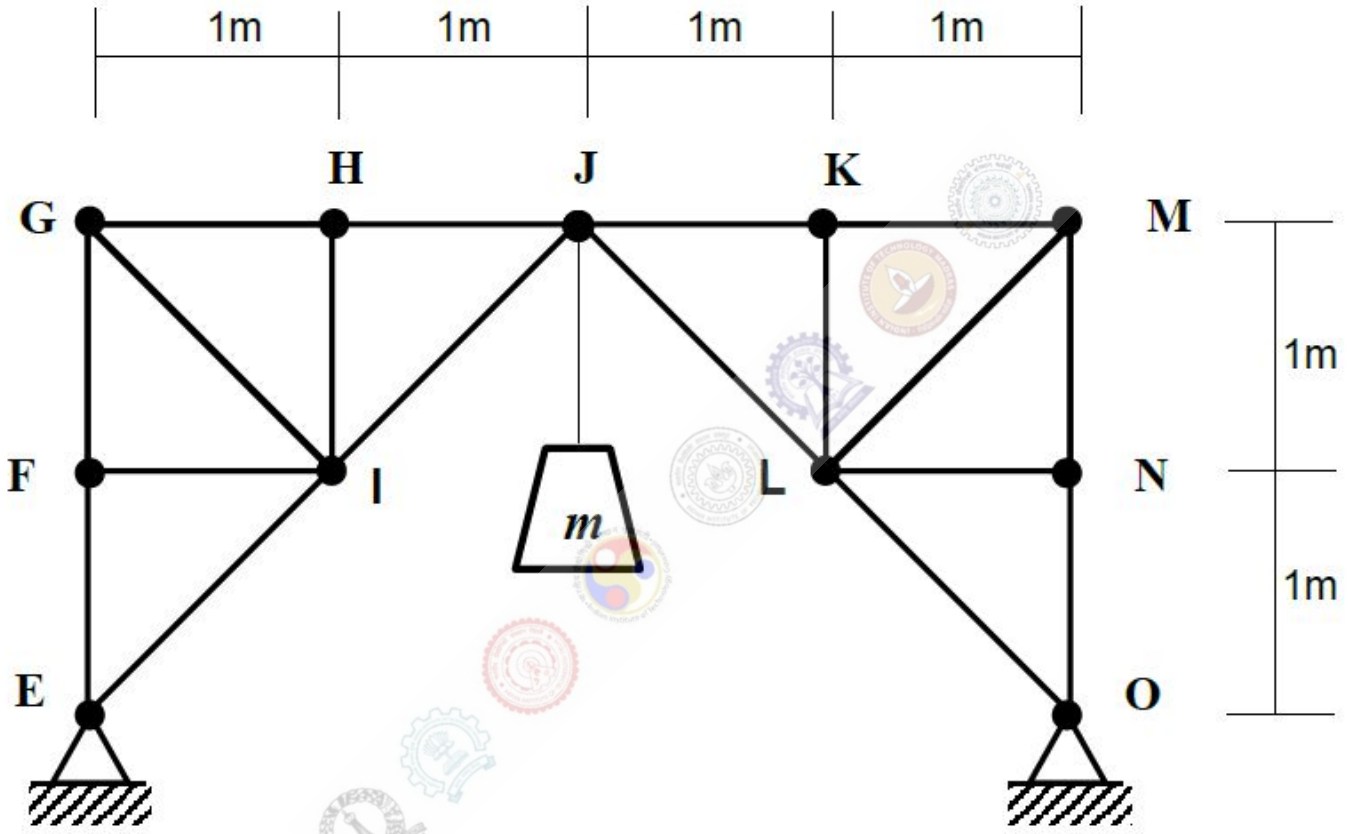
Solid Mechanics (XE - D)

Question Number : 56 **Correct : 1 Wrong : 0**

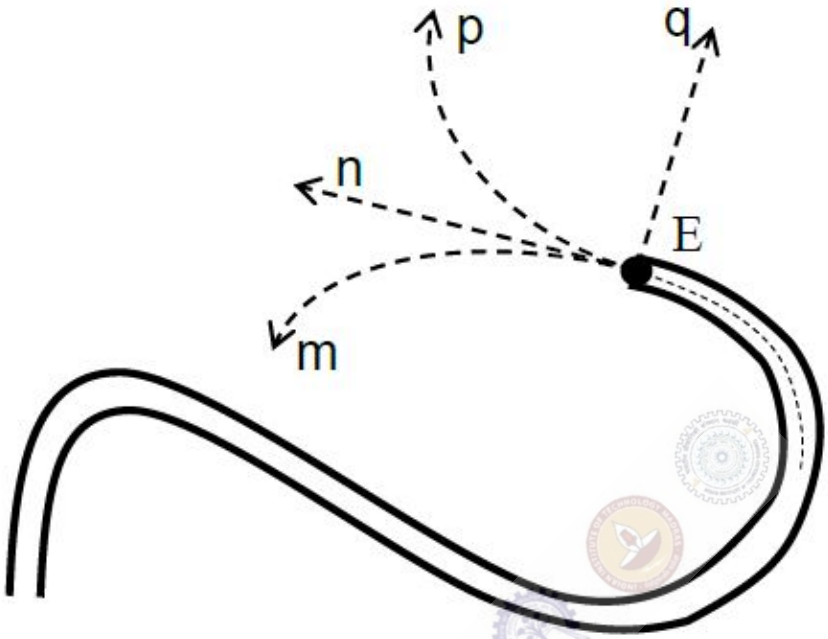
In the truss shown, a mass m = **10kg** is hung from the node **J**. The magnitude of net force (in **Newtons**) transferred by the truss **EFGHIJ** onto the truss **JKLMNO** at the node **J** is _____.

Assume acceleration due to gravity, $g = 10 m/s^2$.



