Test – 01

Sarthak MHT CET Crash Course (2024)

21/01/2024

PHYSICS

1. A stone of mass 0.3 kg attached to a 1.5m long string is whirled around in a horizontal circle at a speed of 6m/s. What is the tension in the string?

(1) 30 N (2) 20 N
(3) 10 N (4) 7.2 N

2. A mass M is suspended by a string of length l. Find the velocity, which must be imparted to it to just reach the top.

(1) $\sqrt{6gl}$ (2) $\sqrt{5gl}$
(3) $\sqrt{4gl}$ (4) $\sqrt{2gl}$

3. If the equation for the displacement of a particle moving on a circular path is given by $(\theta) = 2t^3 + 0.5$, where θ is in radius and t in seconds, then what is the angular velocity of the particle after 2s from its start?

(1) 8 rad/s
(2) 12 rad/s
(3) 24 rad/s
(4) 36 rad/s

4. According to Kepler's law the time period of a satellite varies with its radius as

(1) $T^2 \propto (1/R^2)$
(2) $T^3 \propto R^2$
(3) $T^2 \propto (1/R^3)$
(4) $T^2 \propto R^3$

5. The seconds hand of a watch has length 6 cm. What will be the speed of end point and magnitude of difference of velocities at two perpendicular positions?

(1) 8.88 & 4.44 mm/s
(2) 6.28 & 0 mm/s
(3) 8.88 & 6.28 mm/s
(4) 6.28 & 8.88 mm/s

6. What is the acceleration of an object moving with speed v in a circle of radius r?

(1) $\frac{v^2}{r}$ towards the centre
(2) $\frac{v}{r}$ away from the centre
(3) $\frac{v}{r^2}$ away from the centre
(4) $\frac{r}{v^2}$ towards the centre

7. A 5 kg brick of dimensions 20 cm × 10 cm × 8 cm is lying on the largest base. It is now made to stand with length vertical. If g = 10 m/s^2, then what will be the amount of work done?

(1) 9 J (2) 3 J
(3) 5 J (4) 7 J

8. A cricket ball of mass 150 g is moving with avelocity of 12 m/s and is hit by a bat so that it is turned back with a velocity of 20 m/s. The force below acts for 0.01 second. Then what is average force exerted by the bat on the ball?

(1) 960 N (2) 480 N
(3) 240 N (4) 120 N

9. A thin rod of mass m and length $2l$ is make to rotate about an axis passing through its centre and perpendicular to it. If its angular velocity changes from 0 to ω in time t, the what is torque acting on it?

(1) $\frac{ml^2\omega}{12t}$ (2) $\frac{ml^2\omega}{t}$
(3) $\frac{ml^2\omega}{3t}$ (4) $\frac{4ml^2\omega}{3t}$

10. A particle of mass m is executing uniform circular motion on a path of radius r. If P is the magnitude of its linear momentum, then the radial force acting on the particle is

(1) pmr (2) $\frac{p^2}{rm}$
(3) $\frac{rm}{p}$ (4) $\frac{mp^2}{r}$

11. If the radius of the earth reduces to half of its present value without changes in its mass, the duration of the day in hours will be then _______.

(1) 6 hours (2) 5 hours
(3) 4 hours (4) 3 hours

12. An earth satellite is moved from one stable circular orbit to a further stable circular orbit, which one of the following quantities will increase?

(1) Centripetal acceleration
(2) Linear orbital speed
(3) Gravitational potential energy
(4) Gravitational force

13. A solid sphere is rotating in free space. If the radius of the sphere is increased keeping mass same, which of the following will not be affected?

(1) Angular velocity
(2) Angular momentum
(3) Rotational kinetic energy
(4) Moment of inertia

14. Escape velocity of a body of 1 kg mass on a planet is 100 m/s. Gravitational potential energy of the body at the planet is

(1) –1000 J (2) –5000 J
(3) 1000 J (4) 5000 J

15. A disc of moment of inertia 5 kg-m is acted upon by a constant torque of 40 Nm. Starting from rest the time taken by it to acquire an angular velocity of 24 rad/s is

(1) 2.5 s (2) 3 s
(3) 4 s (4) 120 s

16. Identify the correct relation between linear velocity $\vec{v}$ and angular velocity $\vec{\omega}$ of a particle.

(1) $\vec{v} = \vec{r} \times \vec{\omega}$ (2) $\vec{v} = \vec{\omega} \times \vec{r}$
(3) $\vec{\omega} = \vec{v} \times \vec{r}$ (4) $\vec{\omega} = \vec{r} \times \vec{v}$

