Non-uniform Circular Motion

26. (d) $\omega = \sqrt{\frac{g}{r}} = \sqrt{\frac{9.8}{0.2}} = 7rad/s$

27. (a)

28. (d) In non-uniform circular motion particle possess both centripetal as well as tangential acceleration.

29. (c)

30. (b) $v = \sqrt{2gh} = \sqrt{2 \times 10 \times 0.2} = 2m/s$

31. (d) $T = mg + m\omega^2 r = m\{g + 4\pi^2 n^2 r\}$

$= m\left\{g + \left(4\pi^2 \left(\frac{n}{60}\right)^2 r\right)\right\} = m\left\{g + \left(\frac{\pi^2 n^2 r}{900}\right)\right\}$

32. (d) $h = \frac{5}{2}r \Rightarrow r = \frac{2}{5} \times h = \frac{2}{5} \times 5 = 2metre$

33. (d) In the given condition friction provides the required centripetal force and that is constant. *i.e.* $m\omega^2 r$=constant

$\Rightarrow r \propto \frac{1}{\omega^2} \therefore\ r_2 = r_1 \left(\frac{\omega_1}{\omega_2}\right)^2 = 9\left(\frac{1}{3}\right)^2 = 1cm$

34. (b) By using equation $\omega^2 = \omega_0^2 - 2\alpha\theta$

$\left(\frac{\omega_0}{2}\right)^2 = \omega_0^2 - 2\alpha(2\pi n) \Rightarrow \alpha = \frac{3}{4}\frac{\omega_0^2}{4\pi \times 36}$, ($n$ = 36) ..(i)

Now let fan completes total n' revolution from the starting to come to rest

$0 = \omega_0^2 - 2\alpha(2\pi n') \Rightarrow n' = \frac{\omega_0^2}{4\alpha\pi}$

substituting the value of α from equation (i)

$n' = \frac{\omega_0^2}{4\pi}\frac{4\times 4\pi\times 36}{3\omega_0^2} = 48$revolution

Number of rotation = 48 – 36 = 12

35. (b) $v = \sqrt{3gr}$and $a = \frac{v^2}{r} = \frac{3gr}{r} = 3g$

36. (d) Tension at mean position, $mg + \frac{mv^2}{r} = 3mg$

$v = \sqrt{2gl}$ …(i)

and if the body displaces by angle θ with the vertical then $v = \sqrt{2gl(1 - \cos\theta)}$ …(ii)

Comparing (i) and (ii), $\cos\theta = 0 \Rightarrow \theta = 90°$

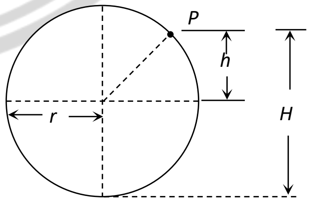
37. (c) Tension, $T = \frac{mv^2}{r} + mg\cos\theta$

For, $\theta = 30°, T_1 = \frac{mv^2}{r} + mg\cos 30°$

$$\theta = 60°, T_2 = \frac{mv^2}{r} + mg\cos 60° \therefore T_1 > T_2$$

38. (c) As we know for hemisphere the particle will leave the sphere at height $h = 2r/3$

$h = \frac{2}{3}\times 21 = 14m$



but from the bottom

$H = h + r = 14 + 21 = 35metre$

39. (c) $x = \alpha t^3$and $y = \beta t^3$ (given)

$v_x = \frac{dx}{dt} = 3\alpha t^2$and $v_y = \frac{dy}{dt} = 3\beta t^2$

Resultant velocity= $v = \sqrt{v_x^2 + v_y^2} = 3t^2\sqrt{\alpha^2 + \beta^2}$

40. (b)

41. (d) Tension at the top of the circle, $T = m\omega^2 r - mg$

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

42. (c) Minimum angular velocity $\omega\sqrt{g/R}_{min}$

$$\therefore T \frac{2\pi}{\omega_{min}\sqrt{\frac{R}{g}}_{max}} == 2\pi\sqrt{\frac{2}{10}} = 2\sqrt{2} \cong 3s$$

43. (a) $\left|\overrightarrow{\Delta v}\right| = 2v\, sin(\theta/2) = 2v\, sin\left(\frac{90}{2}\right) = 2v\, sin\, 45 = v\sqrt{2}$

44. (a) In this problem it is assumed that particle although moving in a vertical loop but its speed remain constant.

Tension at lowest point $T\frac{mv^2}{r}_{max}$

Tension at highest point $T\frac{mv^2}{r}_{min}$

$$\frac{T_{max}}{T_{min}} = \frac{\frac{mv^2}{r} + mg}{\frac{mv^2}{r} - mg} = \frac{5}{3}$$

by solving we get, $v = \sqrt{4gr} = \sqrt{4 \times 9.8 \times 2.5} = \sqrt{98} m/s$

45. (d) There is no relation between centripetal and tangential acceleration. Centripetal acceleration is must for circular motion but tangential acceleration may be zero.

46. (d) Angular momentum is a axial vector. It is directed always in a fix direction (perpendicular to the plane of rotation either outward or inward), if the sense of rotation remain same.

47. (a) Difference in kinetic energy = $2mgr = 2 \times 1 \times 10 \times 1 = 20J$

48. (d) Angular acceleration= $\frac{d^2\theta}{dt^2}$= $2\theta_2$