Motion In Two Dimension

SET Self Evaluation Test -3

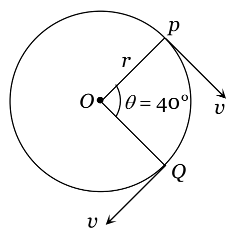
1. Roads are banked on curves so that
(a) The speeding vehicles may not fall outwards
(b) The frictional force between the road and vehicle may be decreased
(c) The wear and tear of tyres may be avoided
(d) The weight of the vehicle may be decreased

2. In uniform circular motion
(a) Both velocity and acceleration are constant
(b) Acceleration and speed are constant but velocity changes
(c) Both acceleration and velocity changes
(d) Both acceleration and speed are constant

3. For a body moving in a circular path, a condition for no skidding if μ is the coefficient of friction, is
(a) $\frac{mv^2}{r} \leq \mu mg$ (b) $\frac{mv^2}{r} \geq \mu mg$
(c) $\frac{v}{r} = \mu g$ (d) $\frac{mv^2}{r} = \mu mg$

4. A car is moving with a uniform speed on a level road. Inside the car there is a balloon filled with helium and attached to a piece of string tied to the floor. The string is observed to be vertical. The car now takes a left turn maintaining the speed on the level road. The balloon in the car will
(a) Continue to remain vertical
(b) Burst while taking the curve
(c) Be thrown to the right side
(d) Be thrown to the left side

5. A particle is moving on a circular path of radius r with uniform velocity v. The change in velocity when the particle moves from P to Q is $(\angle POQ = 40^o)$



(a) $2v\cos 40^o$
(b) $2v\sin 40^o$
(c) $2v\sin 20^o$
(d) $2v\cos 20^o$

6. A body is revolving with a uniform speed v in a circle of radius r. The tangential acceleration is
(a) $\frac{v}{r}$ (b) $\frac{v^2}{r}$
(c) Zero (d) $\frac{v}{r^2}$

7. A particle does uniform circular motion in a horizontal plane. The radius of the circle is 20 *cm*. The centripetal force acting on the particle is 10 *N*. It's kinetic energy is
(a) 0.1 J (b) 0.2 J
(c) 2.0 J (d) 1.0 J

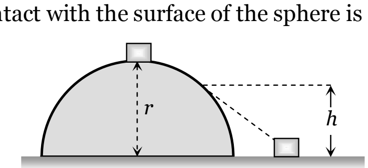
8. A body of mass m is suspended from a string of length l. What is minimum horizontal velocity that should be given to the body in its lowest position so that it may complete one full revolution in the vertical plane with the point of suspension as the centre of the circle
(a) $v = \sqrt{2\,lg}$ (b) $v = \sqrt{3\,lg}$
(c) $v = \sqrt{4\,lg}$ (d) $v = \sqrt{5\,lg}$

9. A particle moves with constant angular velocity in circular path of certain radius and is acted upon by a certain centripetal force F. If the angular velocity is doubled, keeping radius the same, the new force will be
(a) $2F$ (b) F^2
(c) $4F$ (d) $F/2$

10. In the above question, if the angular velocity is kept same but the radius of the path is halved, the new force will be
(a) $2F$ (b) F^2
(c) $F/2$ (d) $F/4$

11. In above question, if the centripetal force F is kept constant but the angular velocity is doubled, the new radius of the path (original radius R) will be
(a) $2R$ (b) $R/2$
(c) $R/4$ (d) $4R$

12. A small body of mass m slides down from the top of a hemisphere of radius r. The surface of block and hemisphere are frictionless. The height at which the body lose contact with the surface of the sphere is



(a) $\frac{3}{2}r$ (b) $\frac{2}{3}r$
(c) $\frac{1}{2}gt^2$ (d) $\frac{v^2}{2g}$

13. A body of mass m kg is rotating in a vertical circle at the end of a string of length r metre. The difference in the kinetic energy at the top and the bottom of the circle is

(a) $\frac{mg}{r}$ (b) $\frac{2mg}{r}$

(c) $2mgr$ (d) mgr

14. A car is travelling with linear velocity v on a circular road of radius r. If it is increasing its speed at the rate of 'a' $meter/\sec^2$, then the resultant acceleration will be

(a) $\sqrt{\left\{\frac{v^2}{r^2}-a^2\right\}}$ (b) $\sqrt{\left\{\frac{v^4}{r^2}+a^2\right\}}$

(c) $\sqrt{\left\{\frac{v^4}{r^2}-a^2\right\}}$ (d) $\sqrt{\left\{\frac{v^2}{r^2}+a^2\right\}}$