17. A stone tied with a string, is rotated in a vertical circle. The minimum speed with which the string has to be rotated,

(1) is independent of the length of the string
(2) is independent of the mass of the stone
(3) decreases with increasing in length of the string
(4) decreases with increasing mass of the stone

18. A metre stick is balanced on a knife edge at its centre. When two coins, each of mass 5 g are put one on top of the other at the 12.0 cm mark, the stick is found to be balanced at 45.0 cm. The mass of the metre stick is

(1) 76 g (2) 86 g
(3) 66 g (4) 56 g

19. Angular momentum is the product of which of the following quantities?

(1) Centripetal force and acceleration
(2) Mass and angular velocity
(3) Linear velocity and angular velocity
(4) Moment of inertia and angular velocity

20. A body of mass 2 kg is tied to a string of length 1m rotated in a vertical circle with a uniform speed of 4 m/s. When the mass is at ____, the tension in the string will be 52 N. (Take g = 10 m/s^2)

(1) top (2) bottom
(3) midway (4) anywhere

21. A particle comes round a circle of radius 1 m once. The time taken by it is 10 s. The average velocity of motion is

(1) zero (2) 0.2π m/s
(3) 2 m/s (4) 2π m/s

22. The displacement of a particle is given by $y = a + bt + ct^2 - dt^4$. What will be the initial velocity and acceleration of the particle?

(1) $-b, 2c$ (2) $b, -4d$
(3) $2c, -4d$ (4) $b, 2c$

23. An uniform rod of length '2L' has mass per unit length 'm'. The moment of inertia of the rod about an axis passing through its centre and perpendicular to its length is

(1) $\frac{4}{3}mL^3$ (2) $\frac{2}{3}mL^3$
(3) $\frac{2}{3}mL^2$ (4) $\frac{1}{3}mL^2$

24. Two bodies of different masses m_a and m_b are dropped from two difference heights i.e. a and b. The ratio of time taken by both bodies through these distances is given as _______.

(1) $\frac{m_a}{m_b} = \frac{b}{a}$ (2) $a : b$
(3) $\sqrt{a} : \sqrt{b}$ (4) $a^2 : b^2$

25. Two identical satellites are at R and 7R away from earth surface, the wrong statement is (R = Radius of earth)

(1) ratio of potential energies will be 4
(2) ratio of kinetic energies will be 4
(3) ratio of total energy will be 4
(4) ratio of total energy will be 4 but ratio of potential and kinetic energies will be 2

26. A torque of 50 Nm acting on a wheel at rest rotates it through 200 radians in 5 seconds. Calculate the angular acceleration produced.

(1) 16 rad s^{-1} (2) 12 rad s^{-1}
(3) 8 rad s^{-1} (4) 4 rad s^{-1}

27. A simple pendulum has a length l. Find out the minimum velocity that should be imparted to its bob at the mean proton, so that the bob reaches a height equal to l above the point of suspension.

(1) $\sqrt{3gl}$ (2) $\sqrt{5gl}$
(3) $\sqrt{2gl}$ (4) $\sqrt{gl}$

28. Two ice skaters A and B approach each other at right angles. Skater A has a mass 30 kg and velocity 1 m/s and skater B has a mass 20 kg and velocity 2 m/s. They meet and cling together. What is the final velocity of the couple?

(1) 1 m/s (2) 2.5 m/s
(3) 2 m/s (4) 1.5 m/s

29. Two balls A and B are thrown vertically upwards from the same location on the surface of the earth with velocities $2\sqrt{\frac{gR}{3}}$ and $\sqrt{\frac{2gR}{3}}$ respectively, where R is the radius of the earth and g is the acceleration due to gravity on the surface of the earth. What is the ratio of the maximum height attained by A to that attained by B?

