SOLUTIONS

LEVEL – I

1. $w = \frac{2\pi}{T}$ as time period is some $\frac{W_1}{W_2} = 1$

2. Centripetal acc. $(a_c) = \frac{v^2}{R}$

   Tarpertial acc. a_f = a

   Net acc. $a = \sqrt{a_c^2 + a_f^2} = \sqrt{\frac{v^4}{R^2} + a^2}$

   $= \sqrt{\frac{(30)^4}{(500)^2} + 2^2} = 2.7 m/s^2$

3. It becomes null
4. Velocity and acceleration both charges
5. Magnitude of acceleration remains constant.
6. Path will be parabola
7 Velocity vector and acceleration vector are perpendicular to each other
8. Acceleration of the particle ac = W^2R = $(2\pi v)^2$ R

9. Angular velocity $W_{P/A} = \frac{v}{2r}$

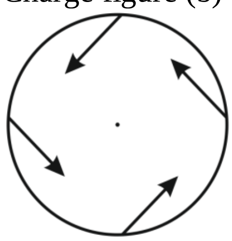
   & $w_{p/o} = \frac{v}{r}$

10. Centripetal acceleration $a_c = \frac{v^2}{R}$

    Targertial acceleration a_t = a

    Not acceleration $= \sqrt{\left(\frac{v^2}{R}\right)^2 + a^2}$

11. Magnitude & direction of acceleration both charges.
12. Speed remain const.
13. Charge figure (b)



14. $N = mg - \frac{mv^2}{R}$, when train moves from east to west relative velocity increases & hence N decreases.
15. Acceleration $a_c = w^2 r$
16. There is no change in angular velocity as it ix an axial vector.
17. Net acceleration

$a=\sqrt{a_c^2+a_f^2}$

$a_c=\frac{v^2}{R}$ & $a_t=a$

18. $a_c=w^2R$ $w=2\pi r$
19. Displacement = 0

Distance $=2R+\frac{2\pi R}{4}=2+\frac{\pi}{2}$

Average speed = $\frac{2+\frac{\pi}{2}}{\frac{10}{60}}=3(\pi+4)$

20. Displacement = $2r\sin\theta/2$
21. $a_c=\frac{v^2}{R}$
22. $w=2\pi r$ and $v=rw$
23. Displacement = $2r\sin(\theta/2)$

$x=a(1-\cos\omega t), y=a\sin wt$

24. $x=a-a\cos wt,$

or $(x-a)=-a\cos wt$ & $y=a\sin wt$

Square and add

$(x-a)^2+y^2=a^2$

25. Position vector $\vec{r}=\left(2t\hat{i}+2t^2\hat{j}\right)m$

Velocity vector $\vec{v}=\frac{d\vec{r}}{dt}=\left(2\hat{i}+4t\hat{j}\right)m/s$

Velocity at $t=2\,sec$.

$\vec{v}=(21\quad 8J)m/s$ & $|\vec{V}|=\sqrt{4+64}=2\sqrt{17}m/s$

Angle made by velocity with x – axis

$\tan\theta=\frac{v_y}{v_x}=\frac{4t}{2}=2t$

Differentiate w.r.t.t

$\sec^2\theta\frac{d\theta}{dt}=2\Rightarrow\frac{d\theta}{dt}=2\cos^2\theta$

or $\frac{d\theta}{dt}=2\times\left(\frac{2}{2\sqrt{17}}\right)^2=\frac{2}{17}Rad/sec$

26.

$a_c=\frac{v^2}{R}$ or $R=\frac{v^2}{a_c}=\frac{(8\sin 30)^2}{2}=8m$

27. $Avg\,ace=\frac{\Delta V}{t}$ $\Delta V=2V$

& $t=\frac{\pi R}{v}$

28. Net acceleration $a\sqrt{a_c^2+a_f^2}$

29. Net acceleration $a = \sqrt{a_c^2 + G_f^2}$

30. Kinetic Energy remains constant.

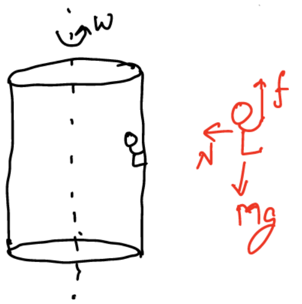
31. $N = mg - \frac{mv^2}{R}$

$R_B > R_A$ so $N_B > N_A$

32. Work done = F S cos θ

As $\theta = 90^o$, so w = 0

33.