Question Number : 57 **Correct : 1 Wrong : -0.33**

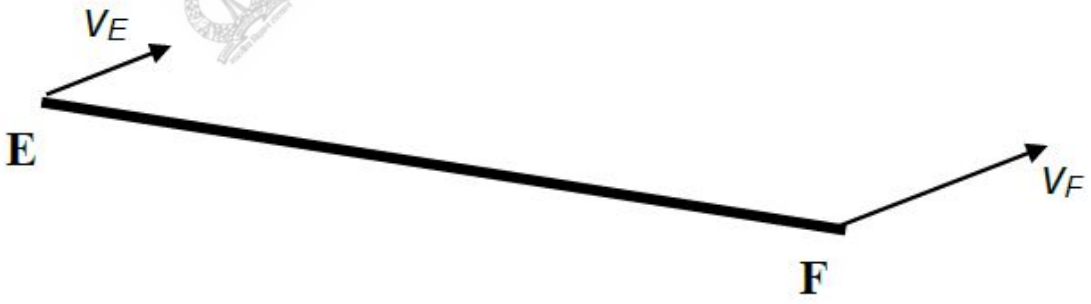
A ball moves along a planar frictionless slot as shown. Which one of the paths shown closely matches the path taken by the ball after it exits the slot at **E**?



(A) path m (B) path n (C) path p (D) path q

Question Number : 58 **Correct : 1 Wrong : -0.33**

A rod **EF** moving in a plane has velocity $\boldsymbol{V_E}$ at **E** and $\boldsymbol{V_F}$ at **F** that are parallel to each other. Which of the following **CANNOT** be true?



(A) Both V_E and V_F are perpendicular to EF.

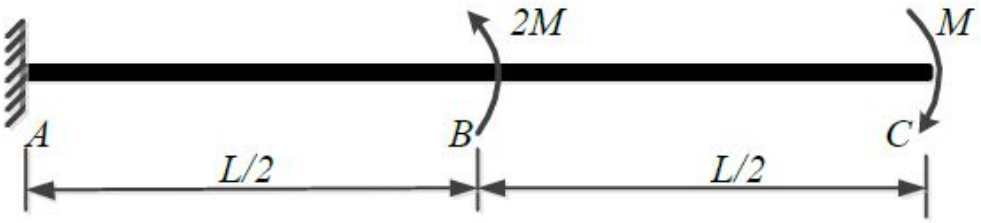
(B) Magnitude of V_E is equal to the magnitude of V_F and the angular velocity of EF is zero.

(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.

Question Number : 59 **Correct : 1 Wrong : -0.33**

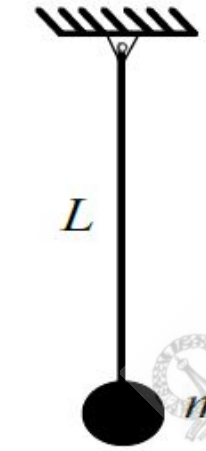
The beam shown below carries two external moments. A counterclockwise moment of magnitude ***2M*** acts at point ***B*** and a clockwise moment of magnitude ***M*** acts at the free end, ***C***. The beam is fixed at ***A***. The shear force at a section close to the fixed end is equal to



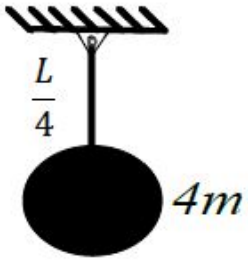
(A) $\frac{2M}{L}$ (B) $\frac{M}{L}$ (C) 0 (D) $-\frac{M}{L}$

Question Number : 60 **Correct : 1 Wrong : -0.33**

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 ***L/4***. The ratio of the natural frequencies of ***Pendulum-A*** and ***Pendulum-B*** is given by



Pendulum-A



Pendulum-B

(A) 1 : 2 (B) 1 : 1 (C) $\sqrt{2}$: 1 (D) 2 : 1

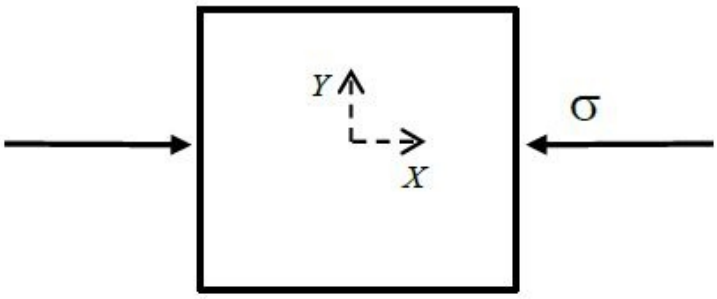
Question Number : 61 **Correct : 1 Wrong : -0.33**

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**).

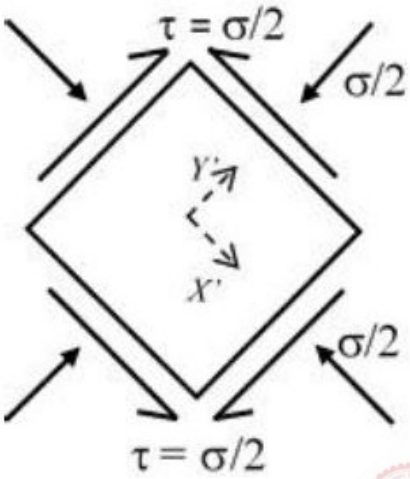
(A) 100 (B) 200 (C) 300 (D) 400

Question Number : 62 **Correct : 1 Wrong : -0.33**

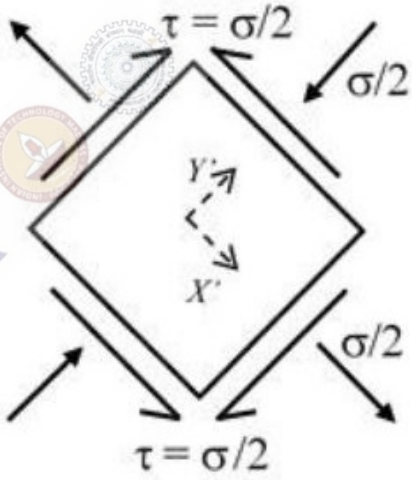
The state of stress at a point in a body is represented using components of stresses along X and Y directions as shown. Which one of the following represents the state of stress along X' and Y' axes? (X' - axis is at **45°** clockwise with respect to X - axis).



