Physicsaholics

DPP – 5 (Work, Energy & Power)

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Q 1. A body slides down a frictionless track which ends in a circular loop of diameter D, then the minimum height h of the body in term of D so that it may just complete the loop, is

(a) $h = \frac{5D}{2}$ (b) $h = \frac{5D}{4}$

(c) $h = \frac{3D}{4}$ (d) $h = \frac{D}{4}$

Q 2. A car moving with speed 30 m/s on a circular path of radius 500m. Its speed is increasing at the rate of 2 m/s^2. The acceleration of the car is

(a) 9.8 m/s^2 (b) 1.8 m/s^2

(c) 2 m/s^2 (d) 2.7 m/s^2

Q 3. A stone tied to the end of a string which is 80cm long is whirled in a horizontal circle with a constant speed. If the stone makes 14 revolutions in 25s, Find work done by tension on stone

(a) 9.91 J (b) 14 J

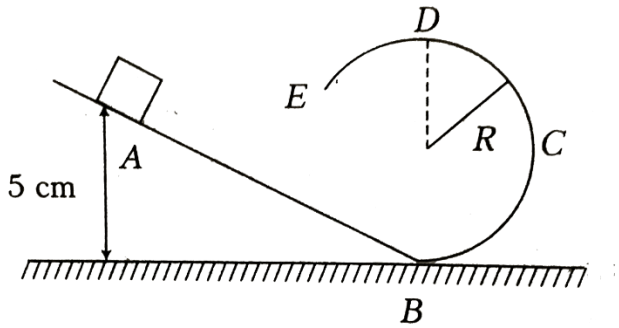
(c) 12.69 J (d) zero

Q 4. The string of pendulum of length l is displaced through 90° from the vertical and released. Then the minimum strength of the string in order to withstand the tension, as the pendulum passes through the mean position is

(a) mg (b) 3mg

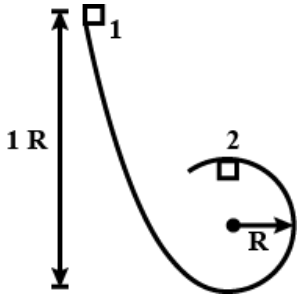
(c) 5mg (d) 6mg

Q 5. A frictionless track ABCDE ends in a circular loop of radius R. A body slides down the track from point A which is at height h = 5cm. Maximum value of R for a body to complete the loop successfully is



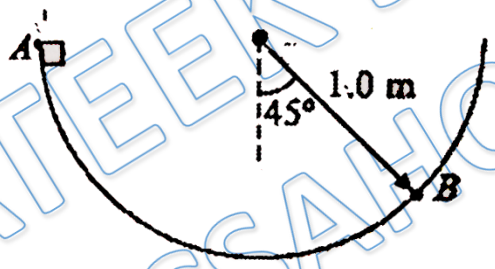
(a) 2 cm (b) $\frac{10}{3}$ cm
(c) $\frac{15}{4}$ cm (d) $\frac{18}{3}$ cm

Q 6. A cube of mass M starts from rest from point 1 at a height 4R, where R is the radius of the circular track. The cube slides down on the frictionless track and around the loop. The force which the track exerts on the cube at point 2 is:



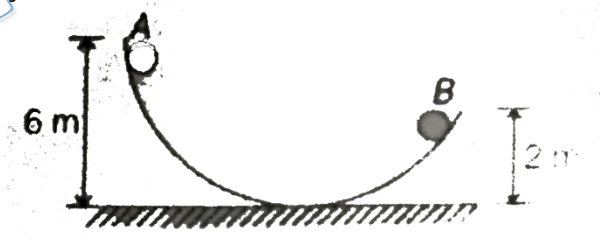
(a) mg (b) 2mg
(c) 3mg (d) 4mg

Q 7. A block shown in figure slides on a semicircular frictionless track. If it starts from rest at position A, what is its speed at the point marked B? Take g=10m/s^2



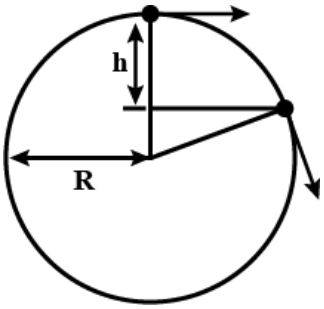
(a) 2.21 m/s (b) 1.32 m/s
(c) 7.54 m/s (d) 3.76 m/s

Q 8. A ball is released from point A as shown in figure. The ball leaves the track at B. All surfaces are smooth. If track makes an angle 30^0 with horizontal at B, then maximum height attained by ball will be



(a) 4m (b) 2m
(c) 3m (d) 1m

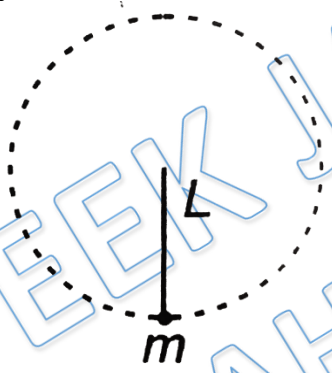
Q 9. A particle originally at rest at the highest point of a smooth vertical circle is slightly displaced. It will leave the circle at a vertical distance h below the highest point such that h = ?



