2
147	6	MSQ	XE-G	A, C	2
148	6	MSQ	XE-G	A, B, D	2
149	6	MSQ	XE-G	A, C	2
150	6	NAT	XE-G	19.0 to 20.5	2
151	6	NAT	XE-G	1700 to 1800	2
152	6	NAT	XE-G	73.00 to 84.00	2
153	6	NAT	XE-G	0.017 to 0.021	2
154	6	MCQ	XE-H	A	1
155	6	MCQ	XE-H	В	1
156	6	MCQ	XE-H	С	1
157	6	MCQ	XE-H	A	1
158	6	MCQ	XE-H	D	1
159	6	MCQ	XE-H	В	1
160	6	MSQ	XE-H	B, D	1
161	6	NAT	XE-H	0.08 to 0.12	1
162	6	NAT	XE-H	0.22 to 0.24	1
163	6	MCQ	XE-H	A	2
164	6	MCQ	XE-H	A	2
165	6	MCQ	XE-H	В	2
166	6	MCQ	XE-H	С	2
167	6	MSQ	XE-H	B, C	2
168	6	MSQ	XE-H	A, B, D	2
169	6	MSQ	XE-H	B, D	2
170	6	MSQ	XE-H	A, D	2
171	6	NAT	XE-H	4.9 to 5.1	2
172	6	NAT	XE-H	9 to 11	2
173	6	NAT	XE-H	49 to 51	2
174	6	NAT	XE-H	2.8 to 3.0	2
175	6	NAT	XE-H	249 to 252	2