15. A ball of mass 0.1 *kg* is suspended by a string. It is displaced through an angle of 60^o and left. When the ball passes through the mean position, the tension in the string is

(a) 19.6 N (b) 1.96 N

(c) 9.8 N (d) Zero

16. An aeroplane moving horizontally at a speed of 200 *m/s* and at a height of $8.0\times10^3\ m$ is to drop a bomb on a target. At what horizontal distance from the target should the bomb be released

(a) 7.234 *km* (b) 8.081 *km*

(c) 8.714 *km* (d) 9.124 *km*

17. A body is projected horizontally from a height with speed 20 *metres/sec*. What will be its speed after 5 *seconds* ($g=10\ metres/\sec^2$)

(a) 54 *metres/sec* (b) 20 *metres/sec*

(c) 50 *metres/sec* (d) 70 *metres/sec*

18. A man standing on the roof of a house of height h throws one particle vertically downwards and another particle horizontally with the same velocity u. The ratio of their velocities when they reach the earth's surface will be

(a) $\sqrt{2gh+u^2}:u$ (b) $1:2$

(c) $1:1$ (d) $\sqrt{2gh+u^2}:\sqrt{2gh}$

19. (A projectile projected at an angle 30^o from the horizontal has a range R. If the angle of projection at the same initial velocity be 60^o, then the range will be

(a) R (b) $2R$

(c) $R/2$ (d) R^2

20. At the highest point of the path of a projectile, its

(a) Kinetic energy is maximum

(b) Potential energy is minimum

(c) Kinetic energy is minimum

(d) Total energy is maximum

21. A cricket ball is hit at 30^o with the horizontal with kinetic energy K. The kinetic energy at the highest point is

(a) Zero (b) $K/4$

(c) $K/2$ (d) $3K/4$

22. A cannon on a level plane is aimed at an angle θ above the horizontal and a shell is fired with a muzzle velocity v_0 towards a vertical cliff a distance D away. Then the height from the bottom at which the shell strikes the side walls of the cliff is

(a) $D\sin\theta-\frac{gD^2}{2v_0^2\sin^2\theta}$ (b) $D\cos\theta-\frac{gD^2}{2v_0^2\cos^2\theta}$

(c) $D\tan\theta-\frac{gD^2}{2v_0^2\cos^2\theta}$ (d) $D\tan\theta-\frac{gD^2}{2v_0^2\sin^2\theta}$

23. A stone is projected from the ground with velocity 50 *m/s* at an angle of 30^o. It crosses a wall after 3 *sec*. How far beyond the wall the stone will strike the ground ($g=10\ m/\sec^2$)

(a) 90.2 *m* (b) 89.6 *m*

(c) 86.6 *m* (d) 70.2 *m*

24. A body of mass m is projected at an angle of 45^o with the horizontal. If air resistance is negligible, then total change in momentum when it strikes the ground is

(a) $2mv$ (b) $\sqrt{2}\,mv$

(c) mv (d) $mv/\sqrt{2}$

25. A ball of mass m is thrown vertically upwards. Another ball of mass $2m$ is thrown at an angle θ with the vertical. Both of them stay in air for same period of time. The heights attained by the two balls are in the ratio of

(a) 2 : 1 (b) $1:\cos\theta$

(c) 1 : 1 (d) $\cos\theta:1$

26. A particle is projected with a velocity *v* such that its range on the horizontal plane is twice the greatest height attained by it. The range of the projectile is (where g is acceleration due to gravity)

(a) $\frac{4v^2}{5g}$ (b) $\frac{4g}{5v^2}$

(c) $\frac{v^2}{g}$ (d) $\frac{4v^2}{\sqrt{5}g}$

Answers and Solutions

(SET -3)

1. (a) By doing so component of weight of vehicle provides centripetal force.

2. (c) Both changes in direction although their magnitudes remains constant.

3. (a) The value of frictional force should be equal or more than required centripetal force. *i.e.* $\mu mg \geq \frac{mv^2}{r}$

4. (d) Air outside the balloon is heavier so it will have more tendency to move towards right and will keep the balloon towards left side (Here in this question car is supposed to be air tight).

5. (c) Change in velocity = $2v\sin(\theta/2) = 2v\sin 20°$

6. (c) In uniform circular motion only centripetal acceleration works.

7. (d) $\frac{mv^2}{r} = 10 \Rightarrow \frac{1}{2}mv^2 = 10 \times \frac{r}{2} = 1\,J$

8. (d) For looping the loop minimum velocity at the lowest point should be $\sqrt{5gl}$.