(a) R (b) $\frac{R}{3}$

(c) $\frac{2R}{3}$ (d) $\frac{R}{2}$

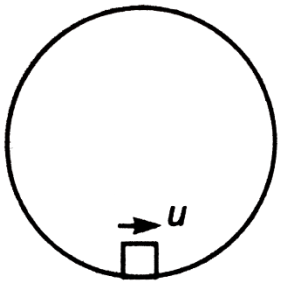
Q 10. A small particle of mass m attached with a light inextensible thread of length L is moving in a vertical circle. In the given case particle is moving in complete vertical circle and ratio of its maximum to minimum velocity is 2:1. Velocity of the particle when it is moving vertically downward is



(a) $\sqrt{\frac{10gL}{3}}$ (b) $2\sqrt{\frac{gL}{3}}$

(c) $\sqrt{\frac{8gL}{3}}$ (d) $\sqrt{\frac{13gL}{3}}$

Q 11. A particle is given an initial speed u inside a smooth spherical shell of radius R=1 m such that it is just able to complete the circle. Acceleration of the particle when its velocity is vertical is



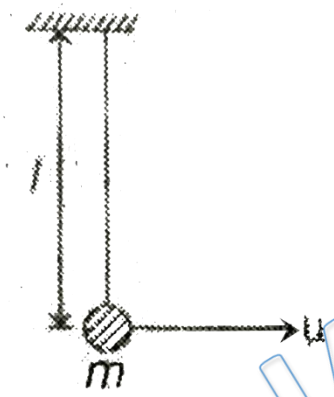
(a) $g\sqrt{10}$ (b) g

(c) $g\sqrt{2}$ (d) $3g$

Q 12. A pendulum bob on a 2 m string is displaced 60° from the vertical and then released. What is the speed of the bob as it passes through the lowest point in its path

(a) $\sqrt{2}$ m/s
(b) $\sqrt{9.8}$ m/s
(c) 4.43 m/s
(d) $\frac{1}{\sqrt{2}}$ m/s

Q 13. A particle of mass m is attached to one end of a light inextensible string and the other end of the string is fixed in vertical plane as shown. Particle is given a horizontal velocity $u = \sqrt{\frac{5}{2}gl}$. The maximum angle made by string with downward vertical is



(a) $\cos^{-1}\left(\frac{1}{4}\right)$
(b) $\sin^{-1}\left(\frac{1}{4}\right)$
(c) $\frac{\pi}{2} + \sin^{-1}\left(\frac{1}{4}\right)$
(d) $\frac{\pi}{2} - \sin^{-1}\left(\frac{1}{4}\right)$

Answer Key

Q.1 b	**Q.2 d**	**Q.3 d**	**Q.4 b**	**Q.5 a**
Q.6 c	**Q.7 d**	**Q.8 c**	**Q.9 b**	**Q.10 a**
Q.11 a	**Q.12 c**	**Q.13 c**		

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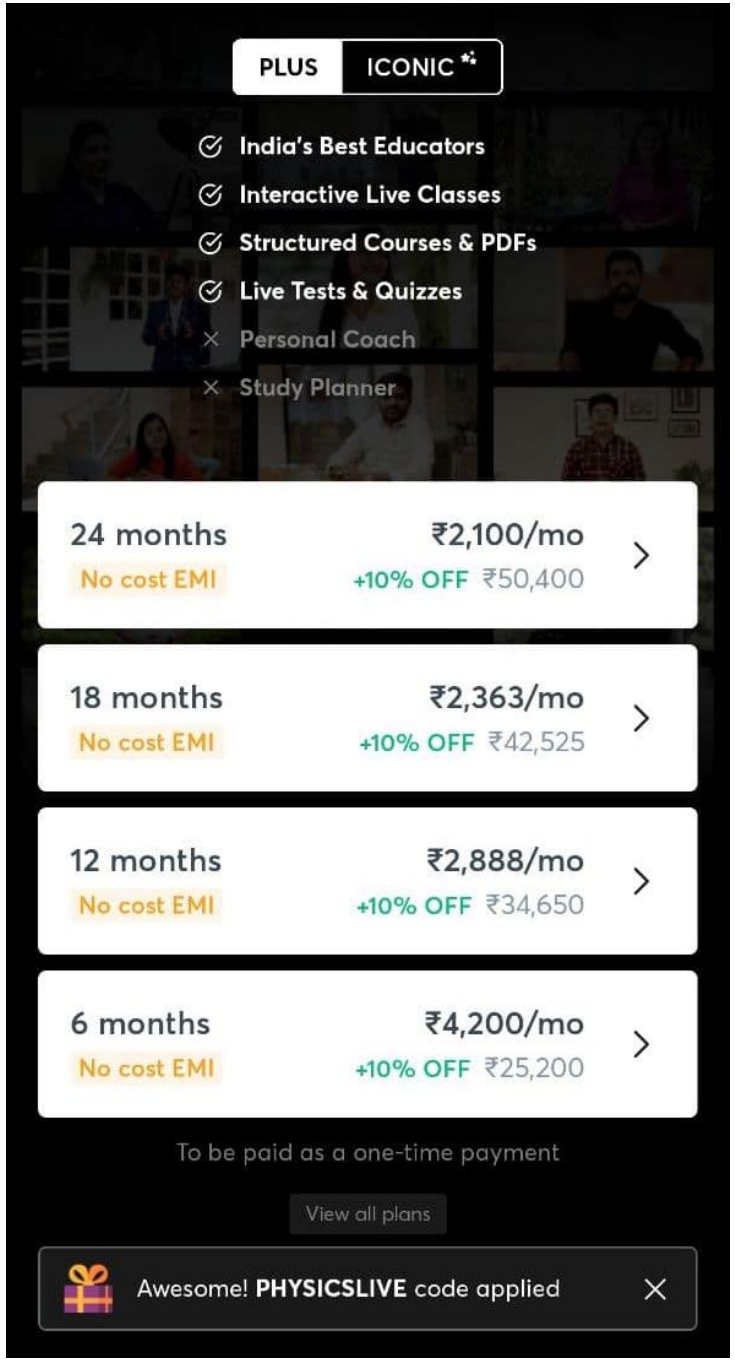


