2013 XE

EE25BTECH11021 - Dhanush sagar

1) If

$$\int_0^{\frac{\pi}{\alpha}} \frac{\sin y}{y}\, dy = \frac{1}{2} \tag{1}$$

for some $\alpha \geq 1$, then the value of α is _ _ _ _ _. [GATE 2017 XE]

2) Three fair dice are rolled simultaneously. The probability of getting a sum of 5 is

   a) $\frac{1}{108}$ b) $\frac{1}{72}$ c) $\frac{1}{54}$ d) $\frac{1}{36}$

[GATE 2017 XE]

3) Suppose $\alpha, \beta, \gamma, \delta$ are constants such that

$$p(x) = \delta + \gamma(x+1) + \beta(x+1)(x-1) + \alpha(x+1)(x-1)(x-2) \tag{2}$$

is the interpolating polynomial for the data $(-1, -3), (0, 1), (1, -1), (2, -3)$. Then the value of $\beta - \alpha$ is _ _ _ _ _. [GATE 2017 XE]

4) Consider the ordinary differential equation

$$y''' + \alpha y' + \beta y = 0 \tag{3}$$

where α and β are constants. If $y(x) = xe^x$ is a solution of the above equation, then the value of $\beta - \alpha$ is _ _ _ _ _. [GATE 2017 XE]

5) Consider the system of linear equations

$$2x_2 + x_3 = 0, \tag{4}$$
$$-2x_1 - x_3 = 0, \tag{5}$$
$$-x_1 + x_2 = 1. \tag{6}$$

The above system has

   a) a unique solution   c) no solution
   b) infinite number of solutions   d) only two distinct solutions

[GATE 2017 XE]

6) Let C be a simple smooth closed curve enclosing the region R in the xy-plane. Let C be oriented counterclockwise. If the value of the integral

$$\iint_R \left(y + e^{x^2}\right) dx + (3x + \cos y)\, dy \tag{7}$$

is 16, then the area of R is _ _ _ _ _. [GATE 2017 XE]

7) Consider the ordinary differential equation

$$x^2 y'' + xy' - y = x, \quad x > 0. \tag{8}$$

In terms of arbitrary constants c_1, c_2, the general solution of the above equation is

a) $c_1 x + c_2 x^{-1} + \frac{1}{3} x^2$
b) $c_1 x + c_2 x^{-1} + \frac{1}{2} x$

c) $c_1 x + c_2 x^{-1} + \frac{1}{4} x^2$
d) $c_1 x + c_2 x^{-1} + \frac{1}{2} x^2$

[GATE 2017 XE]

8) Let $f : \mathbb{R} \to \mathbb{R}$ and $g : \mathbb{R} \to \mathbb{R}$ be defined by

$$f(x) = \begin{cases} (x \sin \frac{1}{x}), & x \neq 0, \\ 0, & x = 0, \end{cases} \qquad (9)$$

$$g(x) = \begin{cases} \cos \frac{1}{x}, & x \neq 0, \\ 0, & x = 0, \end{cases} \qquad (10)$$

where $\mathbb{R}$ denotes the set of real numbers. Then at $x = 0$

a) f is differentiable but g is not differentiable
b) Both f and g are differentiable

c) Neither f nor g is differentiable
d) Only g is differentiable

[GATE 2017 XE]

9) If $u(x, t) = g(t) \sin x$ is the solution of the wave equation

$$\frac{\partial^2 u}{\partial t^2} = \frac{\partial^2 u}{\partial x^2}, \qquad 0 < x < \pi, \qquad (11)$$

with initial conditions

$$u(x, 0) = 2 \sin x, \quad u_t(x, 0) = 0, \quad 0 \leq x \leq \pi, \qquad (12)$$

and the boundary conditions

$$u(0, t) = 0, \quad u(\pi, t) = 0, \quad t \geq 0, \qquad (13)$$

then the value of $g(\frac{\pi}{6})$ is _ _ _ _ _.   [GATE 2017 XE]

10) Let

$$I = \int_{-1}^{1} \frac{e^t}{1 + e^t} \, dt + \int_{-1}^{1} \frac{1}{1 + e^t} \, dt. \qquad (14)$$

If x is a real variable and $I = \frac{1}{x} \int_{-1}^{1} e^t \, dt$, then the value of x is _ _ _ _ _.   [GATE 2017 XE]

11) Let $a_n = 2^n + \sin n$, and $b_n = 2^n + n \sin^2 n$, for $n = 1, 2, \ldots$. Then

a) Both $\sum a_n$ and $\sum b_n$ diverge
b) $\sum a_n$ converges but $\sum b_n$ does NOT converge

c) $\sum a_n$ does NOT converge but $\sum b_n$ converges
d) Both $\sum a_n$ and $\sum b_n$ converge

[GATE 2017 XE]

12) The event would have been successful if you _____ able to come.   [GATE 2017 XE]

a) are
b) had been

c) have been
d) would have been

13) There was no doubt that their work was <u>thorough</u>. Which of the words below is closest in meaning to the underlined word above?   [GATE 2017 XE]

a) pretty
b) complete

c) sloppy
d) haphazard

14) Four cards lie on a table. Each card has a number printed on one side and a colour on the other. The faces visible on the cards are 2, 3, red, and blue.
Proposition: If a card has an even value on one side, then its opposite face is red.
The cards which MUST be turned over to verify the above proposition are   [GATE 2017 XE]

a) 2, red
b) 2, 3, red

c) 2, blue
d) 2, red, blue

15) What is the value of x when

$$81 \times \left(\frac{25}{81}\right)^{x+2} + \left(\frac{25}{81}\right)^{2x+4} = 144?$$ (15)

[GATE 2017 XE]

a) 1
b) -1

c) -2
d) Cannot be determined

16) Two dice are thrown simultaneously. The probability that the product of the numbers appearing on the top faces of the dice is a perfect square is   [GATE 2017 XE]

a) $\frac{1}{9}$
b) $\frac{2}{9}$

c) $\frac{1}{3}$
d) $\frac{4}{9}$

17) Bhaichung was observing the pattern of people entering and leaving a car service centre. There was a single window where customers were being served. He saw that people invariably came out of the centre in the order that they went in. However, the time they spent inside seemed to vary a lot: some people came out in a matter of minutes while for others it took much longer.
From this, what can one conclude?   [GATE 2017 XE]
a) The centre operates on a first-come-first-served basis, but with variable service times.
b) Customers were served in an arbitrary order, since they took varying amounts of time for service completion in the centre.
c) Since some people came out within a few minutes of entering the centre, the system is likely to operate on a last-come-first-served basis.
d) Entering the centre early ensured that one would have shorter service times and most people attempted to do this.

18) A map shows the elevations of Darjeeling, Gangtok, Kalimpong, Pelling, and Siliguri. Kalimpong is at a lower elevation than Gangtok. Pelling is at a lower elevation than Gangtok. Pelling is at a higher elevation than Siliguri. Darjeeling is at a higher elevation than Gangtok.
Which of the following statements can be inferred from the paragraph above?   [GATE 2017 XE]
i. Pelling is at a higher elevation than Kalimpong
ii. Kalimpong is at a lower elevation than Darjeeling
iii. Kalimpong is at a higher elevation than Siliguri
iv. Siliguri is at a lower elevation than Gangtok

a) Only ii
b) Only ii and iii

c) Only ii and iv
d) Only iii and iv

19) P, Q, R, S, T and U are seated around a circular table. R is seated two places to the right of Q. P is seated three places to the left of R. S is seated opposite U. If P and U now switch seats, which of the following must necessarily be true?   [GATE 2017 XE]

a) P is immediately to the right of R

b) T is immediately to the left of P

c) T is immediately to the left of P or P is

immediately to the right of Q

d) U is immediately to the right of R or P is immediately to the left of T

20) Badhan covers a distance of 19 km in 2 hours by cycling one fourth of the time and walking the rest. The next day he cycles (at the same speed as before) for half the time and walks the rest (at the same speed as before) and covers 26 km in 2 hours. The speed in km/h at which Badhan walks is _____. [GATE 2017 XE]

a) 1

b) 4

c) 5

d) 6

21) The points in the graph below represent the halts of a lift for durations of 1 minute, over a period of 1 hour.
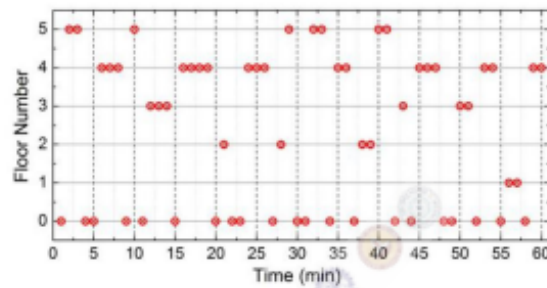
Fig. 21.

Which of the following statements are correct? [GATE 2017 XE]

i. The elevator never moves directly from any non-ground floor to another non-ground floor.

ii. The lift halts on the 2nd floor for the longest duration over the one hour period.

a) Only i

b) Only ii

c) Both i and ii

d) Neither i nor ii

22) In a given flow field, the velocity vector in Cartesian coordinate system is given as:

$$\mathbf{V} = \left(x^2 + y^2 + z^2\right)\hat{i} + \left(y^2 + xy + x^2\right)\hat{j} + \left(yz + z^2\right)\hat{k} \qquad (16)$$

What is the volume dilatation rate of the fluid at a point where $x = 1, y = 2, z = 3$? [GATE 2017 XE]

a) 6

b) 10

c) 16

d) 20

23) A steady, incompressible, two-dimensional velocity field in Cartesian coordinate system is represented by the following expression:

$$\mathbf{V} = (0.7 + 0.4x)\hat{i} + (0.2 - 0.4y)\hat{j} \qquad (17)$$

The coordinates of one possible stagnation point of the velocity field are [GATE 2017 XE]

a) (0.7, 0.5)
b) (-0.5, 0.5)

c) (0.7, -0.5)
d) (-0.5, -0.5)

24) During an experiment, the position of a fluid particle is monitored by an instrument over a time period of 10 s. The trace of the particle given by the following figure represents a

Fluid particle at $t = 4$ s

Fluid particle at $t = 0$

Fluid particle at $t = 10$ s

Fig. 24.

[GATE 2017 XE]

a) Streakline
b) Pathline

c) Streamline
d) Timeline

25) In a Cartesian two-dimensional coordinate system, x and y represent the velocities in x and y directions respectively. For a certain flow, the velocity field is represented by the following expression:

$$\mathbf{V} = (ax + by)\hat{i} + (cx + dy)\hat{j} \qquad (18)$$

where the coefficients a, b, c, d are constants. For an incompressible flow, which one of the following conditions is TRUE? [GATE 2017 XE]

a) $a + d = 0$
b) $b + c = 0$

c) $a + c = 0$
d) $b + d = 0$

26) Which one of the following figures represents potential flow past a circular cylinder with clockwise circulation of the cylinder? [GATE 2017 XE]

Fig. 26.

27) The vorticity function ω of a velocity field at any location is (x, y) is given as,

$$\omega = y^2 + 2x^2 y \qquad (19)$$

What is the rate of rotation of a fluid element located between $x = 2, y = 2$? [GATE 2017 XE]

a) 14
b) 10

c) 8
d) 12

28) The trace of velocity potential within the laminar viscous sublayer in a turbulent pipe flow is [GATE 2017 XE]

a) Linear

b) Log-parabolic

c) Logarithmic

d) Exponential

29) In a 5 m deep vertical cylindrical tank, water is filled up to a level of 3 m from the bottom and the remaining space is filled with oil of specific gravity 0.88. Assume density of water as $1000\,kg/m^3$ and acceleration due to gravity to be $10\,m/s^2$.

The gauge pressure (in kN/m^2, rounded off to the first decimal place) at a depth of 2.5 m from the top of the tank will be _____. [GATE 2017 XE]

30) In a two-dimensional potential flow, a point source is located at the origin ($x = 0, y = 0$) as shown in the figure. The strength of the point source is $2\,cm^2/s$. A uniform flow with velocity $1\,cm/s$ is approaching towards the point source at an angle of $30°$ from the horizontal axis.