$N = m\omega^2 R$

Friction force $f = \mu N = mg$

$\mu m\omega^2 R = mg$

$\omega min = \sqrt{\frac{g}{\mu R}}$

34. Reduired centripetal force

$fc = m\omega^2 \times 4r = \mu mg$

When $\omega^1 = 2\omega$

$m(2\omega)^2 \times r^1 = \mu mg$

On solving r = r

35. Tension T = mw^2r

If tension becomes 2T, keeping r const

2T = $2w^{12}r$

$\Rightarrow w^1 = \sqrt{2}w = 7rpm$

36. Speed remains constant and hence KE.

37. Max. allowed speed $v = \sqrt{\mu g R}$

38. centripetal force = $\frac{mv^2}{R}$ towards centre

39. Tension $T = mw^2r$

40. Reduired centripetal force will be given by friction between tyre and the road.

41. $N = mg - \frac{mV^2}{R}$ compare R

42. Actual forces are mg & T

43. friction froce $f = \mu N = \mu m(L \propto) = \mu mL \propto$

Required contripetal force $f = mw^2 L = \mu L \propto$

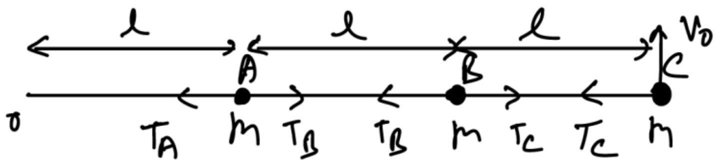
$$w^2 = \mu \propto \Rightarrow w\sqrt{\mu \propto}$$

$w = w_r + \propto t$

$\sqrt{\mu \propto} = 0 + \propto t \Rightarrow t_2 \sqrt{\frac{\mu}{\propto}}$

PYQ

1. Kinetic energy remains constants.
2. Inner wheel leaves the ground first
3. Acceleration $a = w^2R$, $w = 2\pi r$
4. Centripetal force
5. Momentum charges by = $\Delta P = mv - (-mv)$
   $= 2mv$
6. Force and displacement are perpendicular to each other
7. Accleration in towards centre
8. Tangertial acceleration is 300
9. $a_c = \frac{v^2}{R}$
10. Average speed = $\frac{\text{total dixtance}}{\text{total time}}$
11. Linear velocity $v = rw$, acceleration = w^2R
    Tension $T = mw^2R$
12. Acceleration $a_c = \frac{v^2}{R}$
13. $v\sqrt{\mu gR}$
14. $F = \frac{mv^2}{R}$
15. $F = mw^2R, w = \frac{2\pi}{T}$
16. Momentum
17.

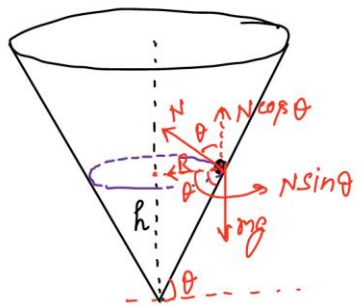


$w = \frac{v_o}{3\ell}$ Centripetal force on C, $T_C = mw^2(3\ell)$

For particle B, $T_B - T_C = mw^2(2\ell)$

For particle A, $T_A - T_B = mw^2\ell$

18.



$N\cos\theta = Mg$ ....(1)

$N\sin\theta = \frac{mv^2}{R}$ ....(2)

Divide(2) / (1)

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

Or $h = \frac{v^2}{g}$

19. Angular velocity $w = \frac{2\pi}{T}$

$T = 24hrs = 24\times 60\times 60\,sec$

20. Angular velocity $w = \frac{2\pi}{T}$

Linear velocity $v = \ell w$

21. Min speed at top $= \sqrt{gR}$

$w = \frac{v}{R} = \sqrt{g/R}$

$T = \frac{2\pi}{w} = 4\,sec$

22. $a = \sqrt{a_c^2 + a_f^2}$, $a_c = \frac{v^2}{R}$, $at = 9 = 2m/s^2$

23. $v = \sqrt{5gl}$

24. min velocity at the highest point $= \sqrt{gr}$

25. $T = mg + mw^2R$ $w = 2\pi r$ & $r = \frac{n}{40}$

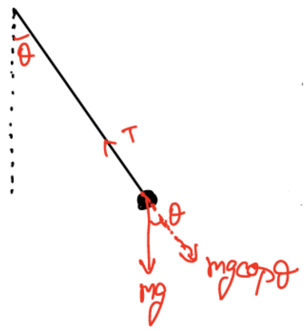
26. To complete circular turn, min speed at lowest point $v = \sqrt{5gR}$

Apply conservation of mechanical energy.

$mgh = \frac{1}{2}mv^2 \Rightarrow v\sqrt{2gh} = \sqrt{5gR}$

$R = \frac{2h}{5} = \frac{2\times 5}{5} = 2m$

27.