Physics DPP

DPP-5 WEP: Vertical Circular Motion

By Physicsaholics Team

Solution: 1

To complete vertical C.M.

$$v_{min} = v = \sqrt{5gr} = \sqrt{\frac{5gD}{2}}$$

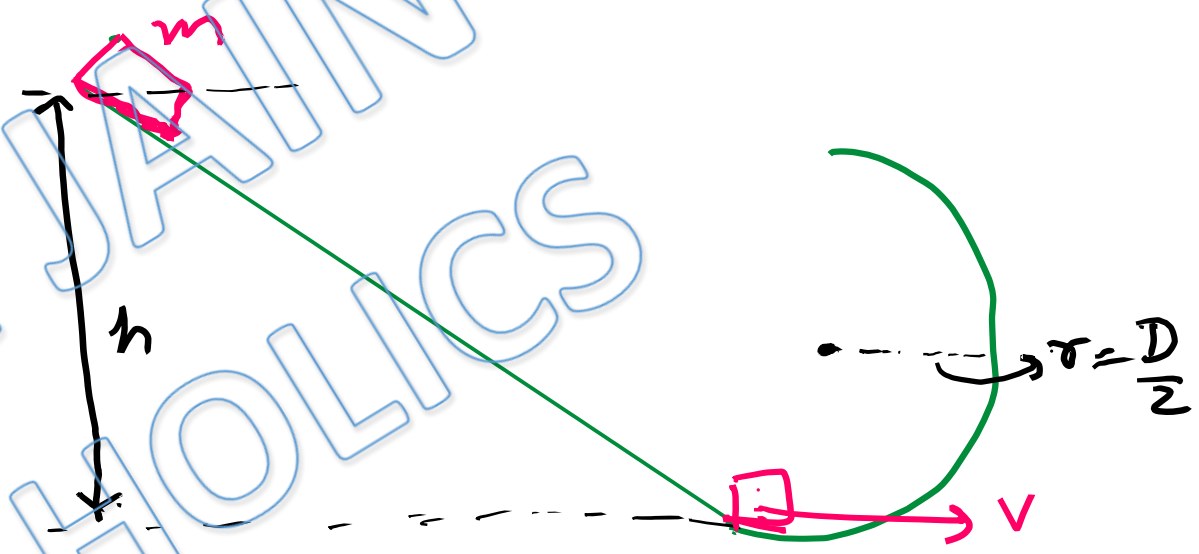
$$KE_i + PE_i = KE_f + PE_f$$

$$0 + mgh = \frac{1}{2}mv^2 + 0$$

$$2gh = v^2$$

$$h = \frac{v^2}{2g} = \frac{5gD}{2(2g)}$$

$$\boxed{h = \frac{5D}{4}}$$ Ans.



Ans. b

Solution: 2

$$a_{net} = \sqrt{a_c^2 + a_t^2}$$

$$a_c = \frac{v^2}{R} = \frac{(30)^2}{5\omega} = \frac{9}{5}\ m/s^2$$

$$a_t = 2\ m/s^2$$

$$a_{net} = \sqrt{2^2 + \left(\frac{9}{5}\right)^2} = \sqrt{4 + \frac{81}{25}} = \sqrt{\frac{181}{25}}$$