What is the distance (cm) of the stagnation point in the flow field from the point source? [GATE 2017 XE]
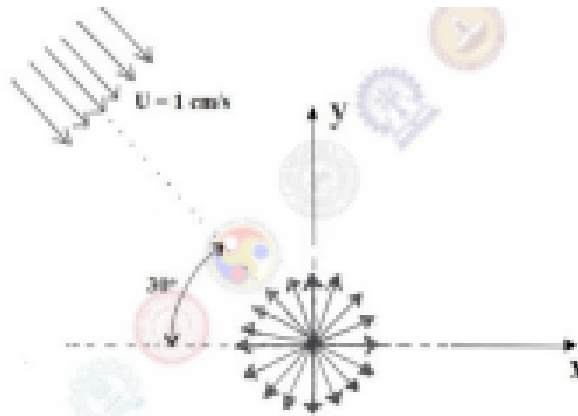
Fig. 30.

a) $\frac{1}{\pi}$

b) $\frac{2}{\pi}$

c) $\frac{1}{2\pi}$

d) $\frac{\sqrt{3}}{2\pi}$

31) Two infinite parallel horizontal plates are separated by a small gap ($h = 20\,mm$) as shown in figure. The lower plate is fixed and the upper plate moves with a velocity of $40\,m/s$, while the gap between the plates is filled with a Newtonian fluid of viscosity $\mu = 0.1\,Pa.s$. Assume linear velocity distribution and no pressure gradient in the flow direction.

The shear stress (N/m^2) on the upper plate is _____. [GATE 2017 XE]
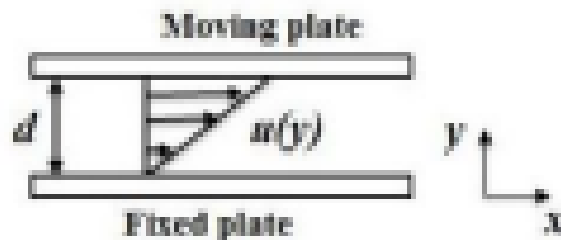
Fig. 31.

32) A spherical balloon of diameter 15 m is supposed to lift a load of 3000 N. The lifting of load is achieved by heating the air inside the balloon. Assume, air to be an ideal gas and atmospheric

pressure either outside or inside the balloon. The value of acceleration due to gravity is 9.81 m/s^2 and the values of temperature and density of atmospheric air are 15°C and 1.2 kg/m^3, respectively. In order to lift the specified load, the air inside the balloon should be heated to a temperature (°C) of _____.

33) The velocity field in Cartesian coordinate system for a two-dimensional steady flow is given as:

$$\mathbf{V} = \left(\frac{V_0}{L}\right)(x\hat{i} - y\hat{j}) \tag{20}$$

where, V_0 and L are constants. Which one of the following expressions represents the acceleration field (**a**) for this flow?

a) $\mathbf{a} = 0$
b) $\mathbf{a} = \left(\frac{V_0}{L}\right)(x\hat{i} + y\hat{j})$

c) $\mathbf{a} = \left(\frac{V_0^2}{L^2}\right)(x\hat{i} - y\hat{j})$
d) $\mathbf{a} = \left(\frac{V_0^2}{L^2}\right)(x\hat{i} + y\hat{j})$

34) A cylindrical tank of 0.8 m diameter is completely filled with water and its top surface is open to atmosphere as shown in the figure. Water is being discharged to the atmosphere from a circular hole of 15 mm diameter located at the bottom of the tank. The value of acceleration due to gravity is 9.81 m/s^2.
How much time (in seconds) would be required for water level to drop from a height of 1 m to 0.5 m?
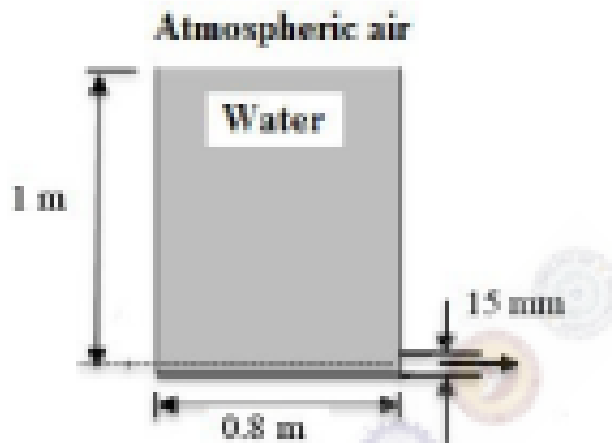
Fig. 34.

a) 188
b) 266

c) 376
d) 642

35) Consider steady laminar flow of an incompressible Newtonian fluid between two infinite parallel plates, separated by a distance of 1 m, as shown in the figure. The bottom plate is stationary but the top one is moving in positive x-direction with a velocity of 3 m/s. The fluid pressure gradient in the flow direction is:

$$\frac{\partial P}{\partial x} = -18 \, \text{N/m}^3 \tag{21}$$

If the viscosity of the fluid is 1 kg/m.s then the distance of the point of maximum velocity (in meters, rounded off to the second decimal place) from the bottom plate would be _____.
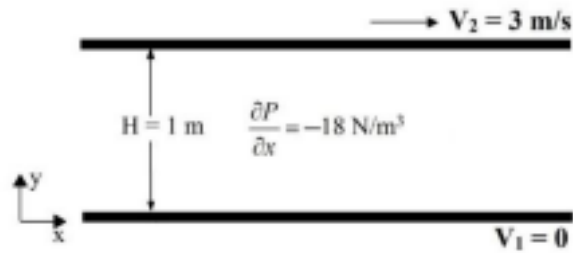
Fig. 35.

36) An inviscid incompressible fluid of density $1000\,\text{kg/m}^3$ is flowing in a horizontal pipe of tapered cross-section with a flow rate of $4000\,\text{cm}^3/\text{s}$. The area of cross-section at two different locations 'A' and 'B' are $10\,\text{cm}^2$ and $20\,\text{cm}^2$, respectively. The velocity of the fluid at the location 'A' is 4 m/s and pressure is $5\,\text{N/cm}^2$.
The pressure (N/m^2) at location 'B' would be _____. [GATE 2017 XE]

37) A viscous, incompressible and Newtonian fluid flowing through the main branch of a circular pipe bifurcates into two daughter branches whose radii are a cm and $2a$ cm, respectively. The flow in both the daughter branches are laminar and fully developed.
If the pressure gradients in both the daughter branches are same, then the fraction of total volumetric flow rates (rounded off to the second decimal place) through the smaller branch to the larger branch is _____. [GATE 2017 XE]
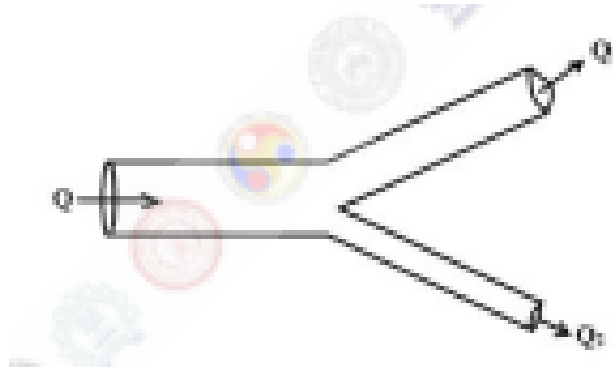
Fig. 37.

38) The volumetric flow rate (Q) of a triangular notch is a function of the upstream liquid surface elevation (H) measured from the bottom of the notch, acceleration due to gravity (g), notch angle (θ) and the approach velocity (V).
Which one of the following is the correct expression for Q? [GATE 2017 XE]

a) $Q = H^{\frac{5}{2}} \sqrt{gH} \sqrt{\tan \frac{\theta}{2}}$

c) $Q = H^{\frac{3}{2}} \sqrt{\frac{V}{gH}} \sqrt{\tan \frac{\theta}{2}}$

b) $Q = H^{\frac{3}{2}} \sqrt{\frac{gH}{V}} \sqrt{\tan \frac{\theta}{2}}$

d) $Q = H^{\frac{5}{2}} \sqrt{V} \sqrt{\tan \frac{\theta}{2}}$

39) Model tests are to be carried out to study the flow through a large prototype valve of 0.6 m diameter at a flow rate of 10 m³/s. The same working fluid is used for both the model and the prototype. A complete geometric similarity is maintained between the model and the prototype. If the valve diameter of the model is 80 mm, its required flow rate (in m³/s, rounded off to the first decimal place) would be _____. [GATE 2017 XE]

40) Water is flowing at a rate of 0.6 m³/s in a horizontal pipeline of inside diameter 0.3 m. The density and kinematic viscosity of water are $1000 \, \text{kg/m}^3$ and $10^{-6} \, \text{m}^2/\text{s}$, respectively. Assume Darcy-Weisbach friction factor for the flow to be 0.02 and acceleration due to gravity as 9.81 m/s².
To maintain constant flow rate, the required power per unit length of the pipeline (in W/m, rounded off to the first decimal place) would be _____. [GATE 2017 XE]

41) Air flows over a smooth flat plate at a velocity of 43.9 m/s. The density of air is $1.031 \, \text{kg/m}^3$ and the kinematic viscosity is $1.34 \times 10^{-5} \, \text{m}^2/\text{s}$. The plate length is 1.2 m in the direction of the flow. The boundary layer thickness $\delta(x)$ is given as:

$$\delta(x) = \frac{0.37x}{Re_x^{\frac{1}{5}}} \tag{22}$$

where Re_x is the Reynolds number and x is the distance from the leading edge.
The boundary layer thickness (in meters, rounded off to the second decimal place) at 1.2 m from the leading edge will be _____. [GATE 2017 XE]

42) A venturimeter of diameter 0.2 m at the entrance and 0.1 m at the throat is inclined upwards. The difference in elevation between the entrance and the throat is 0.5 m. The pressure at the entrance and throat are measured by two pressure gauges. The entrance pressure gauge shows a pressure of 10 kN/m² and the throat pressure gauge shows a pressure difference of 30 kN/m². Assume acceleration due to gravity as 9.81 m/s².
The velocity of the water (in m/s, rounded off to the second decimal place) at the throat would be _____. [GATE 2017 XE]

43) A spherical bubble of radius r is rising upward with a constant velocity U, in quiescent water of dynamic viscosity μ. The density of air and water are denoted by ρ_a and ρ_w, respectively, and g is acceleration due to gravity. The bubble motion is such that, the Reynolds number, Re $\ll$ 1. The density of air can be neglected in comparison to the water density ($\rho_a \ll \rho_w$). Which one of the following expressions is TRUE for the density of water?

[GATE 2017 XE]

a) $\rho_w = \frac{2}{9} \frac{\mu U}{r^2 g}$

b) $\rho_w = \frac{9}{2} \frac{\mu U}{r^2 g}$

c) $\rho_w = \frac{9}{4} \frac{\mu U}{r^2 g}$

d) $\rho_w = \frac{4}{9} \frac{\mu U}{r^2 g}$

44) The event would have been successful if you _____ able to come. [GATE 2017 XE]

a) are

b) had been

c) have been

d) would have been

45) There was no doubt that their work was thorough.
Which of the words below is closest in meaning to the underlined word above? [GATE 2017 XE]

a) pretty

b) complete

c) sloppy

d) haphazard

46) Four cards lie on a table. Each card has a number printed on one side and a colour on the other. The faces visible on the cards are 2, 3, red and blue.
Proposition: If a card has an even value on one side, then its opposite face is red.
The cards which MUST be turned over to verify the above proposition are [GATE 2017 XE]

a) 2, red

b) 2, blue

c) 2, 3, red

d) 2, red, blue

47) What is the value of x when $81 \times \left(\dfrac{25}{16}\right)^{x+2} \times \left(\dfrac{2}{3}\right)^{2x+4} = 144$?   [GATE 2017 XE]

a) -1

b) -2

c) -3

d) Cannot be determined

48) Two dice are thrown simultaneously. The probability that the product of the numbers appearing on the top faces of the dice is a perfect square is   [GATE 2017 XE]

a) 1/9

b) 2/9

c) 1/3

d) 4/9

49) Bhaichung was observing the pattern of people entering and leaving a car service centre. There was a single window where customers were being served. He saw that people inevitably came out of the centre in the order that they went in. However, the time they spent inside seemed to vary a lot: some people came out in a matter of minutes while for others it took much longer.
From this, what can one conclude?

[GATE 2017 XE]

a) The centre operates on a first-come-first-served basis, but with variable service times, depending on specific customer needs.

b) Customers were served in an arbitrary order, since they took varying amounts of time for service completion in the centre.

c) Since some people came out within a few minutes of entering the centre, the system is likely to operate on a last-come-first-served basis.

d) Entering the centre early ensured that one would have shorter service times and most people attempted to do this.