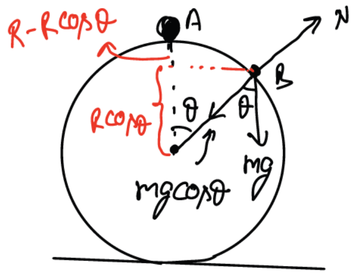
$T - mg\cos\theta = \frac{mv^2}{\ell}$

$T = mg\cos\theta + \frac{mv^2}{\ell}$

28. $mg\cos\theta - N = \frac{mv^2}{R}$

When particle reaves the surface, N = 0

$V = \sqrt{gR\cos\theta}$



Apply ME conservation at
A & B
$ME_A = ME_B$

$O = \frac{1}{2}mv^2 - mgR(1-\cos\theta)$

$\text{Or } V = \sqrt{2gR(1-\cos\theta)}$

$= \sqrt{gR\cos\theta}$

OR

$2gR(1-\cos\theta) = gR\cos\theta$

$2 - 2\cos\theta = \cos\theta \Rightarrow 2 = 3\cos\theta$

$\text{or } \cos\theta = \frac{2}{3}$

Height from ground $h = R + R\cos = R(1+\cos\theta)$

29. $v_x = \frac{dx}{dt} = 3at^2 \text{ \& } vy = \frac{dy}{dt} = 3bt^2$

Net speed $V = \sqrt{V_x^2 + V_y^2}$

30. $\overrightarrow{\Delta V} = \overrightarrow{V_2} - \overrightarrow{V_1}$

$|\overrightarrow{\Delta V}| = \sqrt{V^2 + V^2} = V\sqrt{2}$

31. Required centripetal force $fc = \frac{mv^2}{R} = \mu mg$

Or $v = \sqrt{\mu gR}$

32. $\vec{R} = 4\sin(2\pi t)\hat{i} + 4\cos(2\pi t)\hat{j}$

$x = 4\sin 2\pi t, y = 4\cos 2\pi t$

Sduare and add

$x^2 + y^2 = 4^2$

$\vec{V} = \frac{d\vec{R}}{dt} = 8\pi\cos 2\pi t\hat{i} - 8\pi\sin 2\pi t\hat{j}$

Acceleration $\vec{a}=\frac{\overrightarrow{dV}}{dt}=-16\pi^2\sin 2\pi t\hat{i}-16\pi^2\cos 2\pi t\hat{j}$

$=4\pi^2\left(4\sin 2\pi t\hat{i}+4\cos 2\pi+\hat{j}\right)$

$=-4\pi^2\vec{R}$

33. $\sqrt{gR\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}$

34. $\vec{r}=\cos\omega t\hat{x}+\sin\omega t\hat{y}$

$\vec{v}=\frac{\overrightarrow{dr}}{dt}=-w\sin\omega t\hat{x}+w\cos\omega t\hat{y}$

$\vec{a}=\frac{\overrightarrow{dv}}{dt}=-\omega^2\cos\omega t\hat{x}-w^2\sin\omega+\hat{y}$

& $=-\omega^2\left(\cos\omega t\hat{x}+\sin\omega t\hat{y}\right)=-\omega^2\vec{r}$

$\vec{v}.\vec{r}=0$

35. min speed at lowest point $=\sqrt{5gR}$

$KE=\frac{1}{2}mv^2=8\times10^{-1}3$

36. $\Rightarrow\frac{1}{2}\times10\times10^{-3}\times V^2=8\times10^{-1}$

$V^2=\frac{16\times10^{-1}}{10^{-2}}=160\Rightarrow v=\sqrt{160}\,M/R$

So, $a_c=\frac{v^2}{R}$

To find technical acc.

$v^2=4\alpha fas$

$160=0\ f\alpha\times2\times2\pi R$

find a, then $a=\sqrt{a_c^2+a^2}$

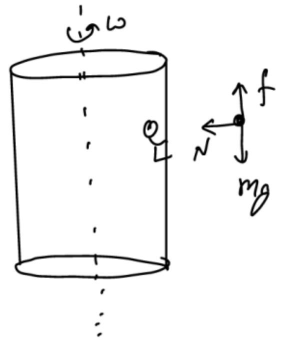
37. Acceleration towards centre

$a\cos30^o=\frac{v^2}{R}$

$15\times\frac{\sqrt{3}}{2}=\frac{v^2}{2.5}$

38. net force = T

39.



$N = mw^2R$

$f = \mu N = \mu m w^2 R = mg$

$w = \sqrt{\dfrac{g}{\mu R}}$

40.

Given, the radius of the circular path = R

The time taken by the particle to complete one revolution = T

When the particle is projected with the same speed (by which it is moving in circular orbit) at angle θ to the horizontal, the maximum height attained it is given as

$$H_{max} = \frac{u^2 \sin^2\theta}{2g} \quad \text{...(i)}$$

$$H_{max} = 4R \quad \text{(given)}$$

Also, we know that,
speed of the particle in circular path,

$$u = \frac{2\pi R}{T}$$

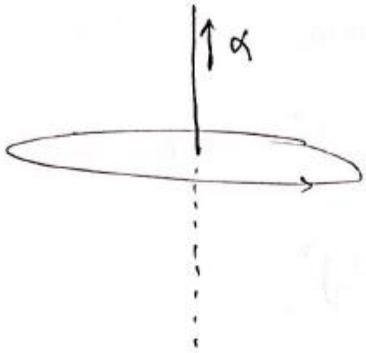
Substituting the values in the Eq. (i), we get

$$4R = \frac{\left(\frac{2\pi R}{T}\right)^2 \sin^2\theta}{2g}$$

$$\Rightarrow \quad \sin\theta = \left(\frac{2gT^2}{\pi^2 R}\right)^{1/2}$$

$$\Rightarrow \quad \theta = \sin^{-1}\left(\frac{2gT^2}{\pi^2 R}\right)^{1/2}$$

41.



Angular Acceleration is axial vector.