(1) 4 (2) 2
(3) 8 (4) $4\sqrt{2}$

30. Which of the following statements is incorrect in respect of a body in uniform circular motion?

(1) Its kinetic energy is constant
(2) Its acceleration is constant
(3) Its angular velocity is constant
(4) Its speed is constant

31. A cyclist goes round a circular path of circumference 34.3 m in $\sqrt{22}$ s. The angle made by him, with the vertical, will be

(1) 40° (2) 42°
(3) 45° (4) 48°

32. The moment of inertia of a uniform circular disc of radius 'R' and mass 'M' about an axis touching the disc at its diameter and normal to the disc is

(1) MR^2 (2) $\frac{1}{2}MR^2$
(3) $\frac{3}{2}MR^2$ (4) $\frac{2}{5}MR^2$

33. What is the unit of angular momentum?

(1) Nm (2) $kg^2m^2s^{-1}$
(3) kgm^2s^{-1} (4) $kgm^{-1}s^{-1}$

34. Two circular iron discs are of the same thickness. The diameter of A is twice that of B. The moment of inertia of A as compared to that of B is

(1) 16 times as large
(2) 8 times as large
(3) 4 times as large
(4) twice as large

35. A body of mass 3 kg is under a constant force which causes a displacement s in metre in it, given by the relation $s = \frac{1}{3}t^2$, where t is in seconds. What will be the work done by the force in 2 sec?

(1) $\frac{3}{8}$ J (2) $\frac{5}{19}$ J
(3) $\frac{8}{3}$ J (4) $\frac{19}{5}$ J

36. A person sitting in a chair in a satellite feels weightless because

(1) the normal force is zero
(2) the person in satellite is not accelerated
(3) the earth does not attract the objects in a satellite
(4) the normal force by the chair on the person balances the earth's attraction

37. A solid cylinder rolls down an inclined plane of height 3 m and reaches the bottom of plane with angular velocity of $2\sqrt{2}$ rad s^{-1}. The radius of cylinder must be (Take g = 10 ms^2)

(1) $\sqrt{5}$ m (2) 0.5 cm
(3) 5 cm (4) $\sqrt{10}$ cm

38. What is the acceleration of a particle performing a uniform circular motion?

(1) $v^2/2$ (2) $v\omega$
(3) $r\omega$ (4) zero

39. A thin circular ring of mass M and radius r is rotating about its axis with a constant angular velocity ω. Four objects each of mass m, are kept gently to the opposite ends of two perpendicular diameters of the ring. The angular velocity of the ring will be

(1) $\frac{M\omega}{M+4m}$ (2) $\frac{M\omega}{4m}$
(3) $\frac{(M-4m)\omega}{M+4m}$ (4) $\frac{(M+4m)\omega}{M}$

40. A bomb of mass 3.0 kg explodes in air into two pieces of masses 2.0 kg and 1.0 kg. The smaller piece goes at a speed of 80 m/s. Calculate the total energy imparted to the two pieces.

(1) 2.14 kJ (2) 1.07 kJ
(3) 2.4 kJ (4) 4.8 kJ

41. Suppose earth to be a homogeneous sphere. Scientist A goes deep down in a mine and scientist B goes high up in a balloon. The value of g measured by

(1) B goes on decreasing and that by A goes on increasing
(2) A goes on decreasing and that by B goes on increasing
(3) Each decreases at different rates
(4) Each decreases at the same rate

42. One circular ring and one circular disc, both are having the same mass and radius. The ratio of their moments of inertia about the axes passing through their centres and perpendicular to their planes, will be

(1) 1 : 1 (2) 1 : 2
(3) 2 : 1 (4) 4 : 1

43. Two racer cars A and B start from the same place at the same instant with initial velocities of 8 m/s and 5 m/s respectively. The car A moves with a uniform acceleration of 1 m/s^2 and the car B moves with a uniform acceleration of 1.1 m/s^2. Both A and B reach the winning post at the same time. The length of the track is _____.

(1) 2080 m (2) 2280 m
(3) 1680 m (4) 1880 m

44. A mass is revolving in a circle which is in the plane of the paper. The direction of angular acceleration

(1) Upward to the radius
(2) Towards the radius
(3) Tangential
(4) At right angle to angular velocity

45. A body of mass 0.4 kg is whirled in a vertical circle making 2 rev/s. If the radius of the circle is 2 m, then tension in the string when the body is at the top of the circle, is

(1) 115.86 N (2) 109.86 N
(3) 89.86 N (4) 41.56 N

46. When a uniform solid sphere and a disc of the same mass and of the same radius rolls down an inclined smooth plane from rest to the same distance, then the ratio of the time taken by them is

(1) $15^2 : 14^2$
(2) $15 : 14$
(3) $14 : 15$
(4) $\sqrt{14} : \sqrt{15}$

47. A stone is thrown vertically downward with velocity of 2 m/s from top of tower of height 40 m. What is the height of stone from ground after 2 second of release?