50) A map shows the elevations of Darjeeling, Gangtok, Kalimpong, Pelling, and Siliguri. Kalimpong is at a lower elevation than Gangtok. Pelling is at a lower elevation than Gangtok. Pelling is at a higher elevation than Siliguri. Darjeeling is at a higher elevation than Gangtok.
Which of the following statements can be inferred from the paragraph above?   [GATE 2017 XE]

i. Pelling is at a higher elevation than Kalimpong

ii. Kalimpong is at a lower elevation than Darjeeling

iii. Kalimpong is at a higher elevation than Siliguri

iv. Siliguri is at a lower elevation than Gangtok

a) Only ii   b) Only ii and iii   c) Only ii and iv   d) Only iii and iv

51) P, Q, R, S, T and U are seated around a circular table. R is seated two places to the right of Q. P is seated three places to the left of R. S is seated opposite U. If P and U now switch seats, which of the following must necessarily be true?   [GATE 2017 XE]

a) P is immediately to the right of R

b) T is immediately to the left of P

c) T is immediately to the left of P or P is immediately to the right of Q

d) U is immediately to the right of R or P is immediately to the left of T

52) Budhan covers a distance of 19 km in 2 hours by cycling one fourth of the time and walking the rest. The next day he cycles (at the same speed as before) for half the time and walks the rest (at the same speed as before) and covers 26 km in 2 hours. The speed in km/h at which Budhan walks is

[GATE XE 2017]
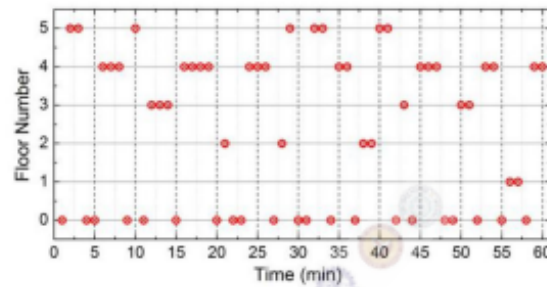
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Fig. 53.

    a) 1   b) 4   c) 5   d) 6

53) The points in the graph below represent the halts of a lift for durations of 1 minute, over a period of 1 hour.
   Which of the following statements are correct?
   a) The elevator never moves directly from any non-ground floor to another non-ground floor over the one hour period.
   b) The elevator stays on the fourth floor for the longest duration over the one hour period.

   a) Only i   c) Both i and ii
   b) Only ii   d) Neither i nor ii

54) Which processing technique is best suited for manufacturing decorative PVC floor tiles?   [GATE 2017 XE]

   a) Blow molding   c) Rotational molding
   b) Filament winding   d) Calendering

55) During deformation of a semi-crystalline polymer, with spherulitic morphology, stressed in tension, what happens to the amorphous and the crystalline regions at the later stages?   [GATE 2017 XE]

   a) Amorphous regions remain intact and only crystallites experience bending and stretching of chains
   b) Only amorphous regions elongate in the stress direction and crystallites remain intact
   c) Amorphous regions elongate in the stress direction and crystallites experience bending and stretching of chains
   d) None of the above

56) Which of the following statement(s) is / are true regarding the structure-property correlation in polymers?
   (i) Polymers that are less coiled are more crystalline than those that are more coiled
   (ii) Branched polymers are more crystalline than the linear ones
   (iii) Polymers with inter-chain interactions have higher glass transition temperature than those without inter-chain interactions
   (iv) Polymers with inter-chain interactions are more crystalline than those without inter-chain interactions

   [GATE 2017 XE]

a) (i) and (ii)
b) (ii) and (iii)
c) (iii) and (iv)
d) (i) and (iii)

57) The contrast obtained in scanning electron microscope using back scattered electrons depends on [GATE 2017 XE]

a) Atomic number of the specimen material
b) Accelerating voltage of the microscope
c) Working distance in the microscope
d) Type of the electron emitter in the microscope

58) Ceramic materials fail at stresses much lower than their theoretical strength due to   [GATE 2017 XE]

a) Presence of dislocations
b) High elastic modulus
c) Presence of voids
d) Anisotropy in crystal structure

59) The Miller indices of the first three Bragg peaks in the X-ray diffraction pattern obtained from a polycrystalline iron sample at room temperature are   [GATE 2017 XE]

a) (111), (200), (220)
b) (100), (110), (111)
c) (100), (110), (200)
d) (110), (200), (220)

60) The number of close packed planes in the lattice of an FCC metal is   [GATE 2017 XE]

a) 2
b) 4
c) 6
d) 12

61) Which of the following treatment(s) can increase the electrical conductivity of silicon
 (i) Heating
 (ii) Doping with arsenic
(iii) Doping with aluminium
 (iv) Exposure to light

[GATE 2017 XE]

a) Only (i)
b) Only (i) and (ii)
c) Only (ii), (iii) and (iv)
d) All (i), (ii), (iii) and (iv)

62) The unit cell volume of polyethylene (PE) is 0.0933 nm^3. Assuming two ethylene repeat units are contained within each unit cell, the density of a totally crystalline PE will be _____ g/cm^3. (Take the atomic weights for carbon and hydrogen as 12.01 g/mol and 1.008 g/mol, respectively and the Avogadro's number as 6.023×10^{23} repeat units/mol) [GATE 2017 XE]

63) A continuous, aligned carbon fibre (CF) reinforced polymer composite with 30 vol% of CF and rest resin was designed for a specific application. The modulus of elasticity of CF is 170 GPa and that of the resin is 3.0 GPa. The modulus of elasticity for this composite in the direction of fibre alignment is _____ GPa. [GATE 2017 XE]

64) Match the composites in Column I with the most suitable application in Column II   [GATE 2017 XE]

Column I	Column II
(P) Exfoliated silicates filled butyl rubber	(1) Automobile pistons
(Q) Fiber reinforced aluminium alloy	(2) Contact lenses
(R) Silicon carbide whiskers reinforced alumina	(3) Ski boards
(S) Carbon particles reinforced plastic composites	(4) Tennis balls
	(5) Cutting tools inserts for machining

a) P-4; Q-1; R-5; S-3   c) P-3; Q-5; R-2; S-1

b) P-2; Q-3; R-4; S-5   d) P-2; Q-1; R-5; S-3

65) Match the processes in Column I with products in Column II   [GATE 2017 XE]

Column I	Column II
(P) Slip casting	(1) Metal powders
(Q) Zone refining	(2) Thin films
(R) Sputtering	(3) Ceramic parts
(S) Atomization	(4) Single crystal
	(5) Metal sheets

a) P-3; Q-4; R-2; S-1   c) P-3; Q-4; R-5; S-1

b) P-2; Q-1; R-2; S-5   d) P-2; Q-4; R-1; S-5

66) The value of diffusivity (D) for the diffusion of carbon (C) in γ-iron at 727°C is _____ $\times 10^{-13}$ m^2/s.(Given $D_o = 2 \times 10^{-5}$ m^2/s, activation energy $Q = 142$ kJ/mol; $R = 8.314$ J/mol $\cdot$ K).

[GATE 2017 XE]

67) Refer to the figure below:
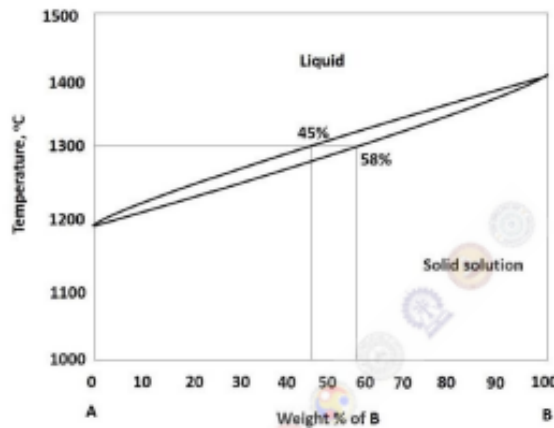
Fig. 67.

If the alloy contains 47 wt. % of A and 53 wt.% of B at 1300 $^{\circ}$C, the wt.% of liquid present in the alloy at this temperature will be ...   [GATE 2017 XE]

68) Which of the following statement(s) is/are true

(i) All piezoelectric materials are necessarily ferroelectric

(ii) All ferroelectric materials are necessarily piezoelectric

(iii) All pyroelectric materials are necessarily piezoelectric

(iv) All pyroelectric materials are necessarily ferroelectric

[GATE 2017 XE]

a) (i) and (ii)   c) (iii) and (iv)

b) (ii) and (iii)   d) (ii) and (iv)

69) If the energy of formation of vacancies in pure copper is 0.9 eV, the fraction of vacancies in pure copper at 27°C will be _____ $\times 10^{-6}$ (Boltzmann's constant is 8.62×10^{-5} eV/K). [GATE 2017 XE]

70) A ceramic material with a critical flaw size of 30 μm has fracture stress of 300 MPa. For the same material the fracture stress for a critical flaw size of 90 μm will be _____ MPa. [GATE 2017 XE]

71) An inorganic material that is transparent under solar light appears coloured when doped with transition metal ions. The possible reason(s) for the colour is/are

   (i) The electronic energy levels of the host material changes significantly by doping

   (ii) The doped element selectively absorbs certain wavelength of light other than the band gap absorption

   (iii) The doped element emits radiation of specific wavelength

   [GATE 2017 XE]

   which of the statement is correct

   a) Only (i)
   b) Both (i) and (ii)
   c) Both (ii) and (iii)
   d) Both (i) and (iii)

72) Copper is an FCC metal with lattice parameter of 3.62 Å. Hall effect measurement shows electron mobility to be 3.2×10^{-2} m^2/V-s. Electrical resistivity of copper is 1.7×10^{-8} Ωm. The electron mean free path in copper at room temperature (300 K) is _____ nm. (Take electronic charge as 1.6×10^{-19} C) [GATE 2017 XE]

73) In an ionic solid the cation and the anion have ionic radii as 0.8 Å and 1.6 Å respectively. The maximum coordination number of the cation in the structure will be [GATE 2017 XE]

   a) 3
   b) 4
   c) 6
   d) 8

74) Which of the following statement(s) is / are true regarding susceptibility of a material [GATE 2017 XE]

   (i) Magnetic susceptibility is positive for a diamagnetic material
   (ii) Magnetic susceptibility is negative for a diamagnetic material
   (iii) Magnetic susceptibility is negative for an antiferromagnetic material
   (iv) Magnetic susceptibility is positive for a paramagnetic material

   a) (ii) and (iv)
   b) (i) and (iii)
   c) (ii) and (iii)
   d) (i) and (iv)

75) In the truss shown, a mass m = 10kg is hung from the node J. The magnitude of net force (in Newtons) transferred by the truss EFGHIJ onto the truss JKLMNO at the node J is _____. Assume acceleration due to gravity, g = 10m/s^2. [GATE 2017 XE]
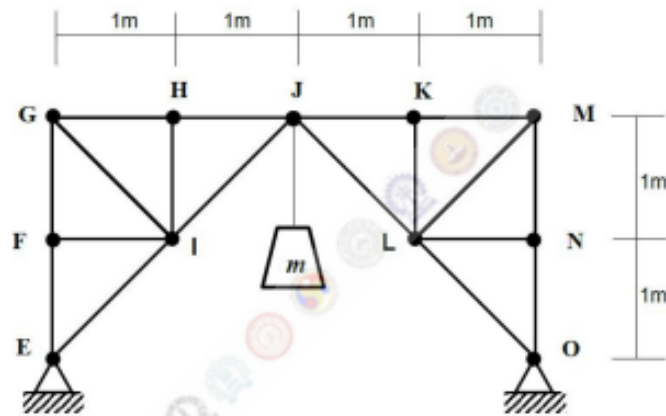
Fig. 75.

76) A ball moves along a planar frictionless slot as shown. Which one of the paths shown closely matches the path taken by the ball after it exits the slot at E?
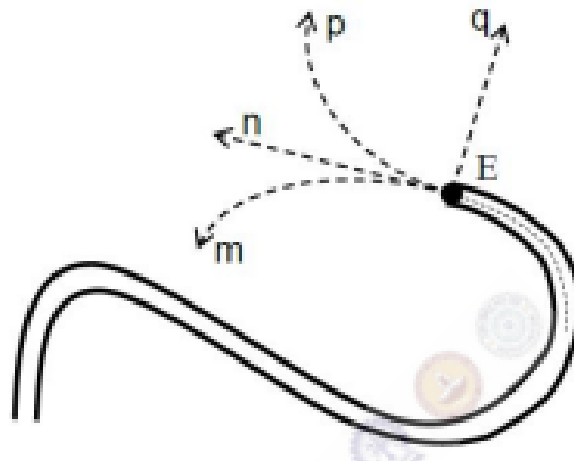
Fig. 76.