$$\boxed{a_{net} = 2.7\ m/s^2}\ \text{Ans.}$$

Ans. d

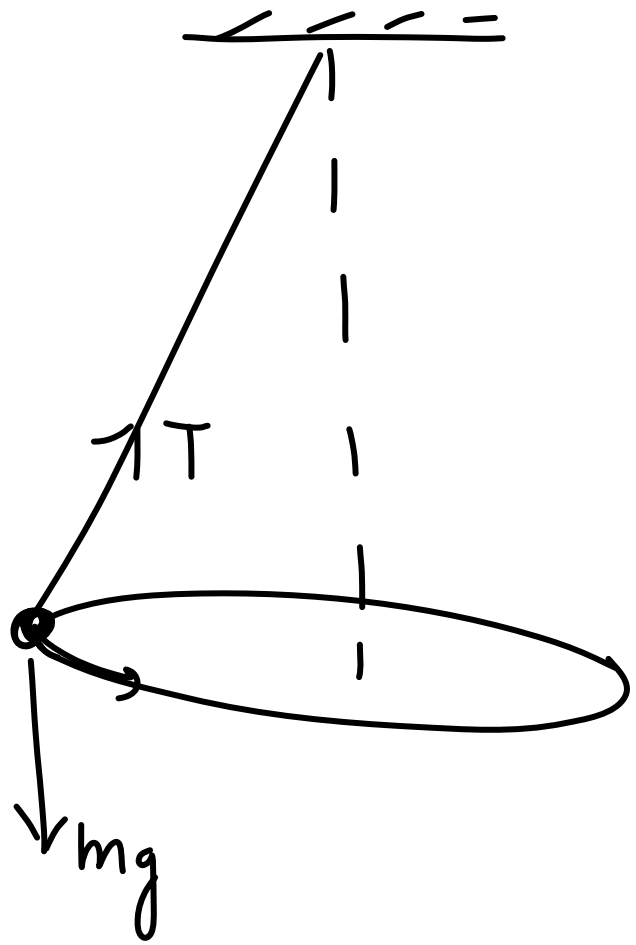
Solution: 3

Using Work-energy theorem →

$$W_T + W_{mg} = \Delta K$$

$$\Rightarrow \quad W_T + 0 = 0$$

$$\Rightarrow \quad W_T = 0$$



Ans. d

Solution: 4

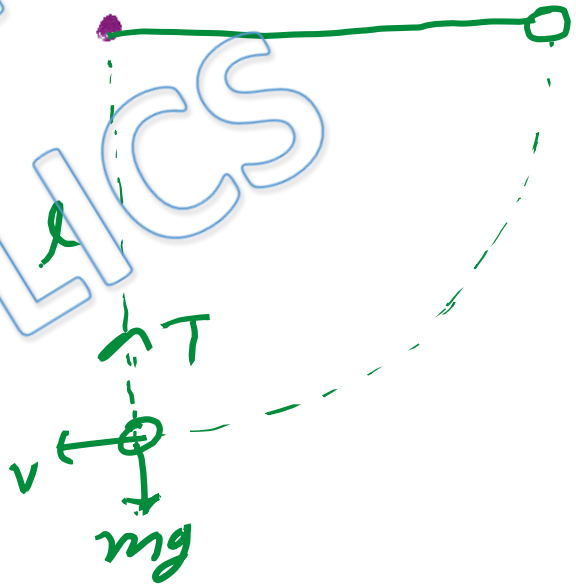
$$mgl = \frac{1}{2}mv^2$$

$$v = \sqrt{2gl}$$

$$T = mg + \frac{mv^2}{r}$$

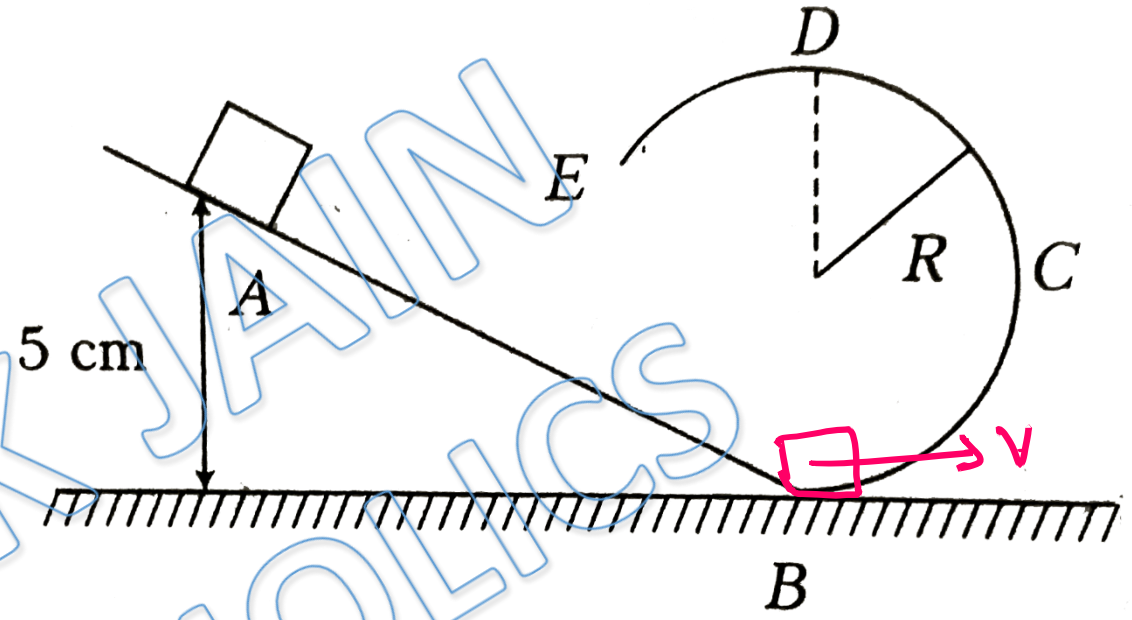
$$T = mg + \frac{m(2gl)}{l}$$

$$\boxed{T = 3mg}$$ Ans.