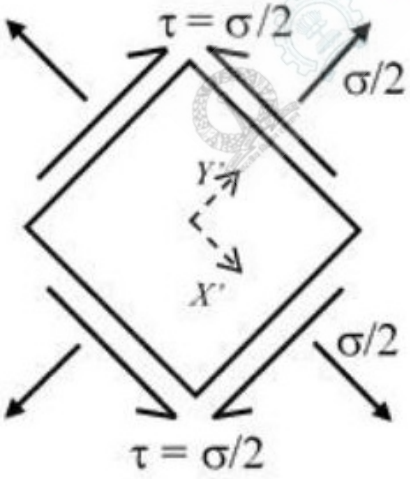
(A)



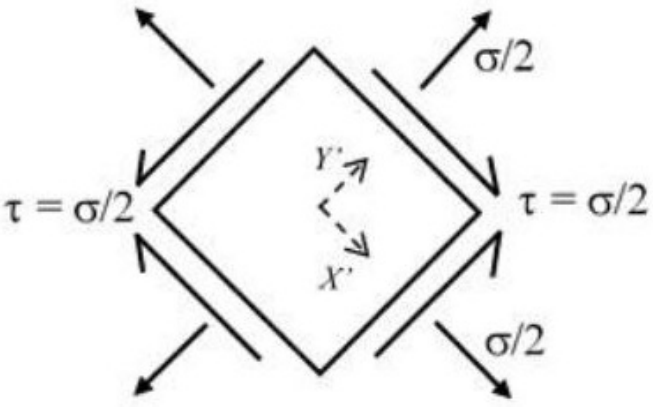
(B)



(C)

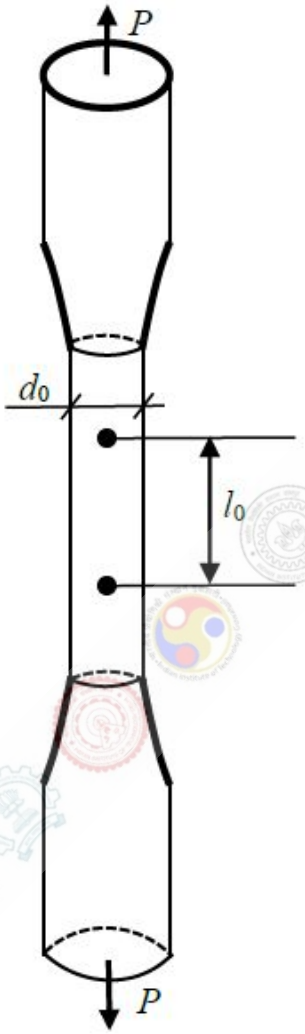


(D)



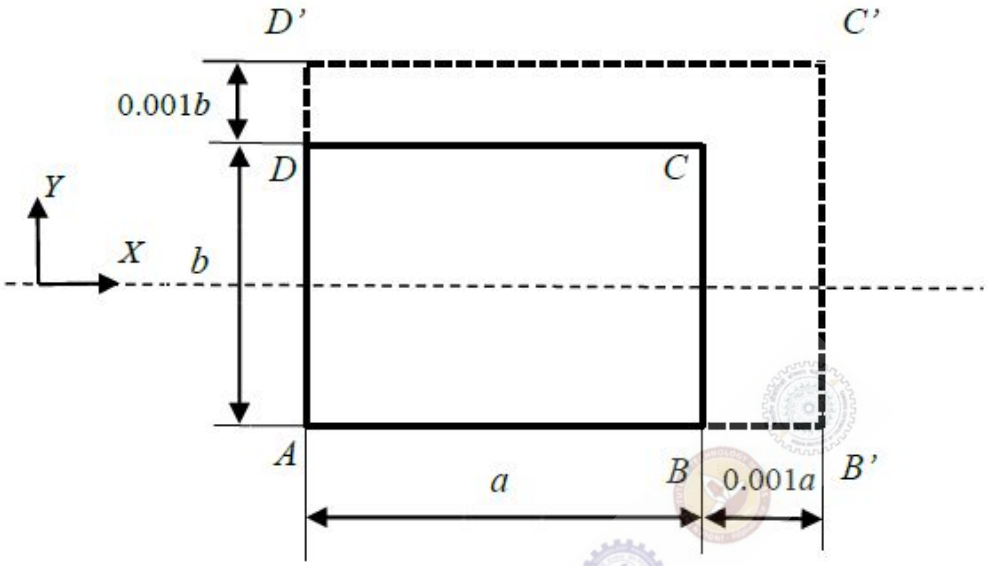
An aluminum specimen with an initial gauge diameter $d_0 = 10\text{mm}$ and a gauge length $l_0 = 100\text{mm}$ is subjected to tension test. A tensile force $P = 50\text{kN}$ is applied at the ends of the specimen as shown resulting in an elongation of **1mm** in the gauge length. The Poisson's ratio (ν) of the specimen is _____.

Shear modulus of the material **G = 25GPa**. Consider engineering stress-strain conditions.