(1) 10 m (2) 23.6 m
(3) 16.4 m (4) 30 m

48. A vehicle is moving with a velocity v on a curved road of width k and radius of curvature R. For counteracting the centrifugal force on the vehicle, find out the difference in elevation required in between the outer and inner edges of the road.

(1) $\frac{kv^2}{Rg}$ (2) $\frac{k^2v}{Rg}$
(3) $\frac{kv}{Rg}$ (4) $\frac{kv}{R^2g}$

49. A sphere of mass 200 g is attached to an inextensible string of length 130cm whose upper end is fixed to the ceiling. The sphere is made to describe a horizontal circle of radius 50 cm. What is the tension in the string?

(1) 1.12 N (2) 1.28 N
(3) 2.28 N (4) 2.15 N

50. A player caught a cricket ball of mass 150 g moving at a rate of 20 m/s. If the catching process is completed in 0.1 s, the force of the blow exerted by the ball on the hand of the player will be equal to:

(1) 3 N (2) 150 N
(3) 30 N (4) 300 N

ANSWER KEY

1. (4)
2. (2)
3. (3)
4. (4)
5. (4)
6. (1)
7. (2)
8. (2)
9. (3)
10. (2)
11. (1)
12. (3)
13. (2)
14. (2)
15. (2)
16. (2)
17. (2)
18. (3)
19. (4)
20. (2)
21. (1)
22. (4)
23. (2)
24. (3)
25. (4)
26. (1)
27. (2)
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35. (3)
36. (1)
37. (1)
38. (2)
39. (1)
40. (4)
41. (3)
42. (3)
43. (2)
44. (3)
45. (1)
46. (4)
47. (3)
48. (1)
49. (4)
50. (3)

Hints and Solution

1. (4)
Here, mass of the stone, $m = 0.3$ kg
Length of a string = 1.5 m
$\Rightarrow$ Speed $v = 6$ m/s
$$F = \frac{mv^2}{R} = \frac{(0.3)(6)^2}{1.5} = 7.2 \text{ N}$$

2. (2)

3. (3)
$$\omega = \frac{d\theta}{dt} = \frac{d}{dt}\left(2t^3 + 0.5\right) - 6t^2$$
At $t = 2$ s, $\omega = 6 \times (2)^2 = 24$ rad/s

4. (4)

5. (4)
$$v = r\omega = r\left(\frac{2\pi}{T}\right) = 60 \times \frac{2\times 3.14}{60} = 6.28 \text{ mms}^{-1}$$
In perpendicular positions, velocities will be perpendicular.
Magnitude of difference of velocities
$$= \sqrt{2}\left(6.28 \text{ mms}^{-1}\right) = 8.88 \text{ mms}^{-1}$$

6. (1)
Centripetal force acting on a object in uniform circular motion is $F = \frac{mv^2}{r}$
$\Rightarrow$ acceleration $= \frac{F}{m} = \frac{v^2}{r}$ towards the centre.

7. (2)
Given:
In the first case, the height of the brick = 8 cm
$\therefore$ The height of its centre of gravity = 4 cm
In the second case, the height of centre of gravity = 10 cm
$\therefore$ The increase in the height of centre of gravity = 10 – 4 = 6 cm
$\therefore$ Work done $= mgh = 5 \times 10 \times \frac{6}{100} = 3$ J

8. (2)
M = 150 g = 150 × 10^{-3} kg, u = 12 m/s, V = –20 m/s
Impulse imparted to the bat
= Change in moment of the bat
= –Change in momentum of the ball
= –$(mv - mu) = mu - mv = m(u - v)$
$Ft = m(u - v)$
$$F = \frac{m(u-v)}{t} = \frac{150\times 10^{-3}(12+20)}{0.01} = 480 \text{ N}$$

9. (3)
As, $\tau = I\alpha$
Therefore, $\tau = \left[\frac{m(2l)^2}{12}\right]\left(\frac{\omega}{t}\right) = \frac{m\times 4l^2\times\omega}{12\times t}$
$$= \frac{4ml^2\omega}{12t} = \left(\frac{ml^2\omega}{3t}\right)$$

10. (2)
Radial force $= \frac{mv^2}{r} = \frac{m}{r}\left(\frac{p}{m}\right)^2 = \frac{p^2}{mr}\left[\because p = mv\right]$

11. (1)
Present angular momentum, $L_1 = I\omega$
$$L_1 = \frac{2}{5}MR^2\omega$$
New angular momentum, $L_2 = \frac{2}{5}M\left(\frac{R}{2}\right)^2\omega^1$
If $\tau = 0$, $L_1 = L_2 \Rightarrow \frac{2}{5}MR^2\omega = \frac{1}{4}\times\frac{2}{5}MR^2\omega$
$\therefore$ $\omega' = 4\omega$
$\therefore$ $T' = \frac{T}{4} = \frac{24}{4} = 6$ hours

12. (3)
Here potential energy $U = \frac{-GMm}{r}$. Thus, if r increases then U also increases.