Ans. b

Solution: 5



To complete V.C.M.

$V \geq \sqrt{5gR}$

A → B (WET)

$mgh + 0 = 0 + \frac{1}{2}mv^2$

$v = \sqrt{2gh}$

$\sqrt{2gh} \geq \sqrt{5Rg}$

$2gh \geq 5gR$

$R \leq \frac{2h}{5}$

$R \leq \frac{2 \times 5}{5}$ cm

$R \leq 2$ cm

$\Rightarrow \boxed{R_{max} = 2 \text{ cm}}$ Ans.

Ans. a

Solution: 6

by Conservation of machenical energy

$$mg(2R) + 0 = 0 + \frac{1}{2}mv^2$$

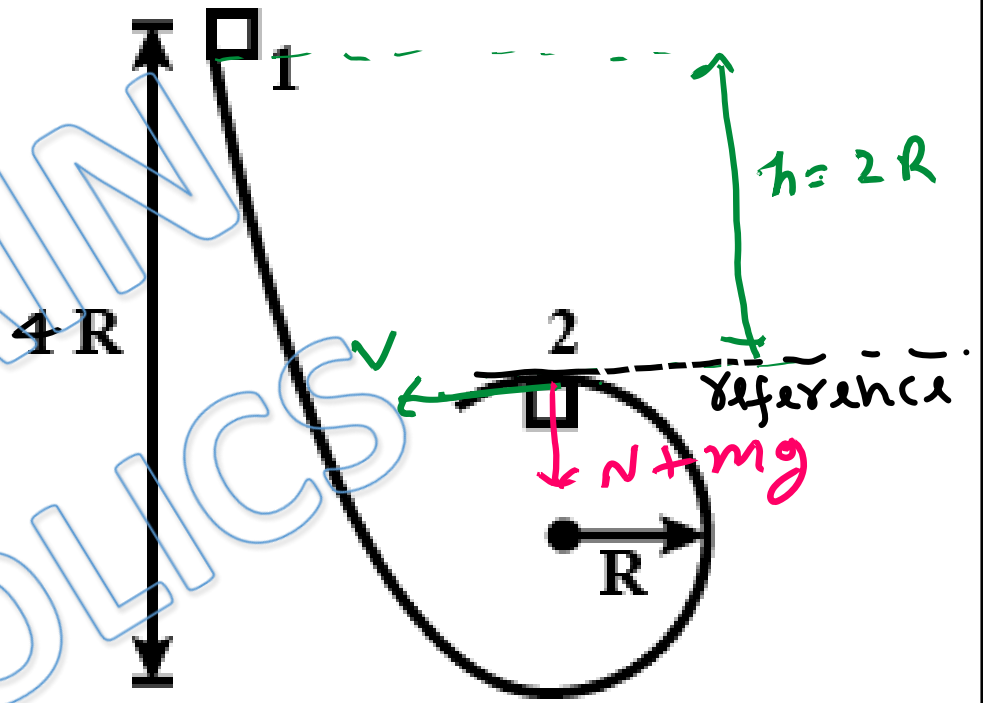
$$v = \sqrt{4Rg}$$

$$N + mg = \frac{mv^2}{R}$$

$$N + mg = \frac{m(4Rg)}{R}$$

$$N + mg = 4mg$$

$$\boxed{N = 3mg} \quad \text{Ans.}$$

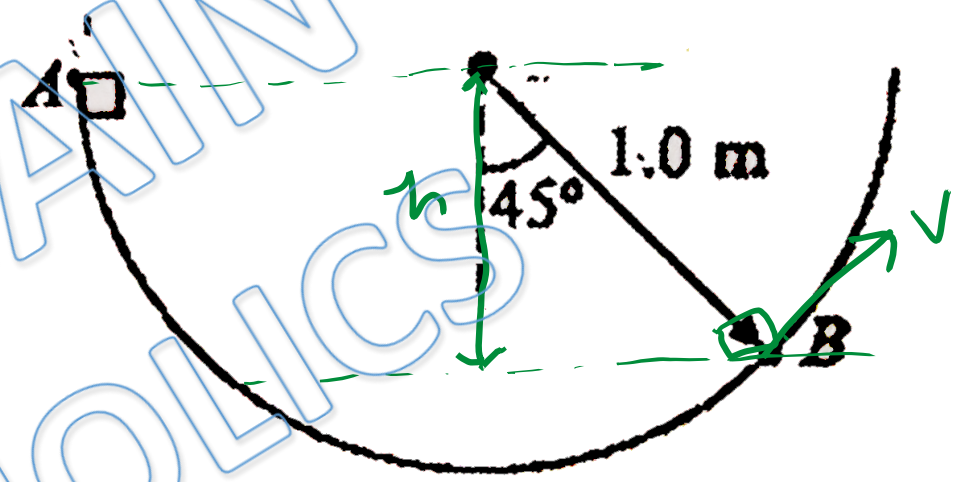


Ans. c

Solution: 7

$h = R\cos 45^\circ = 1 \times \frac{1}{\sqrt{2}}$

$\boxed{h = \frac{1}{\sqrt{2}}\ m}$



WET (A to B)