Question Number : 64 **Correct : 1 Wrong : -0.33**

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 ($\boldsymbol{\varepsilon_1}$) and minimum principal strain ($\boldsymbol{\varepsilon_2}$) due to the stretch are given by



(A) $\varepsilon_1 = 0.001$ and $\varepsilon_2 = 0.001$

(B) $\varepsilon_1 = -0.001$ and $\varepsilon_2 = 0.001$

(C) $\varepsilon_1 = 0.001$ and $\varepsilon_2 = -0.001$

(D) $\varepsilon_1 = -0.001$ and $\varepsilon_2 = -0.001$

Question Number : 65 **Correct : 2 Wrong : -0.66**

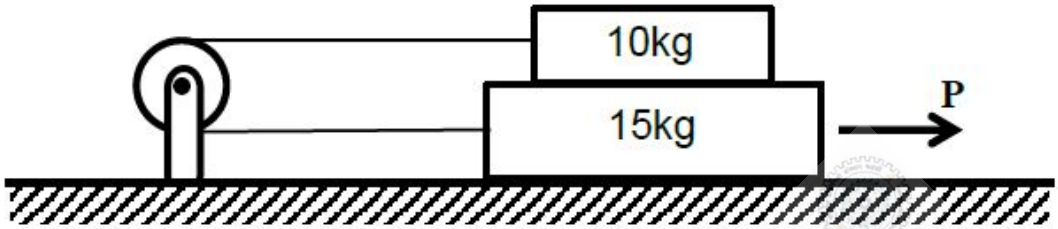
A solid bar of uniform square cross-section of side ***b*** and length ***L*** is rigidly fixed to the supports at the two ends. When the temperature in the rod is increased uniformly by ***Tc***, the bar undergoes elastic buckling. Assume Young's modulus ***E*** and coefficient of thermal expansion $\boldsymbol{\alpha}$ to be independent of temperature. The coefficient of thermal expansion $\boldsymbol{\alpha}$ is given by

(A) $\dfrac{3\pi^2 b^2}{T_c L^2}$ (B) $\dfrac{\pi^2 b^2}{T_c L^2}$ (C) $\dfrac{\pi^2 b^2}{2T_c L^2}$ (D) $\dfrac{\pi^2 b^2}{3T_c L^2}$

Question Number : 66 Correct : 2 Wrong : 0

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 _____.

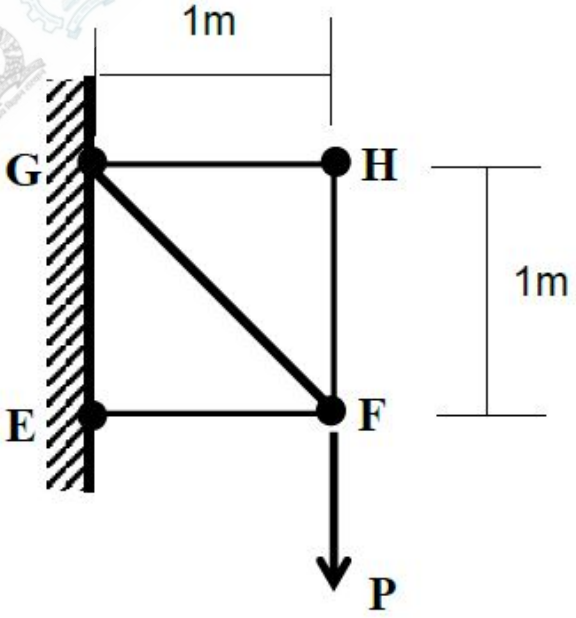
(Assume acceleration due to gravity $\mathbf{g = 10 m/s^2}$).



Question Number : 67 Correct : 2 Wrong : 0

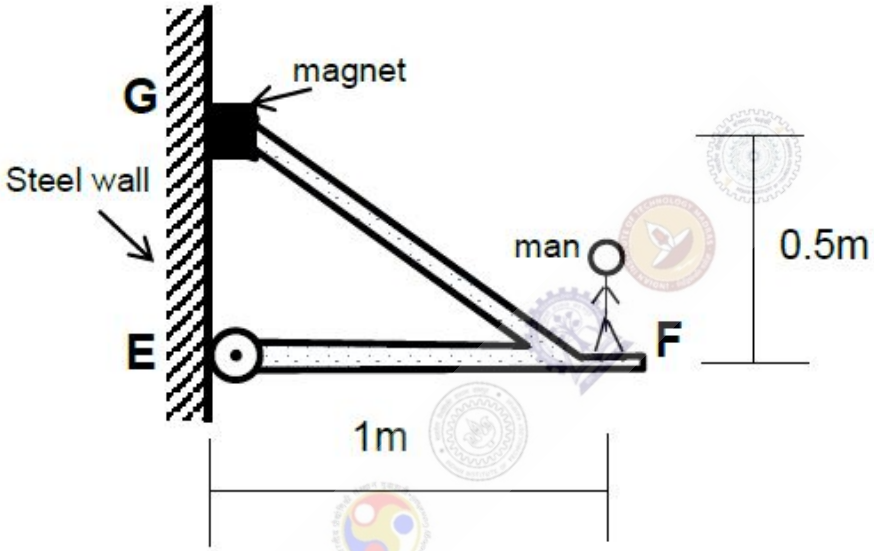
A truss system **EFGH** shown below is built using members **EF, GH** and **FH** of the same cross-sectional area $\mathbf{10 mm^2}$ and member **FG** of cross-sectional area $\mathbf{20 mm^2}$. The total **strain energy** stored (in **Nm**) in the system due to a force **P = 1kN** acting at **F** is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