[GATE 2017 XE]

77) A rod EF moving in a plane has velocity V_E at E and V_F at F that are parallel to each other. Which of the following CANNOT be true?

[GATE 2017 XE]

Fig. 77.

a) Both V_E and V_F are perpendicular to EF.

b) Magnitude of V_E is equal to the magnitude of V_F and the angular velocity of EF is zero.

c) The velocity V_E is not perpendicular to EF and

the angular velocity of EF is nonzero.

d) Magnitude of V_E is not equal to the magnitude of V_F and the angular velocity of EF is nonzero.

78) The beam shown below carries two external moments. A counterclockwise moment of magnitude $2M$ acts at point B and a clockwise moment of magnitude M acts at the free end C. The beam is fixed at A. The shear force at a section close to the fixed end is equal to _____ .

[GATE 2017 XE]

Fig. 78.

a) $\dfrac{2M}{L}$

b) $\dfrac{M}{L}$

c) 0
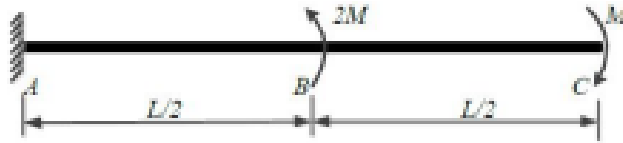
d) $\dfrac{M}{2L}$

79) Two pendulums are shown below. Pendulum-A carries a bob of mass m, hung using a hinged massless rigid rod of length L, whereas Pendulum-B carries a bob of mass $4m$ and length $\dfrac{L}{4}$. The ratio of natural frequencies of Pendulum-A and Pendulum-B is given by _____ .

[GATE 2017 XE]

Fig. 79.

a) $1 : 2$

b) $1 : 1$

c) $\sqrt{2} : 1$

d) $2 : 1$

80) A closed thin-walled cylindrical steel pressure vessel of wall thickness $t = 1mm$ is subjected to internal pressure. The maximum value of pressure p (in kPa) that the wall can withstand based on the maximum shear stress failure theory is given by (Yield strength of steel is 200MPa and mean radius of the cylinder $r = 1m$).

[GATE 2017 XE]

a) 100

b) 200

c) 300

d) 400

81) The state of stress at a point in a body is represented using components of stresses along X and Y directions as shown. Which one of the following represents the state of stress along X' and Y' axes? (X' - axis is at 45° clockwise with respect to X - axis).

[GATE 2017 XE]
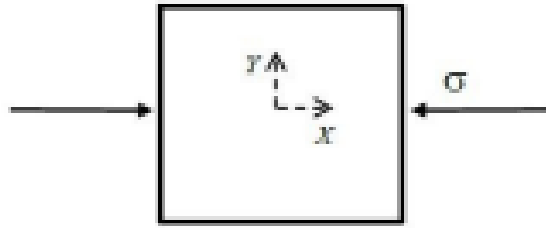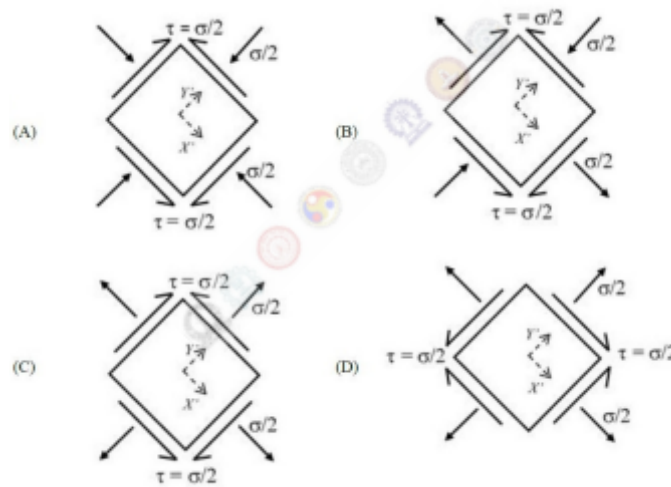
Fig. 81.

Fig. 81.

82) An aluminum specimen with an initial gauge diameter $d_0 = 10$mm and a gauge length $l_0 = 100$mm is subjected to tension test. A tensile force $P = 50$kN is applied at the ends of the specimen as shown resulting in an elongation of 1mm in the gauge length. The Poisson's ratio (v) of the specimen is _____ Shear modulus of the material $G = 25$GPa. Consider engineering stress-strain conditions.

[GATE 2017 XE]
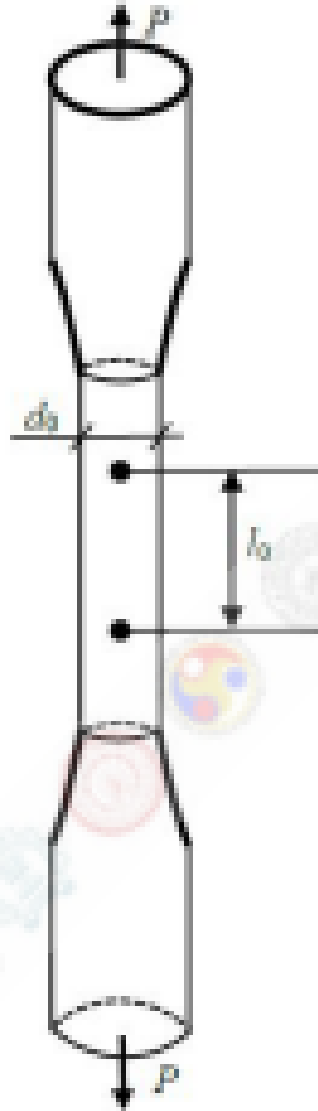
Fig. 82.

83) A rectangular sheet $ABCD$ of dimensions a and b along X and Y directions, respectively, is stretched to a rectangle $AB'C'D'$, as shown. The maximum principal strain (ϵ_1) and minimum principal strain (ϵ_2) due to the stretch are given by

[GATE 2017 XE]
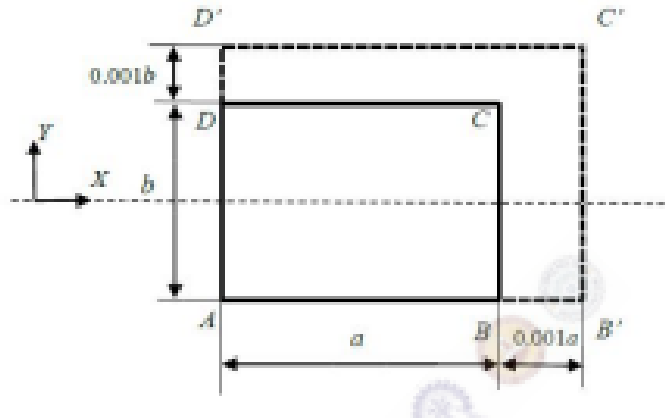
Fig. 83.

(A) 0.001 and 0.001
(B) −0.001 and 0.001

(C) −0.001 and −0.001
(D) −0.001 and 0.001

84) A solid bar of uniform square cross-section of side b and length L is rigidly fixed to the supports at the two ends. When the temperature in the rod is increased uniformly by T_c, the bar undergoes elastic buckling. Assume Young's modulus E and coefficient of thermal expansion α to be independent of temperature. The coefficient of thermal expansion α is given by [GATE 2017 XE]

(A) $\dfrac{3\pi^2 b^2}{ET_c L^2}$

(B) $\dfrac{\pi^2 b^2}{T_c L^2}$

(C) $\dfrac{\pi^2 b^2}{2T_c L^2}$

(D) $\dfrac{3T_c}{2bL^2}$

85) Two rigid blocks, of masses 10kg and 15kg, are arranged one on top of the other and placed on a horizontal rough surface as shown. The blocks are connected to each other through an inextensible cable passing over a frictionless pulley. The coefficients of static friction between the blocks and also between the bottom block and the surface are all equal to 0.3. The force P (in Newtons) needed to set the blocks in motion towards right is (Assume acceleration due to gravity $g = 10\text{m/s}^2$)

[GATE 2017 XE]
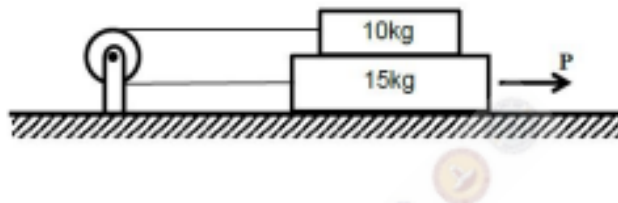
Fig. 85.

86) A truss system EFGH shown below is built using members EF, GH and FH of the same cross-sectional area 10mm^2 and member FG of cross-sectional area 20mm^2. The total strain energy stored (in Nm) in the system due to a force $P = 1$kN acting at F is _____

Assume elastic deformations and members are made of steel with elastic modulus of 200GPa. 1m

[GATE 2017 XE]
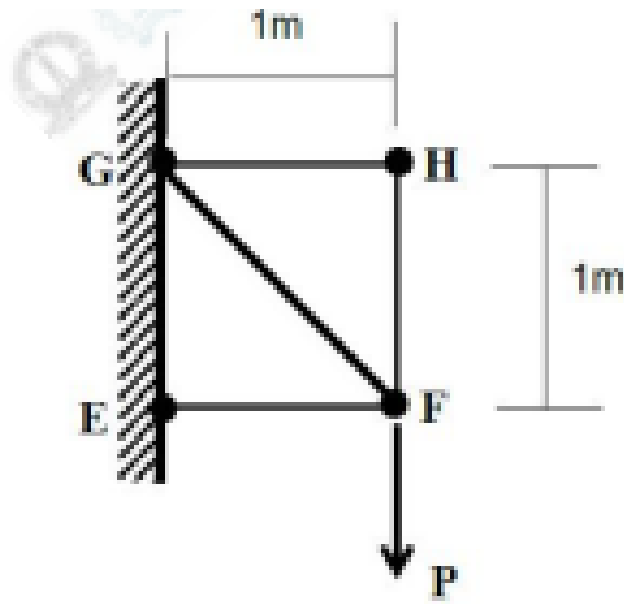
Fig. 86.

87) A rigid frame grips on to a steel wall as shown using a powerful magnet at the top support G and with a roller support at E. EF is horizontal. A man stands on the platform attached to the frame 1m away from the wall as shown. Assume the frame and magnet assembly to be of negligible weight and the mass of the man to be 80kg. The magnitude of the reaction (in Newtons) exerted by the frame onto the steel wall due to the weight of the man is _____ The magnetic force of attraction of the magnet at no load condition is 1kN. Magnet can be assumed to be small enough that it offers negligible moment resistance. Assume acceleration due to gravity, g=10m/s^2.

[GATE 2017 XE]
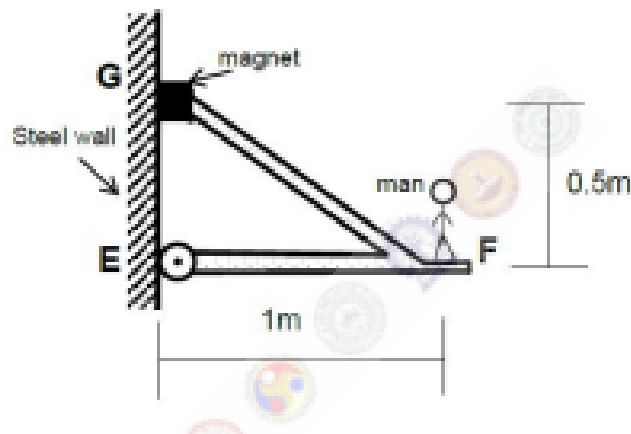
Fig. 87.

88) A manually operated band brake has a control lever EFG as shown and has a coefficient of kinetic friction equal to 0.2. The cylinder initially rotates clockwise at a constant frequency of 10 revolutions per second. A force P=300N is applied at G. The pin support at O is frictionless. The radius of the cylinder $r = 0.15$m and the radius of gyration is 0.1m. The mass of the cylinder is 50kg. Assume acceleration due to gravity $g = 10$m/s^2. The time required (in seconds) to reduce the rotational frequency to 5 revolutions per second is _____
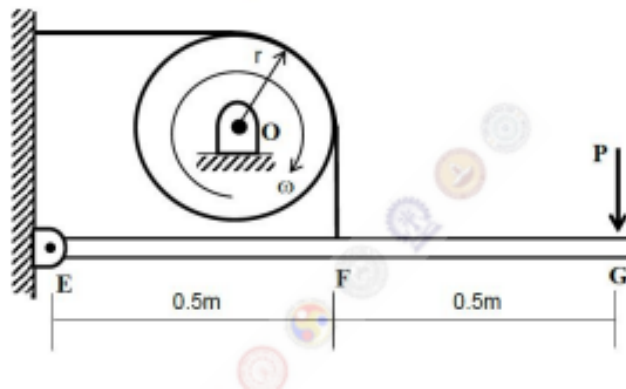
Fig. 88.