$0 + mgh = \frac{1}{2}mv^2 + 0$

$v = \sqrt{2gh} = \sqrt{2 \times 10 \times \frac{1}{\sqrt{2}}}$

$V = \sqrt{\sqrt{2} \times 10} = \sqrt{1.414 \times 10}$

$\boxed{V = 3.76\ m/s}$ Ans.

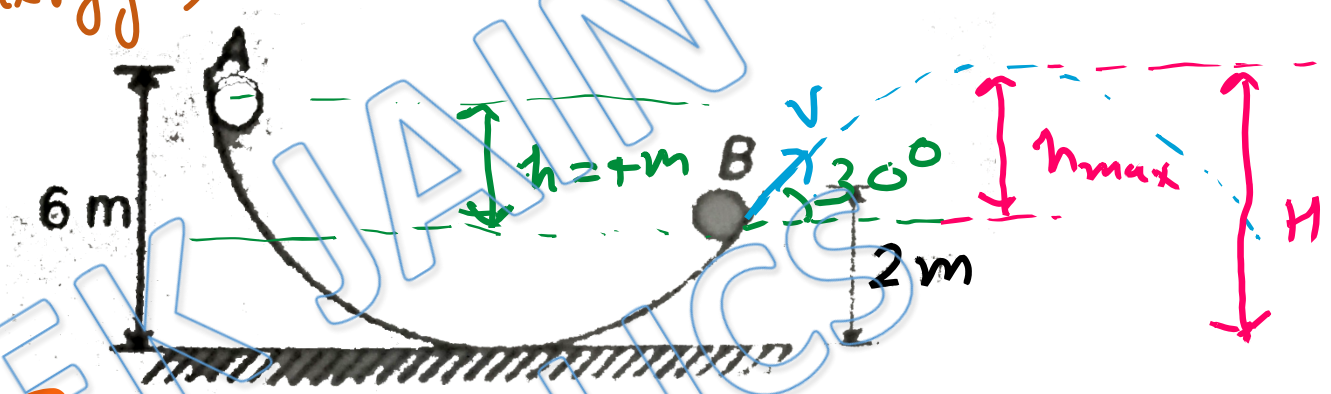
Ans. d

Solution: 8

by Conservation of machenical energy →

$0 + mg(4) = \frac{1}{2}mv^2 + 0$

$v = \sqrt{8g}$ m/s



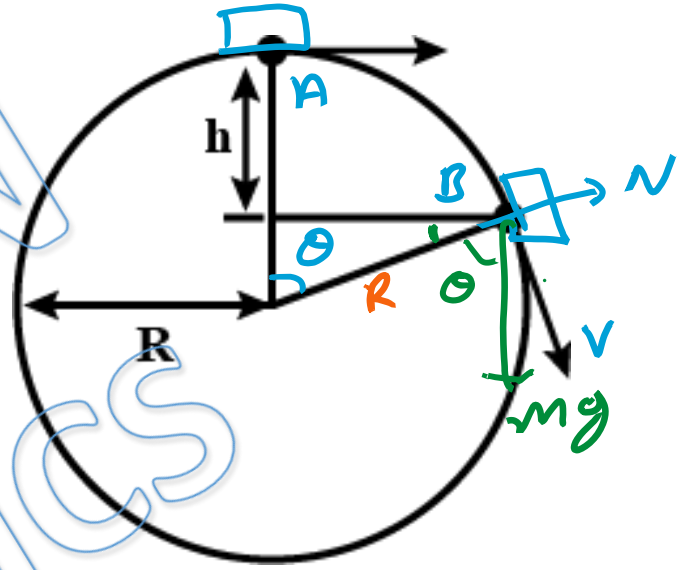
$h_{max} = \frac{v_y^2}{2g} = \frac{(8g)\sin^2 30°}{2g} = 4 \times \left(\frac{1}{2}\right)^2 = 1\text{m}$

$H = 2 + 1$

$H = 3\text{m}$ Ans.

Ans. c

Solution: 9



at, B

$N = 0$

$mg\cos\theta - N = \frac{mv^2}{R}$ — ①

by Conservation of machenical energy →

$mgh + 0 = \frac{1}{2}mv^2 + 0$

$v = \sqrt{2gh}$

$\Rightarrow mg\cos\theta - N = \frac{m(2gh)}{R}$

$h = \frac{R\cos\theta}{2} = \frac{(R-h)}{2} \Rightarrow$

$2h = R - h \Rightarrow 3h = R$

$\boxed{h = \frac{R}{3}}$ Ans.