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



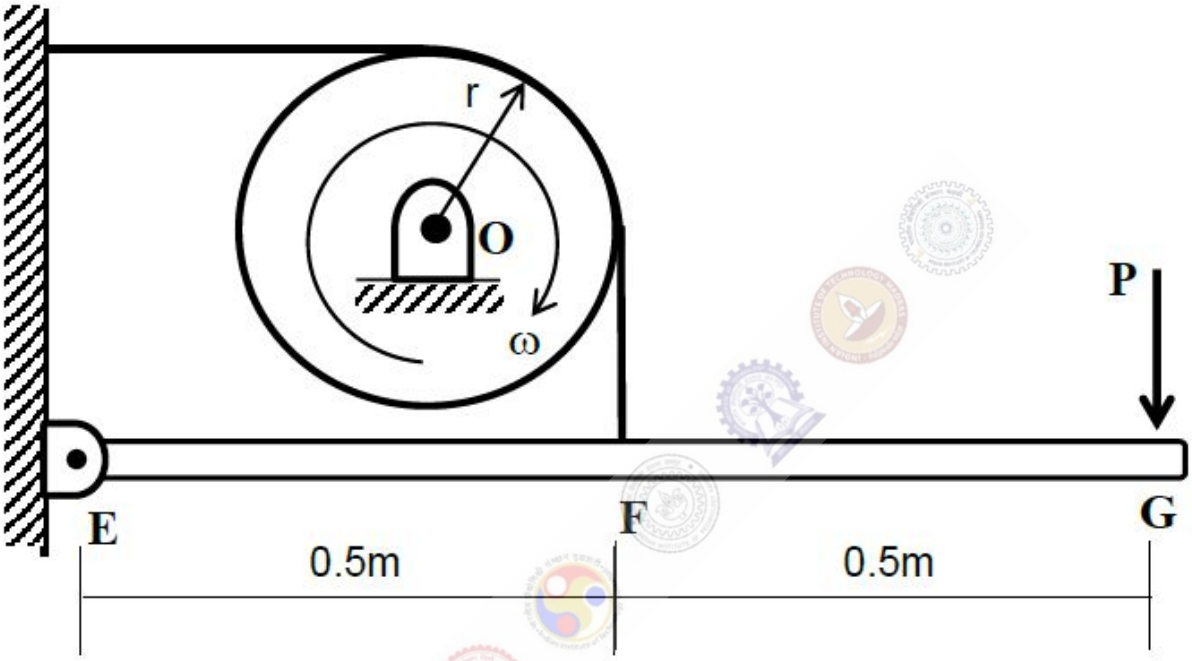
A rigid frame grips on to a steel wall as shown using a powerful magnet at the top support **G** and with a roller support at **E**. **EF** is horizontal. A man stands on the platform attached to the frame **1m** away from the wall as shown. Assume the frame and magnet assembly to be of negligible weight 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, $\mathbf{g = 10 m/s^2}$.



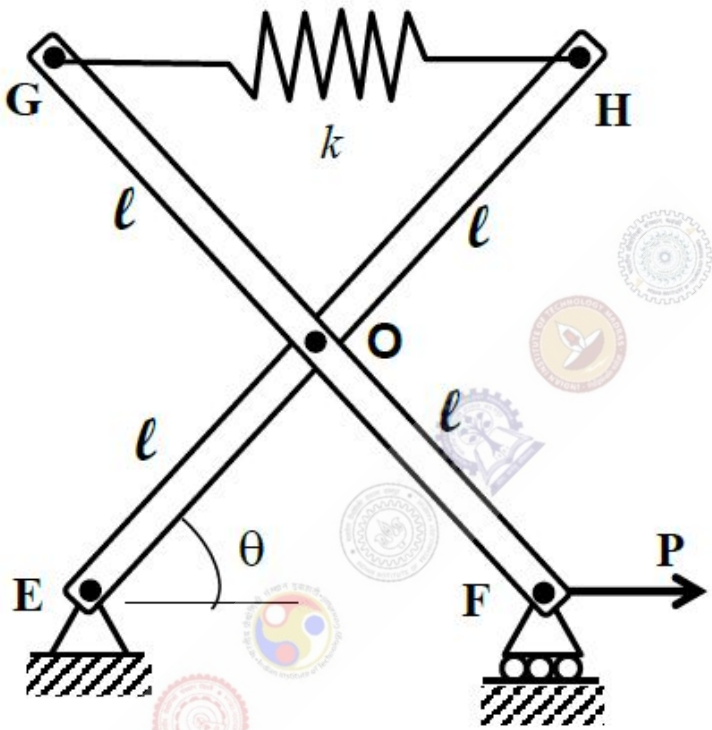
Question Number : 69 **Correct : 2 Wrong : 0**

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 is r = **0.15m** and the radius of gyration is **0.1m**. The mass of the cylinder is **50kg**. Assume acceleration due to gravity **g = 10m/s^2**. The **time required** (in **seconds**) to reduce the rotational frequency to **5 revolutions per second** is _____.



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 $\theta = 45^{o}$.

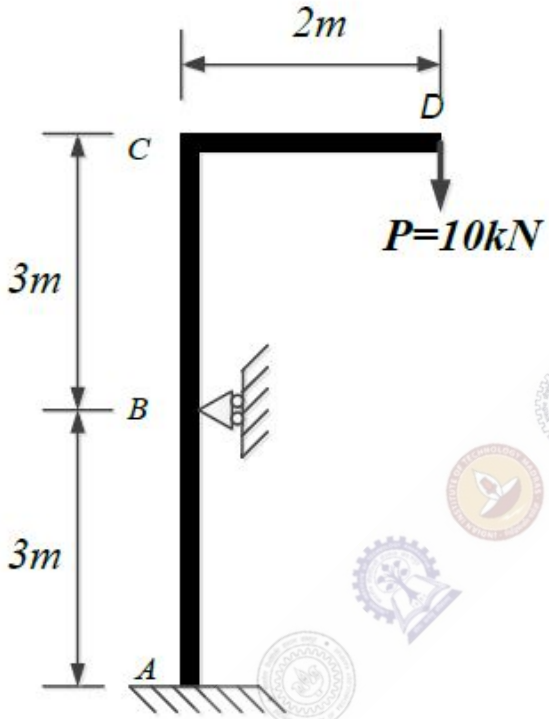
The angle θ (in **degrees**) under equilibrium is _____.