89) In a pin-connected mechanism shown, load P applied at F is 50N. Neglect the weight of the links and assume k = 1kN/m for the spring. The bars EH and FG are pinned at O at their centre such that the lengths of EO, GO, HO and FO are all equal to l = 0.2m. The spring between G and H is unstretched when θ = 45°. The angle θ (in degrees) under equilibrium is _____

[GATE 2017 XE]
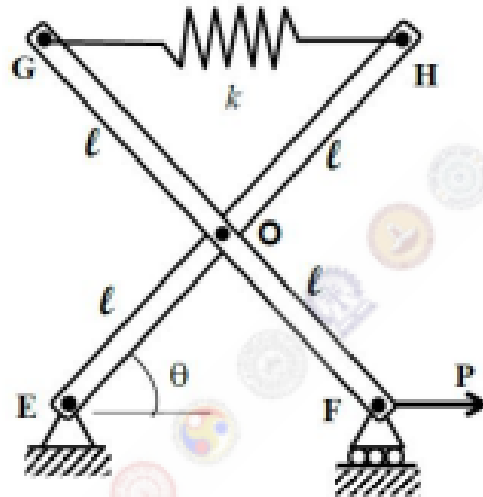
Fig. 89.

90) The frame shown below carries a vertical load P = 10kN at its free end D. The frame is fixed at A and has a roller support at B. Magnitude of the reaction force at B (in kN) is _____.
Assume that the effect of the axial force on bending is negligible.

[GATE 2017 XE]
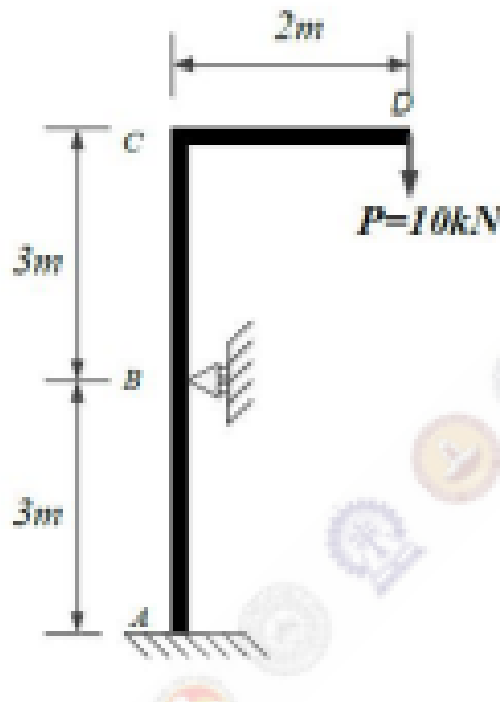
Fig. 90.

91) Consider the system shown below. Mass M is fixed to the rod AC at a distance x from the hinge point at B. Two springs of stiffness $3K$ and K are attached to the rod at points A and C, respectively. The natural frequency of angular oscillation of the system about B is 20 rad/s. Assume the rod to be rigid and massless. Magnitude of x (in metres) is _____ (M = 30kg and K = 1kN/m).

[GATE 2017 XE]
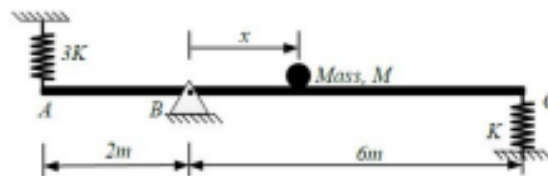
Fig. 91.

92) The simply supported beam shown below is subjected to a clockwise moment M at point A and two counterclockwise moments $2M$ and M at points B and C, respectively. Which one of the following is the correct bending moment diagram (tensile at bottom is positive moment) for the beam?
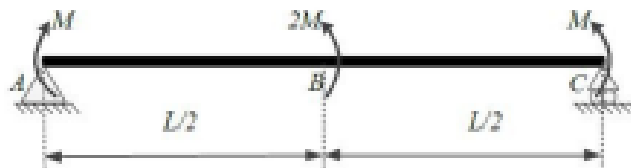
Fig. 92.

[GATE 2017 XE]
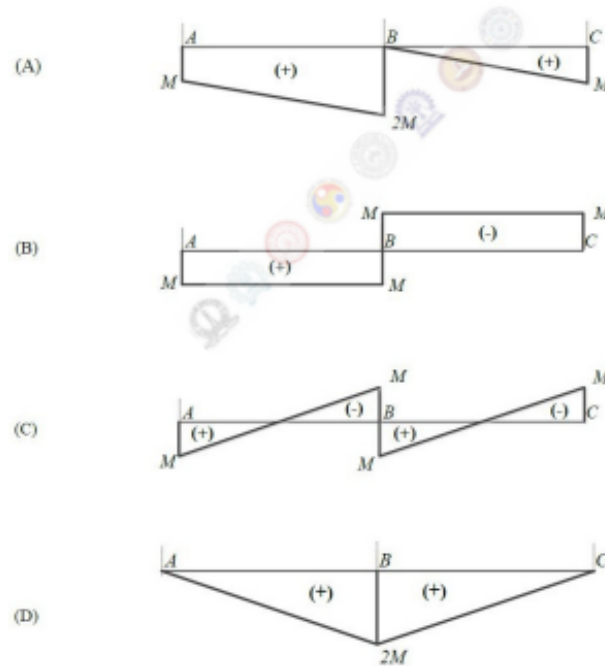
Fig. 92.

93) The structure shown below is of rectangular cross section and carries a load of 10kN at its free end E. Maximum bending stress (in MPa) developed in the beam due the external load is_____ The depth of the beam is 300mm and the width is 150mm

[GATE 2017 XE]
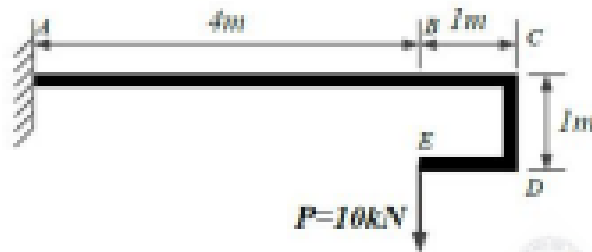
Fig. 93.

94) Two circular rods shown below carry the same axial load *P*. The Rod-A has uniform cross-section and the Rod-B has non-uniform cross-section as shown. The ratio of elongation of Rod-A to Rod-B is given by

[GATE 2017 XE]
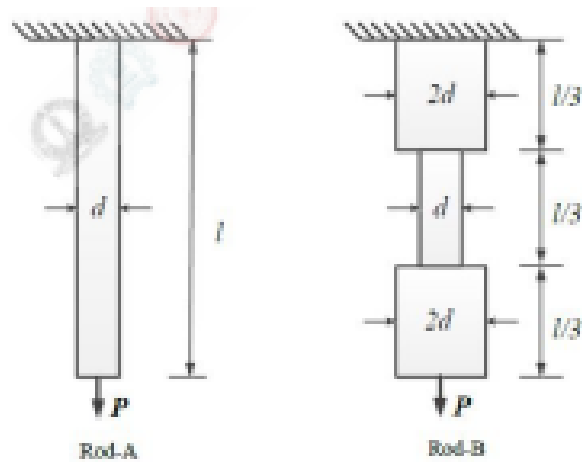
Fig. 94.

    a) 1:1   c) 2:1
    b) 1:2   d) 3:1

95) A composite shaft is made of a steel tube with an inner brass core perfectly bonded together as shown. The shaft is fixed at one end and subjected to a torque of $2T$ at the other end. Shear modulus of steel is G and that of brass is $G/2$. The outer radius of the steel tube is $R = 2r$ and radius of the inner brass core is r. The magnitude of shear stress at the interface (point X) and in the steel tube is closest to

[GATE 2017 XE]
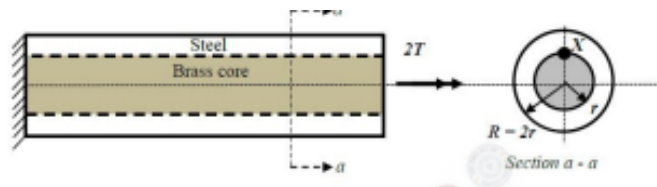
Fig. 95.

    a) $0.041\frac{T}{r^3}$ b) $0.082\frac{T}{r^3}$ c) $0.16\frac{T}{r^3}$ d) $0.41\frac{T}{r^3}$

96) A massless rod of rectangular cross-section is subjected to a force P at origin O as shown. The expression for the stress σ_{zz} at point Q is given by

[GATE 2017 XE]
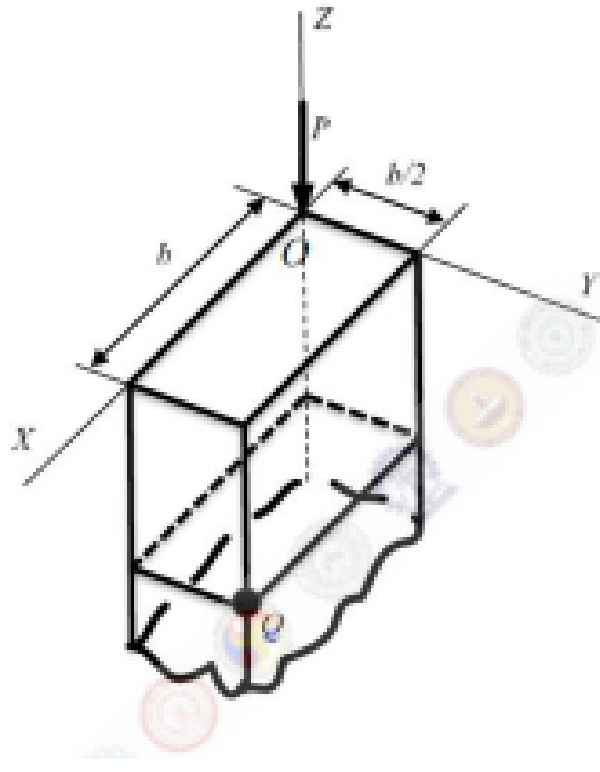
Fig. 96.

(A) $\frac{6P}{b^2}$

(C) $-\frac{14P}{b^2}$

(B) $\frac{10P}{b^2}$

(D) $-\frac{P}{b^2}$

97) Given $d\phi = f(T)dT + (T/V)dV$ and $d\psi = Tdp + (T/p^2)dV$, then

[XE GATE 2017]

a) Both ϕ and ψ are properties

c) ϕ is a property but ψ is not a property

b) Neither ϕ nor ψ is a property

d) ψ is a property but ϕ is not a property

98) A paddle wheel is installed in a rigid insulated tank containing 10 kg air ($C_v = 0.718\,kJ/kg.K$). A torque of 100 N.m is applied on the paddle wheel to rotate it at 60 revolutions per minute for 2 minutes. At the end of the process, the increase in temperature of air in °C is

[XE GATE 2017]

a) 0

c) 10.50

b) 5.25

d) 21.50

99) Consider two systems each containing 20 kg of air at the same temperature and pressure. It is desired to increase the temperature of the air in both systems by 10°C. One system undergoes a constant pressure heat addition process and the other undergoes a constant volume heat addition process. The difference in the values of heat transferred to the two systems in kJ is

[XE GATE 2017]

a) 30.5

c) 57.5

b) 144.2

d) 73.2

100) A refrigerator is used to maintain certain space at 10°C. It pumps 18000 kJ/hour of heat from the space to the atmosphere at 30°C. If the power input to the refrigerator is 2 kW, the ratio of COP of this refrigerator to that of a Carnot refrigerator (up to 2 decimal places) is

101) A thermal cycle receives 2000 kJ of heat from a heat source at 1000 K. It rejects 300 kJ of heat to a heat sink at 300 K and also rejects 250 kJ of heat to another heat sink at 200 K during the cycle. The cycle is

a) reversible

b) irreversible

c) impossible

d) work absorbing

102) Saturated liquid water is slowly heated at a constant pressure of 200 kPa to a final state where its quality reaches 0.65. For water at 200 kPa: T_{sat} = 120.23°C, h_f = 504.68 kJ/kg, h_{fg} = 2706.60 kJ/kg. The increase in specific entropy in kJ/kg.K is

a) 3.44

b) 3.64

c) 3.84

d) 4.04

103) Given the thermodynamic functional relations: $p = p(v, T)$ and $T = T(p, v)$, the term

$$\left(\frac{\partial^2 v}{\partial T \partial p} \right) \tag{23}$$

is equal to

a) $\left(\frac{\partial T}{\partial v} \right)_p$

b) $\left(\frac{\partial T}{\partial p} \right)_v$

c) $\left(\frac{\partial T}{\partial v} \right)_T$

d) 1

104) Two closed cycle gas turbine engines, A and B, operate on air standard Brayton cycle with efficiencies of η_A and η_B, respectively. If they operate between the same maximum and minimum temperatures, but with different pressure ratios of r_{pA} and r_{pB} ($r_{pA} > r_{pB}$), then

a) $\eta_A > \eta_B$

b) $\eta_A < \eta_B$

c) $\eta_A = \eta_B$

d) Cannot be determined as the efficiencies are maximum only at the optimal r_p values.