Ans. b

Solution: 10

$$\frac{v_1}{v_2} = \frac{2}{1} \Rightarrow (v_1 = 2v_2)$$

$$\frac{1}{2}mv_1^2 = mg(2L) + \frac{1}{2}mv_2^2$$

$$\frac{1}{2}m(2v_2)^2 = mg(2L) + \frac{1}{2}mv_2^2$$

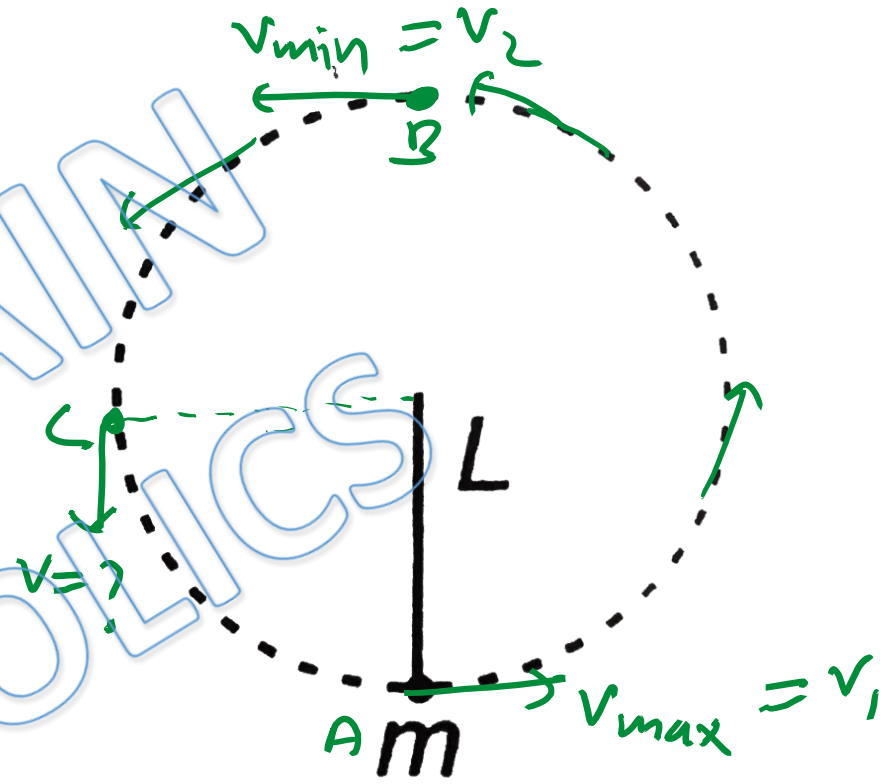
$$2v_2^2 = 2gL + \frac{v_2^2}{2} \Rightarrow \frac{3v_2^2}{2} = 2gL$$

$$\boxed{v_2 = 2\sqrt{\frac{gL}{3}}} \Rightarrow \boxed{v_1 = 4\sqrt{\frac{gL}{3}}}$$

Now C → A

$$\frac{1}{2}mv^2 + mg(L) = \frac{1}{2}mv_1^2 + 0$$

$$\frac{1}{2}v^2 + gL = \frac{1}{2}\left(16 \times \frac{gL}{3}\right) = \frac{8gL}{3}$$



$$\Rightarrow \frac{v^2}{2} = \frac{8gL}{3} - gL = \frac{5gL}{3}$$

$$\boxed{v = \sqrt{\frac{10gL}{3}}}$$ Ans.

Ans. a

Solution: 11

A to B

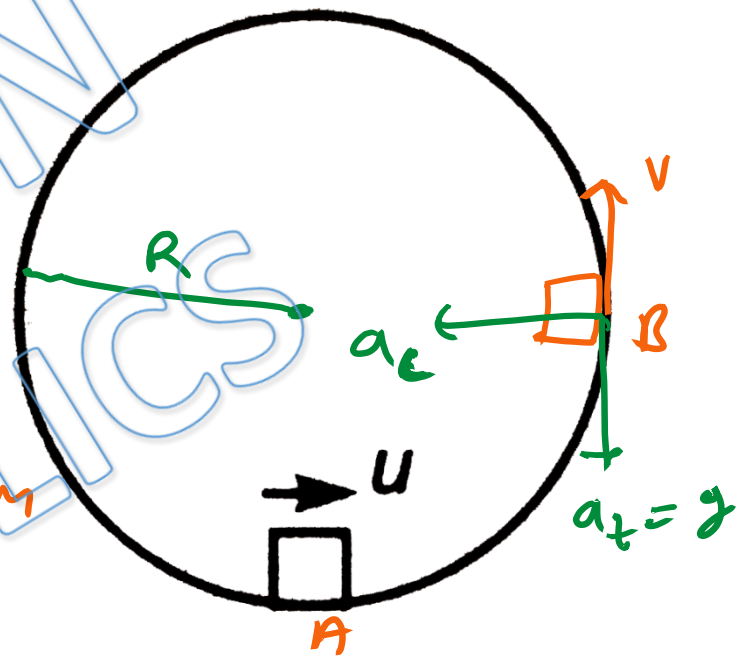
$\frac{1}{2}mu^2 + 0 = \frac{1}{2}mv^2 + mgR$

