Chapter 6 Circular Motion Notes Answers

Check Your Understanding 1

1. Ans

(a) $f = 2$ Hz

$\omega = 2\pi f = 4\pi$ rad s^{-1}

(b) $T = \frac{1}{f} = 0.5$ s

(c) $v = r\omega = 0.3(4\pi) = 3.8$ m s^{-1}

(d) $\omega = \frac{v}{r} = \frac{2}{0.4} = 5$ rad s^{-1}

2. (a) friction provides centripetal force

$Friction = m\frac{v^2}{r} = 1500\frac{20^2}{10} = 6\times10^4$ N

(b) When the tires of the car are worn out, there is lesser friction to provide centripetal force.

Since centripetal force is proportional to v2 for the same radius, the car has to move slower.

3. (a) vertical component of T balances weight

$T\cos30 = 0.2(9.81) \rightarrow T = 2.3\,\text{N}$

(b) horizontal component of T provides centripetal force

$T\sin30 = m\frac{v^2}{r} \rightarrow 2.3\sin30 = 0.2\frac{v^2}{0.5}$

$v = 1.7$ m s^{-1}

4. 108 km h^{-1} = 30 m s^{-1}

resolving forces, $N\cos\theta = mg$ .. (1)

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

$\frac{(2)}{(1)}: \tan\theta = \frac{v^2}{rg} \rightarrow \theta = \tan^{-1}\frac{v^2}{rg} = 42^0$

$N = \frac{mg}{\cos\theta} = \frac{1000(9.81)}{\cos42} = 1.35\times10^4\,\text{N}$

Check Your Understanding 2

1. Ans

(a) Minimum tension occurs at top of circle, where $T+mg=\frac{mv^2}{r}$

$3+0.4(9.81)=0.4\frac{v^2}{1}\rightarrow v=4.16=4.2 \text{ m s}^{-1}\text{(2 sf)}$

(b) Maximum tension occurs at bottom, where $T-mg=\frac{mv^2}{r}$

$T=m\left(\frac{v^2}{r}+g\right)=0.4\left(\frac{4.16^2}{1}+9.81\right)=10.8=11 \text{ N (2 sf)}$

(c) Tension used to provide centripetal force

$T=\frac{mv^2}{r}=0.4(4.16^2)=6.9\text{N}$

2. Ans: D

At P, loss in GPE = gain in KE

$mgr=\frac{1}{2}mv^2\rightarrow v^2=2rg$

consider forces at P,

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

thus, $T=3mg$

3. Ans: A

Taking centripetal motion,

$T-mg\cos\theta=ma_c$

$T=ma_c+mg\cos\theta$

4. Ans

(a) to remain just in touch, weight must be used to provided centripetal force

$mg=\frac{mv^2}{r}\rightarrow v=\sqrt{rg}=\sqrt{0.25\times9.81}=1.57 \text{ m s}^{-1}$

(b) loss in GPE = gain in GPE + gain in KE

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

$9.81(h)=9.81(2\times0.25)+\frac{1}{2}(1.57^2)\rightarrow h=0.63 \text{ m}$