105) The values of density and isentropic compressibility of water at certain pressure and temperature are given as 1000 kg/m³ and 4×10^{-10} Pa⁻¹, respectively. The speed at which sound travels in water under these conditions in m/s is equal to

106) Length of a certain metal rod at 0°C is 10 cm. The coefficient of linear expansion of that metal varies with temperature as $10^{-4} + 10^{-7}T$ (cm/cm)/°C. When the length of the metal rod is 10.2 cm, the rise in temperature in °C is

107) In a polytropic compression process, one kg of an ideal gas having a molecular weight of 40 kg/kmol is compressed from 100 kPa, 300 K to 400 kPa, 360 K. The magnitude of the work in kJ for the process is

a) 52.3   c) 72.3
b) 62.3   d) 82.3

108) Two streams of air (C_p = 1005 J/kg.K) flow through insulated pipes 1 and 2 with the conditions as shown in figure. They mix in an insulated pipe-3 and the mixture steadily exits with a velocity of 100 m/s at 150 kPa. Neglecting the change in potential energy in all the pipes, the exit area of the pipe-3 in m² (up to 3 decimal places) is _____
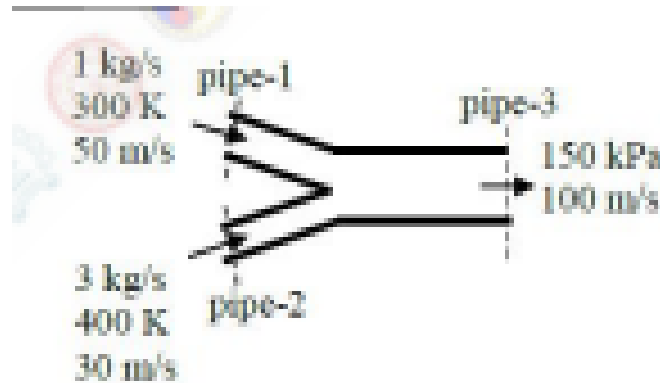
[XE GATE 2017]

Fig. 108.

109) A 1 m³ rigid vessel contains air at 200 kPa. A vacuum pump is connected to the vessel in order to control the pressure inside. The volume flow rate of air through the pump is maintained at a constant value of 0.1 m³/s. If the pump operates for 10 seconds and the temperature of the air is maintained constant during operation, the pressure in the tank in kPa after 10 seconds (up to 2 decimal places) is

[XE GATE 2017]

110) A heat engine receives Q_1 kJ of heat from a hot reservoir and rejects Q_2 kJ of heat to a cold reservoir. The work delivered by the heat engine is entirely supplied to a heat pump, which receives Q_3 kJ of heat from another reservoir and rejects Q_4 kJ of heat to the same cold reservoir. If the efficiency of the heat engine is 0.4 and COP of the heat pump is 4.0, the value of $(Q_2 + Q_4)/Q_1$ (up to 1 decimal place) is

[XE GATE 2017]

111) A block of ice of mass 2 kg at 0°C is dropped into an insulated vessel containing 10 kg of liquid water at 25°C. The latent heat of melting of ice is 330 kJ/kg and specific heat of water is 4.2 kJ/kg.K. The change in the entropy of the universe in kJ/K (up to 3 decimal places) is

[XE GATE 2017]

112) A pure substance (C_v = 0.733 kJ/kg.K) undergoes a reversible process in which its temperature increases linearly from 40°C to 85°C and its specific entropy increases by 600 J/kg.K. The work done by the system in kJ/kg is

[XE GATE 2017]

a) (160.2)   c) (168.3)
b) (164.3)   d) (172.3)

113) An ideal gas having a mass of 0.5 kg is initially at 300 kPa, 80°C and occupies a volume of 0.14 m³. The gas undergoes an adiabatic process, where 50 kJ of work is transferred to the gas. The pressure

and temperature at the final state are 300 kPa and 0.20 m^3. The change in the entropy of the gas in kJ/K is

a) (160.3)   c) (190.3)
b) (175.3)   d) (195.3)

114) The van der Waals equation of state is given as,

$$\left(p + \frac{a}{v^2}\right)(v - b) = RT, \tag{24}$$

where p in bar, v in m^3/kmol and T is in K.
For air, the constants, a and b, are 1.358 (bar m^6/kmol^2) and 0.0367 (m^3/kmol), respectively. Air is contained in a system at 160 K and 0.08 m^3/kmol. If the pressure calculated using ideal gas equation is p$_i$ and the pressure calculated using van der Waals equation of state, then p$_i$/p$_{vdw}$ is equal to _____.

a) 1.78   c) 1.28
b) 1.52   d) 1.04

115) The values of specific volume of H$_2$O at 100°C for saturated liquid and saturated vapor states are 0.00104 m^3/kg and 1.673 m^3/kg, respectively. The slope of saturation pressure versus temperature curve, $\left(\frac{dp_{sat}}{dT}\right)_{sat}$ is 3570 kPa/K. The change in enthalpy in kJ/kg between the two saturation states is _____.

116) In a steam power plant, steam is first expanded isentropically in a turbine from an initial condition of 100 bar and 500 °C to a pressure of 40 bar. Then the steam is reheated up to 500 °C at constant pressure. The steam is then expanded isentropically in another turbine up to a condenser pressure 0.01 bar. For steam, at 100 bar, 500°C: h = 3373.7 kJ/kg, s = 6.5966 kJ/kg.K: at 40 bar, 500°C: h = 3445.3 kJ/kg, s = 7.0901 kJ/kg.K and at 0.01 bar: h_f = 29.3 kJ/kg. h_g = 2514.2 kJ/kg. s_f = 0.1059 kJ/kg.K. s_g = 8.9756 kJ/kg.K. The dryness fraction at the condenser inlet (up to 2 decimal places) is _____.

117) Air contains by volume 79% N$_2$ (molecular weight = 28 kg/kmol) and 21% O$_2$ (molecular weight = 32 kg/kmol). A stream of air flows at 32°C, 1 bar, at a rate of 2 kmol/s and is mixed with another stream of pure O$_2$ flowing at 0.4 kmol/s. The molecular weight of the mixture (up to 2 decimal places) is _____.

118) Moist air enters a duct at a rate of 3 kg/s at 10°C, 80% relative humidity. The air is heated as it flows through the duct and exits at 30°C. No moisture is added or removed and the pressure of air in the duct is constant at 1 bar. The saturation vapor pressure (p_v) of H$_2$O at 10°C is 0.01228 bar. Specific enthalpy values of dry air at inlet and outlet of the duct are respectively 283.1 kJ/kg and 303.2 kJ/kg. The corresponding specific enthalpy values for water vapor are 2519.8 kJ/kg and 2556.3 kJ/kg. For steady state operation the amount of heat added to the moist air in kW (up to 2 decimal places) is _____.

119) Poly(ethylene terephthalate) is synthesized from

a) Ethylene + dimethyl terephthalate

c) Glycerol + terephthalic acid

b) Ethylene + terephthalic acid

d) Ethylene Glycol + terephthalic acid

120) Poly(vinyl chloride) has a higher T_g than polypropylene due to the presence of

[GATE XE 2017]

a) Bulky side groups

c) Restriction of bond rotation

b) Polar interactions

d) Non-polar interactions

121) The filler which would impart electrical conductivity to a polymer is

[GATE XE 2017]

a) Carbon black

c) Glass beads

b) Talc

d) Calcium carbonate

122) Which one of the following catalysts is used to prepare 'isotactic' polypropylene?

[GATE XE 2017]

a) Alkyl lithium

c) Ziegler-Natta

b) BF_3

d) AIBN

123) Novolac and Resole are A-stage low molecular weight phenolic resin products that are

[GATE XE 2017]

a) Soluble and fusible

c) Insoluble and fusible

b) Soluble but infusible

d) Insoluble and infusible

124) Which of the following reagents can act as an initiator at room temperature?

[GATE XE 2017]

a) AIBN

c) Dibenzoyl peroxide

b) Dicumyl peroxide

d) $Fe^{2+} + H_2O_2$

125) The impact strength of polystyrene can be enhanced by blending/mixing with

[GATE XE 2017]

a) Carbon black

c) Polybutadiene

b) PMMA

d) Glass fibre

126) The melt processing temperature of a semicrystalline thermoplastic polymer is

[GATE XE 2017]

a) Between T_g and T_m

c) Lower than T_m

b) Equal to T_m

d) Higher than T_m

127) The unit of viscosity of a polymer is expressed as

[GATE XE 2017]

a) Pa·s

c) Pa·s^2

b) Pa·s^{-1}

d) Pa·s^{-3}

128) Based on the graphs 1-5, which option best describes the stress-strain behaviour of materials listed as P, Q, R, S and T?

P-Hard and brittle
Q-Hard and tough
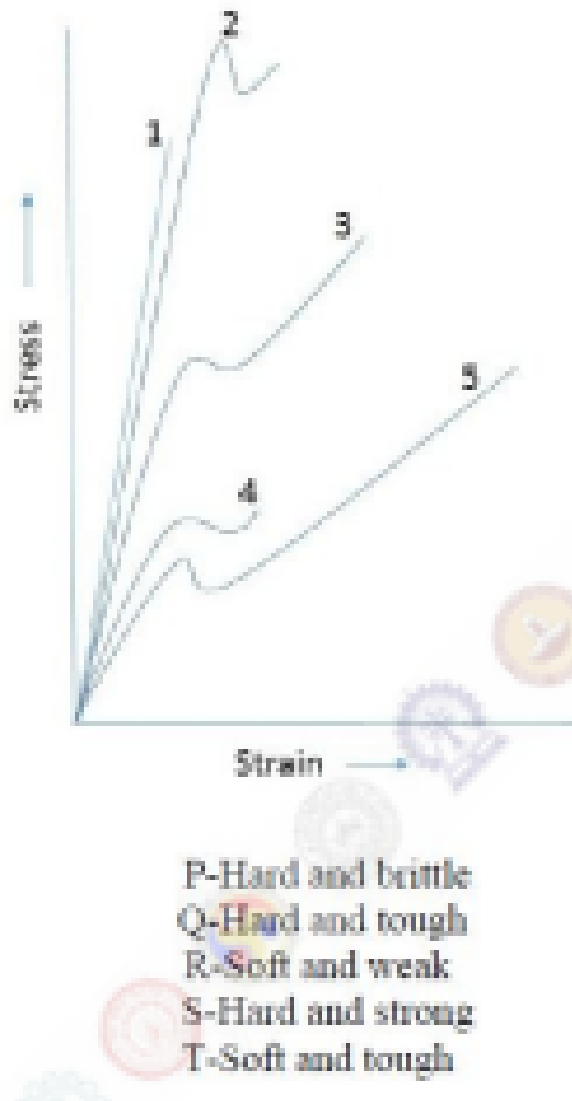R-Soft and weak
S-Hard and strong
T-Soft and tough

Fig. 128.

a) P-2; Q-1; R-5; S-4; T-3
b) P-1; Q-3; R-4; S-2; T-5

c) P-1; Q-2; R-5; S-3; T-4
d) P-2; Q-3; R-1; S-4; T-5

129) The two characterization techniques which can be used to determine degree of crystallinity of a polymer are
P. Scanning Electron Microscopy
Q. Thermogravimetric Analysis
R. Wide Angle X-Ray Diffraction
S. Differential Scanning Calorimetry

[XE GATE 2017]

a) P&R
b) Q&R

c) R&S
d) Q&S

130) The density of polyethylene crystals is 998 kg m^{-3} and that of totally amorphous polyethylene is 856 kg m^{-3}. If the density of a polyethylene sample is 949 kg m^{-3}, the crystallinity in volume fraction is _____. (round off final answer to two digits after decimal place).