13. (2)
The total angular momentum of the sphere remains constant as no external toque act on it.

14. (2)
Given, $v_e = \sqrt{\frac{2GM}{R}} = 100$, $\therefore$ $\frac{GM}{R} = 5000$
Thus, potential energy $U = -\frac{GMm}{R} = -5000$ J

15. (2)
Here angular acceleration, $\alpha = \frac{r}{I} = \frac{40}{50} = 8$ rad/s^2
And we know that,
$\omega + \omega_0 + \alpha t \Rightarrow 24 = 0 + 8t \Rightarrow t = 3$ s.

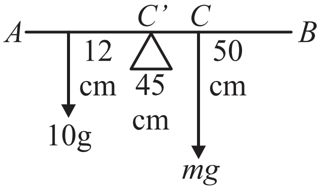
16. **(2)**

The relation between linear velocity $\vec{v}$ and angular velocity $\vec{\omega}$ is, $\vec{v} = \vec{\omega} \times \vec{r}$.

17. **(2)**

18. **(3)**

Let m be the mass of the metre stick concentrated at C, the 50 cm mark as shown in the figure.



In equilibrium, taking moments of forces about C', we get, 10g (45 – 12) = mg (50 – 45)

$\Rightarrow$ 10g × 33 = mg × 5

$$\Rightarrow \quad m = \frac{10 \times 33}{5} = 66\text{ g}$$

19. **(4)**

20. **(2)**

$$T = mg + \frac{mv^2}{r} = 2 \times 10 + \frac{2 \times 16}{1} = 52\text{ N}$$

21. **(1)**

Here, average velocity is zero because in complete revolution, total displacement is zero.

22. **(4)**

Displacement, $y = a + bt + ct^2 - dt^4$

$\therefore$ The velocity, $v = \frac{dy}{dt} = 0 + b + 2ct - 4dt^3$

The initial velocity is obtained by putting $t = 0$

$\therefore$ Initial velocity = $v_0 = b$

Acceleration $= \frac{dv}{dt} = \frac{d}{dt}\left[b + 2ct - 4dt^3\right]$

$= 2c - 4d \times 3t^2 = 2c - 12dt^2$

At $t = 0$, the initial acceleration (a_0)

$\therefore$ $a_0 = 2c$

23. **(2)**

From the given information in the problem,

$$U = \frac{ML^2}{12} = \frac{(m \times 2L) \times (2L)^2}{12}$$

$$\Rightarrow \frac{m \times 2L \times 4L^2}{12} = \frac{2}{3}mL^3.$$

24. **(3)**

$$s = ut + \frac{1}{2}at^2$$

$$a = 0 + \frac{1}{2}at_1^2;\ b = 0 + \frac{1}{2}at_2^2;\ \frac{t_1}{t_2} = \frac{\sqrt{a}}{\sqrt{b}}$$

25. **(4)**

Here, orbital radius of satellites $r_1 = R + R = 2R$ and $r_2 = R + 7R = 8R$

Potential energy, $U_1 = \frac{-GMm}{r_1}$ and $U_2 = \frac{-GMm}{r_2}$

Kinetic energy, $K_1 = \frac{GMm}{2r_1}$ and $K_2 = \frac{GMm}{2r_2}$

and total energy, $E_1 = \frac{GMm}{2r_1}$ and $E_2 = \frac{GMm}{2r_2}$

$$\therefore \quad \frac{U_1}{U_2} = \frac{K_1}{K_2} = \frac{E_1}{E_2} = 4$$

26. **(1)**

From the equation, $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$$\Rightarrow \quad 200 = \frac{1}{2}\alpha(5)^2$$