9. (c) $F = m\omega^2 R \;\therefore\; F \propto \omega^2$ (m and R are constant)
If angular velocity is doubled force will becomes four times.

10. (c) $F = m\omega^2 R \;\therefore\; F \propto R$ (m and ω are constant)
If radius of the path is halved, then force will also become half.

11. (c) $F = m\omega^2 R \;\therefore\; R \propto \frac{1}{\omega^2}$ (m and F are constant)
If ω is doubled then radius will become 1/4 times *i.e.* $R/4$

12. (b)

13. (c) Difference in K.E. = Difference in P.E. = $2mgr$

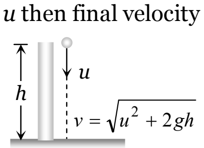
14. (b) $a_{\text{resultant}} = \sqrt{a^2_{\text{radial}} + a^2_{\text{tangential}}} = \sqrt{\frac{v^4}{r^2} + a^2}$

15. (b) $T = mg + \frac{mv^2}{l} = mg + \frac{m}{l}\left[2gl(1-\cos\theta)\right]$
$= mg + 2mg(1 - \cos 60°) = 2mg = 2\times 0.1 \times 9.8 = 1.96N$

16. (b) Horizontal distance travelled by the bomb $S = u \times t$
$= 200 \times \sqrt{\frac{2h}{g}} = 200 \times \sqrt{\frac{2 \times 8 \times 10^3}{9.8}} = 8.081km$

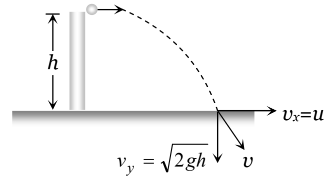
17. (a) Horizontal velocity $v_x = 20\,m/s$
Vertical velocity $v_y = u + gt = 0 + 10 \times 5 = 50\,m/\text{sec}$
Net velocity $v = \sqrt{v_x^2 + v_y^2} = \sqrt{(20)^2 + (50)^2} = 54\,m/s.$

18. (c) When particle thrown in vertical downward direction with velocity u then final velocity at the ground level



$v^2 = u^2 + 2gh \;\therefore\; v = \sqrt{u^2 + 2gh}$

Another particle is thrown horizontally with same velocity then at the surface of earth.



Horizontal component of velocity $v_x = u$

$\therefore$ Resultant velocity, $v = \sqrt{u^2 + 2gh}$

For both the particle final velocities when they reach the earth's surface are equal.

19. (a) For complementary angles of projection horizontal range is same.

20. (c) At the highest point of the path. Potential energy is maximum, so the kinetic energy will be minimum.

21. (d) Kinetic energy at the highest point

$K' = K\cos^2\theta = K\cos^2 30 = K\left(\frac{\sqrt{3}}{2}\right)^2 = \frac{3K}{4}$

22. (c) Equation of trajectory for oblique projectile motion

$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$

Substituting $x = D$ and $u = v_0$

$h = D\tan\theta - \frac{gD^2}{2u_0^2\cos^2\theta}.$

23. (c) Total time of flight $= \frac{2u\sin\theta}{g} = \frac{2 \times 50 \times 1}{2 \times 10} = 5\,s$
Time to cross the wall = 3 *sec* (given)
Time in air after crossing the wall = (5 – 3) = 2 *sec*
$\therefore$ Distance travelled beyond the wall $= (u\cos\theta)t$

$= 50 \times \frac{\sqrt{3}}{2} \times 2 = 86.6\,m$

24. (b) Change in momentum= $2mv\sin\theta = 2mv\sin\frac{\pi}{4} = \sqrt{2}mv$

25. (c) The vertical components of velocity of both the balls will be same if they stay in air for the same period of time. Hence vertical height attained will be same.

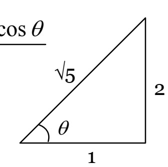
26. (a) $R = 2H$ given

We know $R = 4H\cot\theta \Rightarrow \cot\theta = \frac{1}{2}$

From triangle we can say that $\sin\theta = \frac{2}{\sqrt{5}}$, $\cos\theta = \frac{1}{\sqrt{5}}$

$\therefore$ Range of projectile $R = \frac{2v^2\sin\theta\cos\theta}{g}$

$= \frac{2v^2}{g} \times \frac{2}{\sqrt{5}} \times \frac{1}{\sqrt{5}} = \frac{4v^2}{5g}.$



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