[GATE XE 2017]

131) The polydispersity index of a polymer sample containing 200 molecules each of molecular weight 10,000 g mol^{-1}, 300 molecules each of molecular weight 30,000 g mol^{-1} and 500 molecules each of molecular weight 50,000 g mol^{-1} is _____.. (round off final answer to two digits after decimal place).

[GATE XE 2017]

132) Match the following rubber additives to their function:

[GATE XE 2017]

Additive	Function
P. Dicumyl peroxide	1. Ultrafast accelerator
Q. Pentachlorothiophenol	2. Activator
R. ZnO with stearic acid	3. Curing agent
S. Zinc diethyldithiocarbamate	4. Peptizer

a) P-3; Q-1; R-2; S-4
b) P-3; Q-1; R-4; S-2
c) P-3; Q-4; R-2; S-1
d) P-3; Q-4; R-1; S-2

133) A composite of polypropylene reinforced with 20% by volume of glass fibre is to be prepared. If the density of glass fibre is 2540 kg m^{-3} and polypropylene is 900 kg m^{-3}, the melt flow index of this glass fibre composite is _____. g/10 min. (round off final answer to one digit after decimal place).

[GATE XE 2017]

134) Match the following terminology to the appropriate polymer processing technique:

Terminology	Processing Technique
P. Die-swell	1. Two roll mill mixing
Q. Breathing	2. Thermoforming
R. Plug-assisted	3. Extrusion
S. Mastication	4. Compression moulding

[GATE XE 2017]

a) P-1: Q-2: R-3: S-4
b) P-3: Q-4: R-2: S-1
c) P-2: Q-3: R-4: S-1
d) P-2: Q-1: R-4: S-3

135) Match the polymer in Column A to its application in Column B:

Column A	Column B
P. Nylon	1. Television cabinet
Q. Polyethylene	2. Tyre
R. Cis-1,4-polyisoprene	3. Mechanical gear
S. Acrylonitrile-butadiene-styrene	4. Packaging

[GATE XE 2017]

a) P-3: Q-4: R-2: S-1
b) P-4: Q-3: R-2: S-1
c) P-4: Q-2: R-3: S-1
d) P-3: Q-4: R-1: S-2

136) For the polycondensation of equimolar amounts of adipic acid with hexamethylene diamine, if the number average degree of polymerization is 100, then the extent of reaction is _____

[GATE XE 2017]

137) The relaxation time for a rubber band at 23 °C is 60 days. If it is stressed to 2 MPa initially, then the time required before the stress relaxes to 1 MPa is _____ days (round off final answer to two digits after decimal point).

138) Match the processing technique in Column A to the corresponding shear rate (s^{-1}) in Column B.

Column A	Column B
P. Injection Moulding	1. 1-10
Q. Extrusion	2. 10-100
R. Calendering	3. 100-1000
S. Compression Moulding	4. 1000-10000

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

139) Given T_g of polymer A is 100 °C and that of polymer B is -100 °C, then the T_g of a miscible blend of A and B containing 30 wt% of A is _____ °C (round off final answer to a single digit after decimal point).

140) Match plots 1-4 given in the figure below with the correct flow behavior of polymeric fluid listed as P, Q, R & S.

Fig. 140.

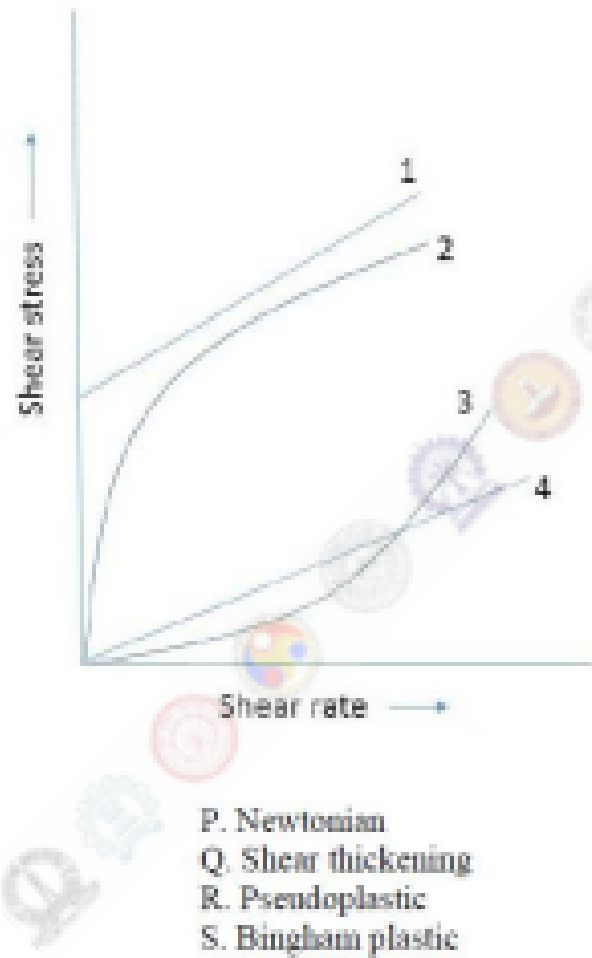a) P-4: Q-2: R-3; S-1
b) P-4: Q-3; R-3; S-1

c) P-4; Q-3; R-1; S-2
d) P-1, Q-3; R-2; S-4

141) Indicate the correct group that contains a monosaccharide, a disaccharide and a trisaccharide.

a) Glucose, sucrose, mannose
b) Ribose, lactose, raffinose

c) Mannose, maltose, lactose
d) Raffinose, stachyose, glucose

142) In which of the following products, 'must' is used as the substrate for fermentation?

a) Beer
b) Wine

c) Idli
d) Tempeh

143) Identify the foodborne illness which is NOT caused by bacteria.

a) Botulism

c) Vibriosis

b) Listeriosis

d) Cysticercosis

144) Nutrient composition of wheat flour changes with extent of extraction from whole wheat grain. Which of the following statements is true if the extraction rate increased from 50% to 90%?

[XE GATE 2017]

a) Starch increases, protein increases, fat increases, mineral increases
b) Starch decreases, protein increases, fat increases, mineral increases
c) Starch decreases, protein decreases, fat increases, mineral increases
d) Starch decreases, protein increases, fat decreases, mineral decreases

145) You have two samples of milk, one (X) with 3.8% fat and another (Y) with 0.5% fat. In order to produce a milk with 3.5% fat, 100 ml of Y should be mixed with _____ ml of X.

[XE GATE 2017]

146) Match the items in column I with the items in column II in relation to food safety and standards.

Column I	Column II
P. HACCP	1. International food standards
Q. FSSAI	2. Quality control protocol
R. CIP	3. Food plant sanitation and hygiene protocol
S. CODEX	4. Indian food standards

[XE GATE 2017]

a) P-2, Q-4, R-3, S-1
b) P-2, Q-3, R-2, S-1
c) P-1, Q-4, R-2, S-3
d) P-4, Q-2, R-3, S-1

147) A 50% sucrose solution at 20 °C is flowing at a rate of 3.5 m^3/h through a pipe with an inside diameter of 0.0475 m and length of 12 m. The viscosity and the density of the solution are 15.43 cp and 1232 kg/m^3, respectively. The Reynolds number of the flow is _____.

[XE GATE 2017]

148) In a pineapple juice, fibre particles having mean diameter of 160 μm and density of 1075 kg/m^3 are settling by gravity. If the density and viscosity of the juice are 1015 kg/m^3 and 0.98 cp, respectively, terminal velocity of the fibre particles is _____ mm/s.

[XE GATE 2017]

149) Power consumption in liquid mixing is proportional to _____.

[XE GATE 2017]

a) Power number × liquid density × (rotational speed)^3 × (impeller diameter)^5
b) Power number × liquid density × (rotational speed)^3 × (impeller diameter)^3
c) Liquid density × viscosity of the liquid × (rotational speed)^2 × (impeller diameter)^2
d) Acceleration due to gravity × liquid density × (rotational speed)^2 × (impeller diameter)^3.

150) Match the following metabolic product (Column I) that indicates the quality of food (Column II)

Group I	Group II
P. Saponification number	1. Unsaturation of fatty acid
Q. Iodine number	2. Volatile water soluble fatty acid
R. Reichert Meissl number	3. Hydroxy fatty acid
S. Acetyl value	4. Molecular weight of fatty acid

[XE GATE 2017]

a) P-1, Q-2, R-3, S-4

b) P-1, Q-3, R-4, S-2

c) P-4, Q-1, R-2, S-3

d) P-2, Q-1, R-3, S-4

151) Match the following metabolic product (Column I) that indicates the quality of food (Column II)

Column I	Column II
P. Ethanol	1. Canned vegetable
Q. Lactic acid	2. Fish
R. Trimethylamine	3. Butter
S. Volatile fatty acid	4. Apple juice

[XE GATE 2017]

a) P-3, Q-2, R-4, S-1

b) P-4, Q-1, R-2, S-3

c) P-4, Q-3, R-2, S-1

d) P-3, Q-4, R-2, S-1

152) Correlate the vitamins in column I with their role in promoting reaction/process in column II.

Column I	Column II
P. Riboflavin	1. Visual cycle
Q. Vitamin D	2. Acyl group transfer
R. Pantothenic acid	3. Regulation of Ca^{2+} metabolism
S. Vitamin A	4. Oxidation-reduction reaction

[XE GATE 2017]

a) P-1, Q-2, R-4, S-3

b) P-2, Q-3, R-1, S-4

c) P-2, Q-1, R-3, S-4

d) P-4, Q-3, R-2, S-1

153) A pure strain with generation time of 60 min is used in a fermentation process. Following inoculation (0 h), the strain takes 2 h for adaptation, 10 h to achieve maximum growth and 12 h to arrive at the point where the death rate is higher than the growth rate. If the inoculation load is 100 cells, the total population at the end of 10 h will be _____ .

[XE GATE 2017]

154) Refer the shear stress – shear rate plot shown in the figure below. Match the lines (Column I) with appropriate rheological behavior (Column II).

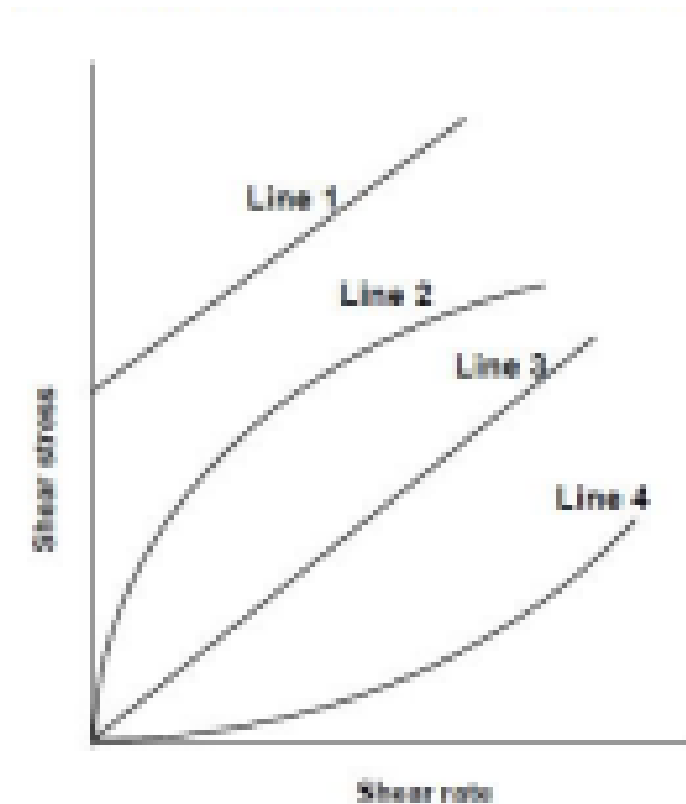| Column I	Column II
P. Line 1	1. Dilatant
Q. Line 2	2. Newtonian
R. Line 3	3. Pseudoplastic
S. Line 4	4. Bingham plastic

Fig. 154.