$\Rightarrow$ α = 16 rad/s^2

27. **(2)**

28. **(1)**

Applying principle of conservation of linear momentum, $p = \sqrt{p_1^2 + p_2^2}$

or $\quad (m_1 + m_2)v = \sqrt{(m_1v_1)^2 + (m_2v_2)^2}$

or $\quad (30 + 20)v = \sqrt{(30 \times 1)^2 + (20 \times 20)^2} = 50$

$$\Rightarrow \quad v = \frac{50}{50} = 1\text{ m/s}$$

29. **(1)**

If h is the maximum height attained, then we have

$$\frac{1}{2}mv^2 - \frac{GMm}{R} = -\frac{GMm}{(R+h)} \Rightarrow v^2 = \frac{2ghR}{(R+h)}$$

$$\left(\because g = \frac{GM}{R^2}\right)$$

For ball A, we get $\frac{4gR}{3} = \frac{2gh_AR}{(R+h_A)} \Rightarrow h_A = 2R$

For ball B, we get $\frac{2gR}{3} = \frac{2gh_BR}{(R+h_B)} \Rightarrow h_B = \frac{R}{2}$

$$\therefore \quad \frac{h_A}{h_B} = 4.$$

30. **(2)**

As speed is constant and $v = r\omega$ and $E_K = \frac{1}{2}mv^2$, so angular velocity and K.E. will be constant but velocity and acceleration are not constant as their directions are always changing.

31. **(3)**

Given, $2\pi r = 34.3$

$\Rightarrow \quad r = \frac{34.3}{2\pi}$ and $v = \frac{2\pi r}{T} = \frac{2\pi r}{\sqrt{22}}$

$\therefore$ Angle of binding i.e., $\theta = \tan^{-1}\left(\frac{v^2}{rg}\right) = 45°$

32. (3)

Here, momentum of inertia of a uniform circular disc about an axis through its centre and perpendicular to its plane is $I_C = \frac{1}{2}MR^2$

Here, momentum of inertia of a uniform circular disc about an axis touching the disc at its diameter and normal to the disc is I. Now by using parallel axis theorem,

$$\therefore \quad I = I_C + Mh^2 = \frac{1}{2}MR^2 + MR^2 = \frac{3}{2}MR^2$$

33. (3)

34. (1)

Here,

M.I. of disc $= \frac{1}{2}mR^2 = \frac{1}{2}(\pi R^2 t)\rho R^2 = \frac{1}{2}\pi R^4 t\rho$

(where ρ is density and t is thickness.)

As discs are made of same material and same thickness, then $I \propto R^4 \propto (\text{Diameter})^4$

$$\therefore \quad \frac{I_A}{I_B} = \left(\frac{D_A}{D_B}\right)^4 = \left(\frac{2}{1}\right)^4 = \frac{16}{1}$$

35. (3)

Work done by a force

$= F \times s$ = mass (m) × acceleration (a) × s

$$\therefore \quad W = \text{mass} = ms.\left(\frac{d^2 s}{dt^2}\right) \qquad \ldots\text{(i)}$$

But $s = \frac{1}{3}t^2$

$$\therefore \quad \frac{ds}{dt} = \frac{1}{3} \times 2t = \frac{2}{3}t \text{ and } \frac{d^{2s}}{dt^2} = \frac{2}{3} \qquad \ldots\text{(ii)}$$

$$\Rightarrow \quad W = 3 \times \frac{1}{3}t^2 \times \frac{2}{3} = \frac{2}{3} \times 2^2 = \frac{8}{3} \text{ J}$$

36. (1)

37. (1)

Here, linear velocity,

$$v = \sqrt{\frac{2gh}{1+\frac{I}{mr^2}}} = \sqrt{\frac{2\times10\times3}{1+\frac{mr^2}{2\times mr^2}}} = \sqrt{\frac{2\times10\times3}{\frac{3}{2}}} = \sqrt{40}$$

As, $v = r\omega$

Thus, radius of cylinder is given as,

$$\Rightarrow \quad r = -\frac{v}{\omega} = \frac{\sqrt{40}}{2\sqrt{2}} = \sqrt{\frac{40}{8}} = \sqrt{5} \text{ m.}$$

38. (2)

$F = mr\omega^2$ or $ma = mr\omega^2$

$\Rightarrow \quad a = mr\omega^2 = v\omega$

39. (1)

Here, initial angular momentum of ring,

$L = I\omega = Mr^2\omega$.

Final angular momentum of ring, and four particles system $L = (Mr^2 + 4mr^2)\omega'$.