Question Number : 71 Correct : 2 Wrong : 0

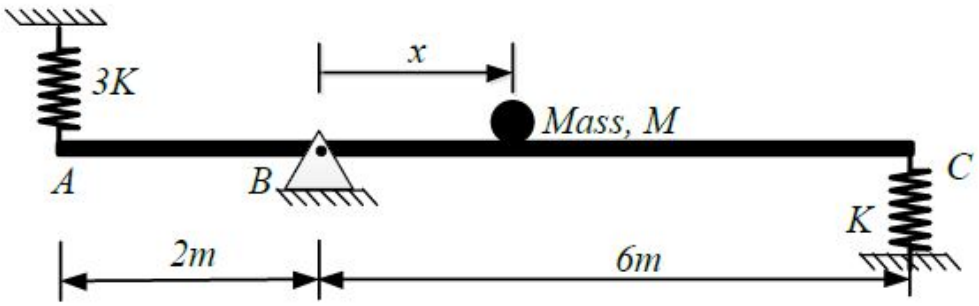
The frame shown below carries a vertical load $P = 10\text{kN}$ at its free end D. The frame is fixed at A and has a roller support at B. Magnitude of the reaction force at B (in **kN**) is _____.

Assume that the effect of the axial force on bending is negligible.

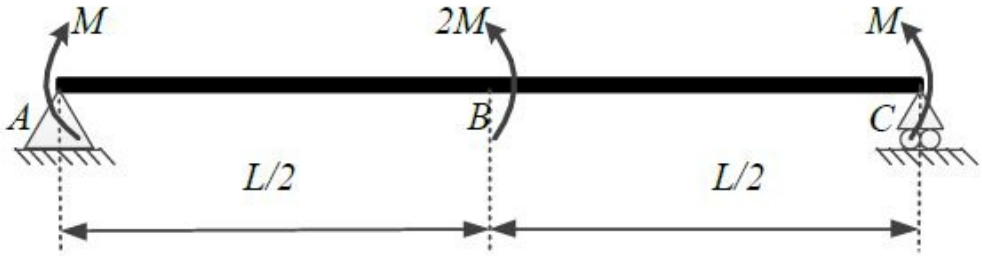


Question Number : 72 Correct : 2 Wrong : 0

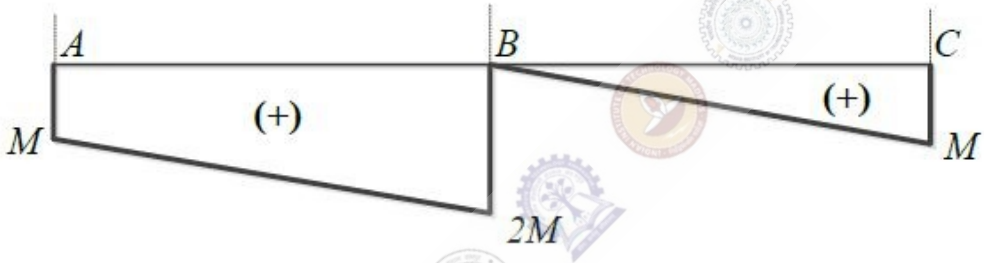
Consider the system shown below. Mass M is fixed to the rod AC at a distance x from the hinge point at B. Two springs of stiffness $3K$ and K are attached to the rod at points A and C, respectively. The natural frequency of angular oscillation of the system about B is **20 rad/s**. Assume the rod to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



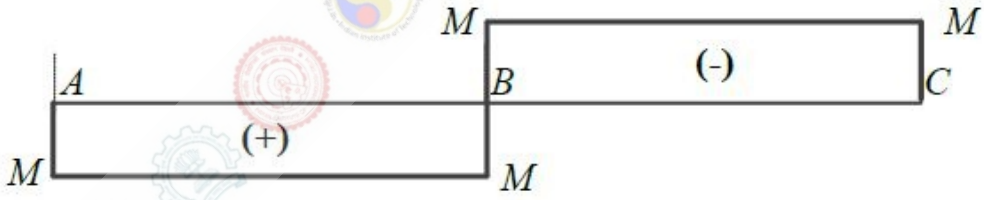
The simply supported beam shown below is subjected to a clockwise moment ***M*** at point ***A*** and two counterclockwise moments ***2M*** and ***M*** at points ***B*** and ***C***, respectively. Which **one** of the following is the correct bending moment diagram (tensile at bottom is positive moment)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



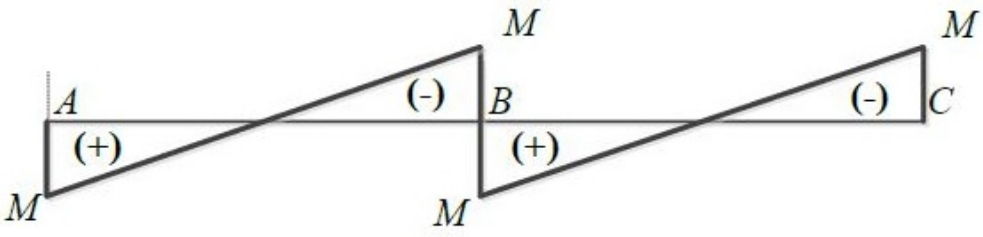
(A)