$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mg(1)$

$u^2 = v^2 + 2g$

$v = \sqrt{u^2 - 2g}$ $\left[u = \sqrt{5gR} = \sqrt{5g}\right] \because R = 1m$

$\boxed{v = \sqrt{3g}}$



$a = \sqrt{a_c^2 + a_t^2} = \sqrt{\left(\frac{v^2}{r}\right)^2 + (g)^2} = \sqrt{\left(\frac{3g}{1}\right)^2 + (g)^2} = \sqrt{9g^2 + g^2}$

$a = \sqrt{10g^2} = \sqrt{10}\,g$

$\boxed{a = \sqrt{10}\,g}$ Ans.

Ans. a

Solution: 12

$h = l - l\cos 60^\circ = l - l \times \frac{1}{2} = \frac{l}{2}$

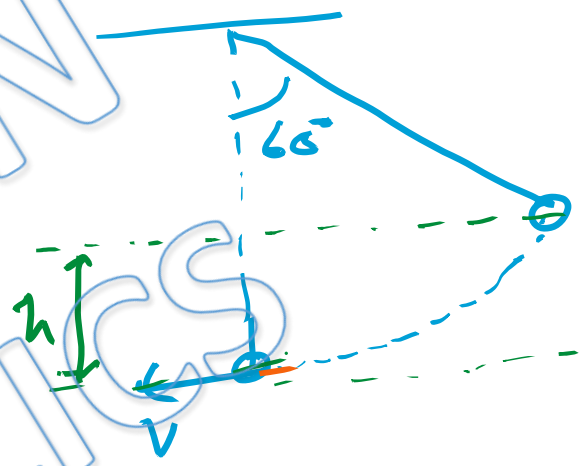
$h = \frac{2}{2} = 1\,m$

$mgh + 0 = \frac{1}{2}mv^2 + 0$

$v = \sqrt{2gh}$

$v = \sqrt{2 \times 9.8 \times 1} = \sqrt{2 \times 9.8}$

$\boxed{v = 4.43\ m/s}$ Ans.



Ans. c

Solution: 13

A to B

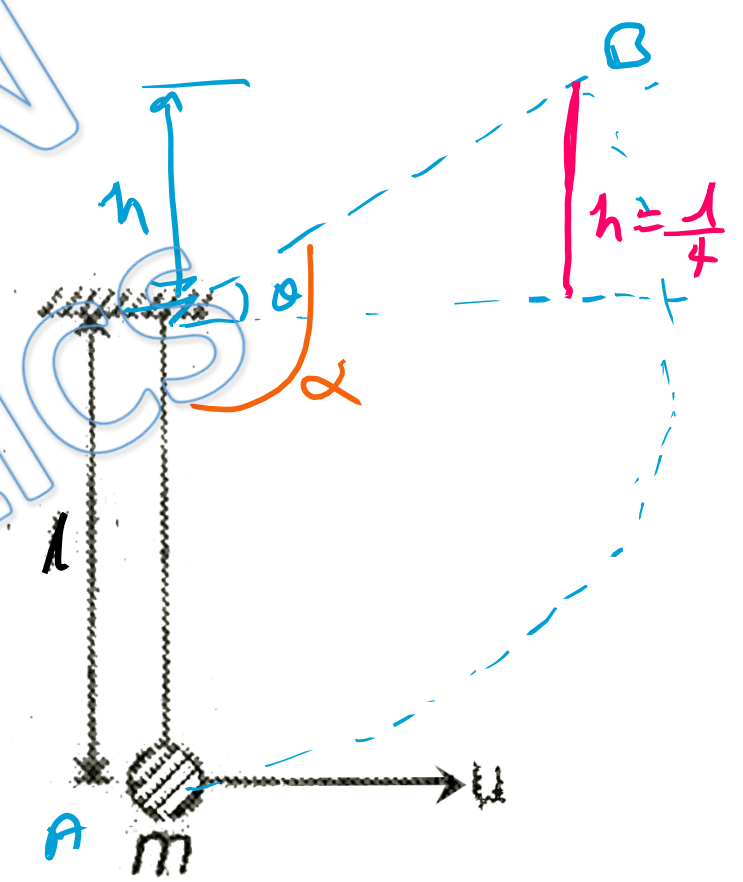
$$\frac{1}{2}mu^2 + 0 = 0 + mg(l+h)$$

$$\frac{1}{2}\times\left(\frac{5}{2}gl\right) = g(l+h)$$

$$\frac{5l}{4} = h + l \Rightarrow h = \frac{l}{4}$$

$$\sin\theta = \frac{l/4}{l} = \frac{1}{4} \Rightarrow \theta = \sin^{-1}\left(\frac{1}{4}\right)$$

$$\boxed{\alpha = \frac{\pi}{2} + \sin^{-1}\left(\frac{1}{4}\right)} \quad \text{Ans.}$$



Ans. c

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