Here angular momentum remains constant because there is no torque on the system.

$$\therefore \quad Mr^2\omega = \left(Mr^2 + 4mr^2\right)\omega'$$

$$\Rightarrow \quad \omega' = \frac{M\omega}{M+4m}$$

40. (4)

Total linear momentum before explosion

= Total linear momentum after explosion

$\therefore \quad Mu = m_1v_1 + m_2v_2$

$\therefore \quad 3 \times 0 = 2 \times v_1 + 1 \times 80$

$\therefore \quad 2v_1 = -80$

$\therefore \quad v_1 = -40$ m/s

This is the velocity of the bigger piece,

$\therefore$ Total energy of the two pieces

$$= \frac{1}{2}m_1v_1^2 \frac{1}{2}m_2v_2^2 = \frac{1}{2} \times 2 \times (-40)^2 + \frac{1}{2} \times 1 \times 1(80)^2$$

= 1600 + 3200 = 4800 J

$\Rightarrow \quad E = 4.8 \times 10^3$ J = 4.8 kJ

41. (3)

From the problem, for scientist A which goes down in a mine, $g' = g\left(1+\frac{d}{R}\right)$

For scientist B, which goes up in a air,

$$g' = g\left(1-\frac{2h}{R}\right)$$

Thus, it is clear that value of g measured by each will decreases at different rates.

42. (3)

Here, as per given in the problem,

$$\frac{I_{\text{Ring}}}{I_{\text{Disc}}} = \frac{MR^2}{I/2MR^2} = 2:1.$$

43. (2)

Both A and B cover the same distance x in the same time t.

For A, $x = u_1t + \frac{1}{2}a_1t^2$ …..(i)

For B, $x = u_2t + \frac{1}{2}a_2t^2$ …..(ii)

$$\therefore \quad u_1t + \frac{1}{2}a_1t^2 = u_2t + \frac{1}{2}a_2t^2$$

$$\therefore \quad (u_1 - u_2)t = \frac{1}{2}(a_2 - a_1)t^2$$

$\therefore \quad (8-5)\frac{1}{2} \qquad (1.1-1)$

$\therefore \quad 3 = \frac{t}{20} \qquad \therefore t = 60$ s

From (i),

$x = 8\times 60 + \frac{1}{2}\times 1\times 3600 = 480 + 1800 = 2280$ m

$\Rightarrow$ Length of track = 2280 m

44. **(3)**

45. **(1)**

We know, tension at the top of the circle,

$T = m\omega^2 r - mg$

$T = 0.4 \times 4\pi^2 n^2 \times 2 - 0.4 \times 9.8 = 115.86$ N

46. **(4)**

The time is given as $t = \frac{1}{\sin\theta}\sqrt{\frac{2h}{g}\left(1+\frac{K^2}{R^2}\right)}$

$$\Rightarrow \frac{t_S}{t_D} = \sqrt{\frac{1+\left(\frac{K^2}{R^2}\right)_S}{1+\left(\frac{K^2}{R^2}\right)_D}} = \sqrt{\frac{1+\frac{2}{5}}{1+\frac{1}{2}}} = \sqrt{\frac{14}{15}}$$

47. **(3)**

Displacement in 2 seconds, $AC = s = ut + \frac{1}{2}at^2$

$\Rightarrow \quad 2(2) + \frac{1}{2}\times 9.8\times 4$

$\Rightarrow$ 4 + 19.6 = 23.6 m

$BC = 40 - 23.6 = 16.4$ m

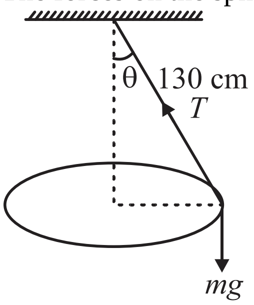
48. **(1)**

$\tan\theta = \frac{v^2}{Rg} = \frac{h}{k}$

$\therefore \quad h = \frac{kv^2}{Rg}$

49. **(4)**

The forces on the sphere are



(1) force of gravity mg in vertically downward

(2) tension T in the string.

The sphere in in equilibrium along the vertical.

$\Rightarrow \quad T = \frac{mg}{\cos\theta} = \frac{0.2\times 9.8}{(120/130)} = 2.12$ N

50. **(3)**

Impulse = Force × Time

$\Rightarrow \quad \text{Force} = \frac{\text{Impulse}}{\text{time}} = \frac{3}{0.1} = 30$ N