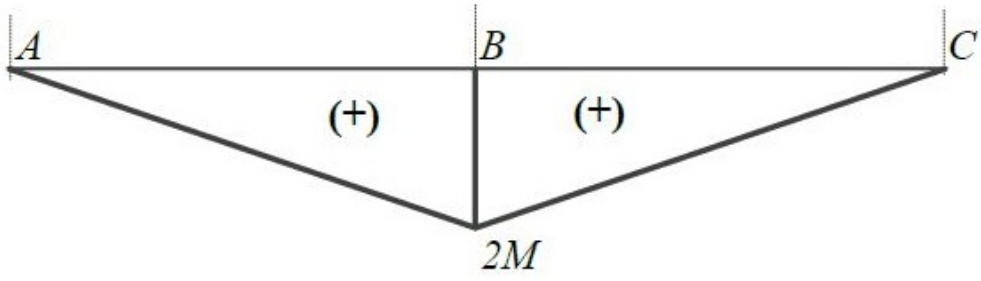
(B)



(C)



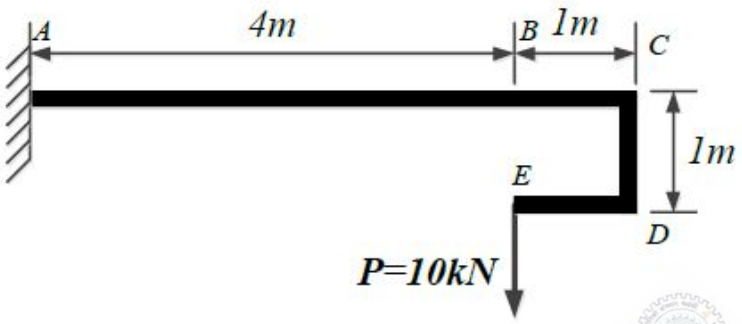
(D)



Question Number : 74 **Correct : 2 Wrong : 0**

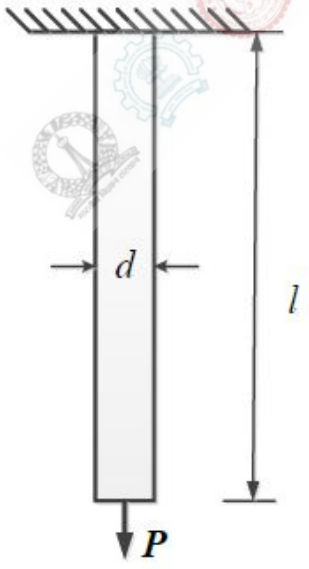
The structure shown below is of rectangular cross section and carries a load of **10kN** at its free end ***E***. Maximum bending stress (in **MPa**) developed in the beam due the external load is _____.

The depth of the beam is **300mm** and the width is **150mm**.