[XE GATE 2017]

a) P-2, Q-4, R-3, S-1
b) P-1, Q-3, R-4, S-2

c) P-4, Q-2, R-1, S-3
d) P-4, Q-3, R-2, S-1

155) Water flowing at a rate of 1 kg/min is heated from 12 to 80 °C with flue gas supplied at a rate of 3 kg/min. The temperature and specific heat of the flue gas are 180 °C and 1.05 kJ/kg.K, respectively. If specific heat of water is 4.2 kJ/kg.K and the flow is parallel, then the logarithmic mean temperature difference will be _____ °C. [XE GATE 2017]

156) The Lineweaver-Burk plot of an enzymatic reaction shows V_{max} of 160 μmol/l.min and K_s of 60 μmol/l. For a substrate concentration of 40 μmol/l, the velocity of the reaction is estimated to be _____ μmol/l.min. [XE GATE 2017]

157) Bread is wrapped in 0.1 mm thick cellophane film having water vapour permeability of 1.82×10^{-10} m^3 water (STP)/s.m^2.atm at 38 °C. If the surface area of pack, vapour pressure of water inside and outside of the pack is 0.20 m^2, 10 mm Hg and 5 mm Hg, respectively, the loss of water vapour at 38 °C in g/day is _____. [XE GATE 2017]

158) Match the following methods / system (column I) with the appropriate operations (column II).

Column I	Column II
A. Parboiling	1. Sugarcane juice extraction
B. Reaming	2. Hydrothermal treatment
C. Milling	3. Oven milling
D. Break rolls	4. Wet milling
E. Unbaked products	5. Barley processing
F. Crushing rolls	6. Pulse milling

[XE GATE 2017]

(A) P4, Q2, R3, S6, T2, U1   (C) P2, Q5, R3, S1, T4, U1

(B) P4, Q5, R3, S1, T4, U1   (D) P2, Q5, R3, S2, T6, U1

159) A 12 mm thick fish fillet having 80% moisture content (wet basis) is to be frozen using a plate freezer. The plates are maintained at -35 °C. Assume the heat transfer coefficient, initial freezing temperature and latent heat of fusion are 2.0 W/m²·K, -2 °C and 330 kJ/kg, respectively. If the density and thermal conductivity of frozen fish fillet are 1050 kg/m³ and 1.48 W/m·K, respectively, the time required to freeze the fillet from the initial freezing temperature is _____ h. [XE GATE 2017]

160) A suspension containing 2×10^4 spores of organism A having a $D_{121.1°C}$ value of 1.5 min and 3×10^5 spores of organism B having a $D_{121.1°C}$ value of 0.8 min is heated at a constant temperature of 121.1 °C. The heating time needed to obtain a probability of spoilage '1 in 1000' is _____ min. [XE GATE 2017]

161) In an evaporation process, a compressor picks up 0.05 m³ air in each revolution and compresses 500 kg of air per minute. If the specific volume of air is 0.9 m³/kg, then the compressor speed is _____ rpm. [XE GATE 2017]

162) For a soybean oil extraction system, solvent : soy ratio is maintained at 0.5 : 1 (w/w). Original seed contains 18% oil (w/w). If the meal (soy solid) after final desolventization contains 1% residual oil (w/w, oil-free meal basis), then the effectiveness of the solvent (kg oil/kg solvent) in the extraction process is _____. [XE GATE 2017]

163) Rossby Number is the ratio of

a) Coriolis Force to Inertial Force   c) Gravitational Force to Coriolis Force

b) Inertial Force to Coriolis Force   d) Viscous Force to Inertial Force

[XE GATE 2017]

164) Kuroshio Current and Gulf Stream are

a) EBC, WBC   c) WBC, WBC

b) EBC, EBC   d) WBC, EBC

[WBC: Western Boundary Current, EBC: Eastern Boundary Current]

[XE GATE 2017]

165) The velocity of a tsunami wave in an ocean basin of depth 1 km is ____ ms⁻¹ [Density of seawater: 1025 kg m⁻³. g: 10 ms⁻²]

[XE GATE 2017]

166) A thin iceberg is observed to move southeastward in the Arctic Ocean. If the surface current is wind driven, the prevailing wind is

[XE GATE 2017]

a) Easterly   b) Northerly   c) Southerly   d) Westerly

167) Equatorial Kelvin and Rossby waves respectively propagate

[XE GATE 2017]

a) Westward and Eastward   b) Eastward and Westward   c) Westward and Westward   d) Eastward and Eastward

168) The largest contributor to the atmospheric greenhouse effect is

[XE GATE 2017]

a) CO_2 b) N_2 c) CH_4 d) H_2O

169) If T_v, T, T_w and T_d denote virtual, dry bulb, wet bulb and dew point temperatures of a moist air parcel, then the correct order of their values is

[XE GATE 2017]

a) $T_v > T > T_w > T_d$
b) $T_v \geq T \geq T_w \geq T_d$

c) $T_v > T \geq T_w \geq T_d$
d) $T > T_v > T_w > T_d$

170) Burning of fossil fuel is increasing the concentration of CO_2 in the atmosphere. A consequence of this is

[XE GATE 2017]

a) Ocean water which is presently basic will drift towards pH neutral
b) Ocean water which is presently acidic will become more acidic

c) No effect on ocean pH
d) Ocean water which is presently slightly basic will become more basic

171) Mixed layer depths measured in the Pacific Ocean in two different years are schematically shown in the figure below. Years P and Q belong to
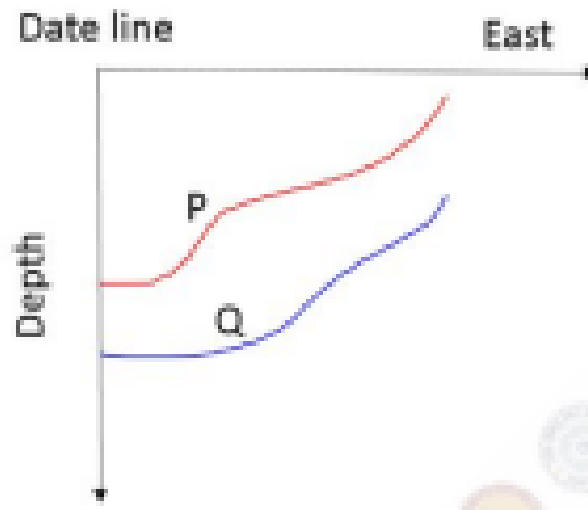
[XE GATE 2017]

Fig. 171.

a) P: El-Niño, Q: La-Niña
b) P: La-Niña, Q: El-Niño

c) P: El-Niño, Q: QBO
d) P: QBO, Q: La-Niña

172) Average surface temperatures of the Sun and the Earth are 6300 K and 285 K, respectively. The ratio of the wavelength of peak radiation of the Earth to that of the Sun is _____.

[XE GATE 2017]

173) In the month of April, the mixed layer in the Arabian Sea received a net heat flux of 50 W m^{-2}. If the mixed layer depth is 50 m, the increase in temperature at the end of April is _____ °C. Density of seawater: 1025 kg m^{-3}, Density of freshwater: 1000 kg m^{-3}, Specific heat of seawater: 4200 J kg^{-1} K^{-1}, Latent heat of evaporation: 2.45×10^6 J kg^{-1}.

[XE GATE 2017]

174) The thickness of an atmospheric layer between 600 hPa and 500 hPa is 1.5 km. If the layer is isothermal, then its temperature is _____ K.
Gas constant of air: 287 J kg^{-1} K^{-1}; g = 10 m s^{-2}.

[XE GATE 2017]

175) At 17°N, a mass of fluid is moving under geostrophic balance at 0.3 m s^{-1} towards east. Suddenly the pressure gradient force becomes zero. Then the fluid will

a) continue to move towards the east at 0.3 m s^{-1}
b) undergo circular motion with radius of about 17 km
c) undergo circular motion with radius of about 7 km
d) move towards south

(Angular velocity of the Earth: 7.27 × 10^{-5} rad s^{-1})

[XE GATE 2017]

176) At 45°N, wind is blowing northward and its magnitude decreases eastward from 10 m s^{-1} to 1 m s^{-1} over a distance of 1000 km. The relative vorticity of the flow is _____ × 10^{-5} s^{-1}.
(Angular velocity of the Earth: 7.27 × 10^{-5} rad s^{-1})

[XE GATE 2017]

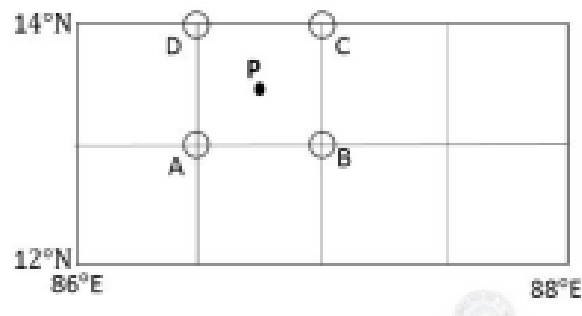177) Sea surface height anomalies at the locations A, B, C and D are -10, -15, 5 and 0 cm respectively.

Fig. 177.

The magnitude of geostrophic velocity at P is _____ m s^{-1}. [Take 1° = 100 km, g = 10 m s^{-2}. Angular velocity of the Earth: 7.27 × 10^{-5} rad s^{-1}]

178) In a severe tropical cyclone, 250 mm of rainfall occurs in an area having a radius of 200 km. If the energy supplied to the system from this rainfall is N times the energy of one atomic bomb (= 1.5 × 10^{15} kJ), then the value of N is _____.
[Density of freshwater: 1000 kg m^{-3}, Specific heat of seawater: 4200 J kg^{-1} K^{-1}, Latent heat of evaporation: 2.45 × 10^6 J kg^{-1}]

[XE GATE 2017]

179) A student wants to numerically solve the linear 1-D advection equation $\frac{\partial q}{\partial t} + c\frac{\partial q}{\partial x} = 0$, where $c = 300$ m s^{-1}. The value of the maximum time-step the student can consider according to CFL criterion for a spatial resolution of 3 km is

[XE GATE 2017]

a) 15 s
b) 10 s
c) 25 s
d) 20 s

180) Planets in the solar system are in radiative equilibrium. Let S_0, α, T_0 and R denote solar constant, albedo, average temperature and radius of a planet, respectively, and σ is Stefan's constant. Then the energy balance of this planet is given by the expression

[XE GATE 2017]

a) $(1 - \alpha)S_0 = 4\sigma T_0^4$

c) $\alpha S_0 = \sigma T_0^4$

b) $(1 - \alpha)S_0 = 2\sigma T_0^4$

d) $\pi R^2(1 - \alpha)S_0 = 4\sigma T_0^4$

181) A cumulonimbus cloud forms by an air parcel rising from the sea level with an initial temperature and specific humidity of 27°C and 20 g kg^{-1}, respectively. Assume that moist static energy is conserved in this cloud. Then the cloud temperature at an altitude of 15 km is _____ K.
[Specific heat of dry air at constant pressure: 1005 J kg^{-1} K^{-1}, Specific heat of water vapour at constant pressure: 1850 J kg^{-1} K^{-1}; g = 10 m s^{-2}, Latent heat of evaporation: 2.45×10^6 J kg^{-1}]

[XE GATE 2017]

182) If u_g and v_g are respectively zonal and meridional components of a flow field in geostrophic balance, then the divergence of this flow is

[GATE XE 2017]

a) 0

b) $\dfrac{u_g}{\rho}\dfrac{\partial r}{\partial x}$

c) $-\dfrac{1}{\rho f}\dfrac{\partial^2 p}{\partial y^2}$

d) $-\dfrac{v_g}{\rho f}\dfrac{\partial r}{\partial y}$

[x, y, f, u, v, p, ρ are zonal distance, meridional distance, Coriolis parameter, pressure and density, respectively]

183) During the Indian summer monsoon season, depressions do not intensify to tropical cyclones because
P: Indian sub-continent is very hot and large land-sea temperature difference pulls depressions quickly to land before they can intensify into cyclones. Q: SST cooling due to strong monsoonal winds prevents cyclone formation. R: SST cooling due to strong monsoonal winds prevents cyclone formation. S: Strong zonal wind shear during the monsoon season does not allow warm core formation.
Which of the above statement(s) is/are correct?

[GATE XE 2017]

a) P & Q

b) Only R

c) Only S

d) R & S

184) Which among the following statement(s) is (are) correct.
P: ENSO and El-Nino are the same and refer to the warming of Equatorial Eastern Pacific SST. Q: ENSO is an atmosphere-ocean coupled phenomenon and El-Nino is its oceanic part. R: ENSO is an atmospheric phenomenon and El-Nino is an ocean phenomenon. S: ENSO is the oscillatory component of El-Nino having a period of 4-7 years.

[GATE XE 2017]

a) P & R

b) Only Q

c) P, Q and S

d) R & S