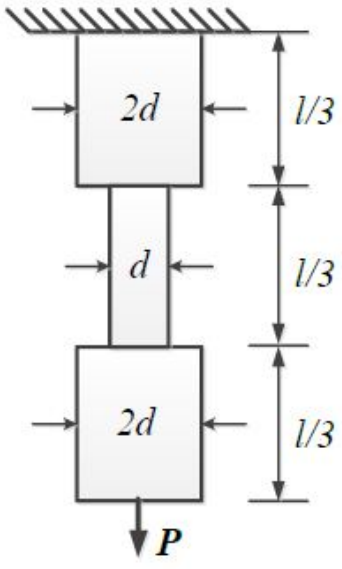


Question Number : 75 **Correct : 2 Wrong : -0.66**

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



Rod-A

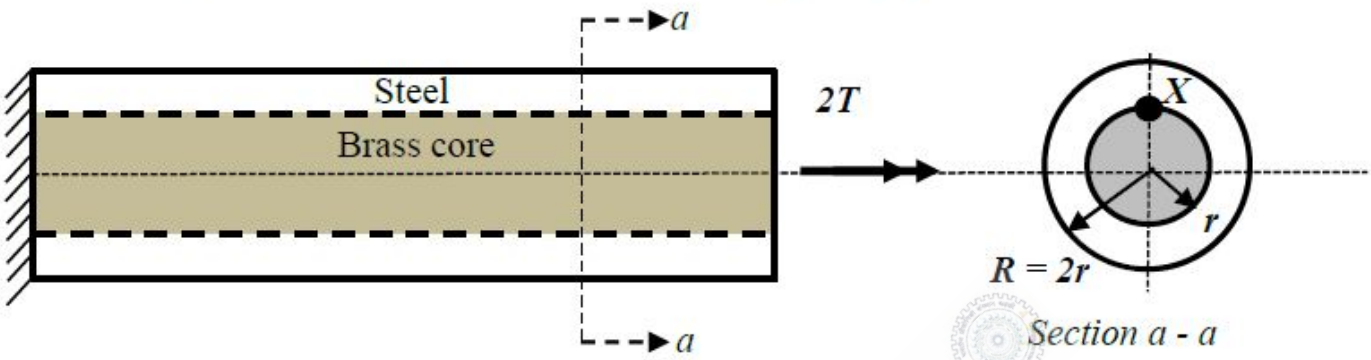


Rod-B

(A) 1:1 (B) 1:2 (C) 2:1 (D) 3:1

Question Number : 76 **Correct : 2 Wrong : -0.66**

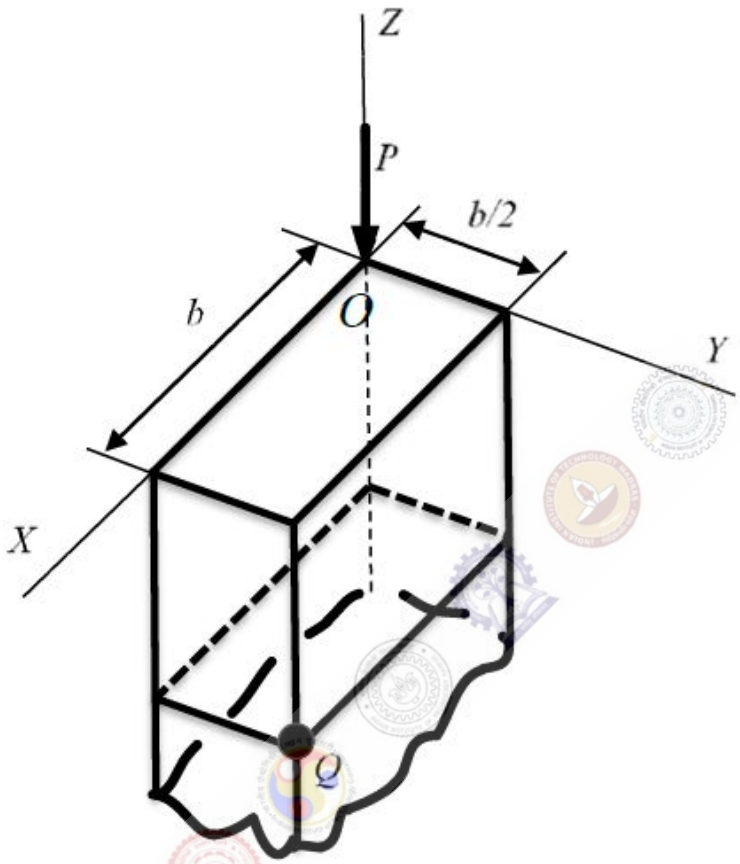
A composite shaft is made of a steel tube with an inner brass core perfectly bonded together as shown. The shaft is fixed at one end and subjected to a torque of ***2T*** at the other end. Shear modulus of steel is ***G*** and that of brass is ***G/2***. The outer radius of the steel tube is ***R = 2r*** 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



(A) $0.041\frac{T}{r^3}$ (B) $0.082\frac{T}{r^3}$ (C) $0.16\frac{T}{r^3}$ (D) $0.41\frac{T}{r^3}$

Question Number : 77 **Correct : 2 Wrong : -0.66**

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



(A) $6\frac{P}{b^2}$ (B) $10\frac{P}{b^2}$ (C) $-14\frac{P}{b^2}$ (D) $-\frac{P}{b^2}$

General Aptitude

Question Number : 166 **Correct : 1 Wrong : -0.33**

The event would have been successful if you _____able to come.

(A) are (B) had been (C) have been (D) would have been

Question Number : 167 **Correct : 1 Wrong : -0.33**

There was no doubt that their work was thorough.

Which of the words below is closest in meaning to the underlined word above?

(A) pretty (B) complete (C) sloppy (D) haphazard

Question Number : 168 Correct : 1 Wrong : -0.33

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

(A) 2, red (B) 2, 3, red (C) 2, blue (D) 2, red, blue

Question Number : 169 Correct : 1 Wrong : -0.33

What is the value of x when $81 \times \left(\frac{16}{25}\right)^{x+2} \div \left(\frac{3}{5}\right)^{2x+4} = 144$?

(A) 1 (B) -1 (C) -2 (D) Cannot be determined

Question Number : 170 Correct : 1 Wrong : -0.33

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

(A) 1/9 (B) 2/9 (C) 1/3 (D) 4/9

Question Number : 171 Correct : 2 Wrong : -0.66

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?

(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.

Question Number : 172 **Correct : 2 Wrong : -0.66**

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?

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

Question Number : 173 **Correct : 2 Wrong : -0.66**

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?

(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

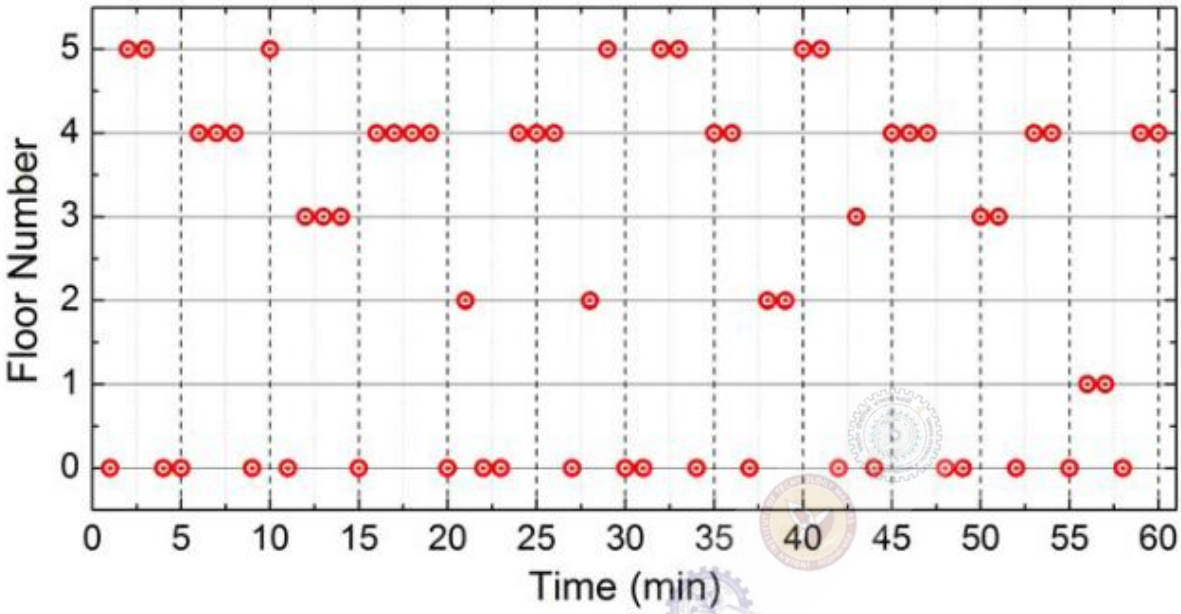
Question Number : 174 **Correct : 2 Wrong : -0.66**

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

(A) 1 (B) 4 (C) 5 (D) 6

Question Number : 175 **Correct : 2 Wrong : -0.66**

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?

i. The elevator never moves directly from any non-ground floor to another non-ground floor over the one hour period

ii. The elevator stays on the fourth 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