

Chapter 6 Circular Motion Notes Answers

Check Your Understanding 1

1. Ans

(a) $f = 2 \text{ Hz}$
 $\omega = 2\pi f = 4\pi \text{ rad s}^{-1}$

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

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

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

2. $T = 0.5 \text{ s}$

$$F_c = mr\omega^2 = mr\left(\frac{2\pi}{T}\right)^2 = 10(0.20)\left(\frac{2\pi}{0.5}\right)^2 = 316\text{N}$$

3. (a) vertical component of T balances weight

$$T \cos 30 = 0.2(9.81) \rightarrow T = 2.3 \text{ N}$$

(b) horizontal component of T provides centripetal force

$$T \sin 30 = m \frac{v^2}{r} \rightarrow 2.3 \sin 30 = 0.2 \frac{v^2}{0.5}$$
$$v = 1.7 \text{ m s}^{-1}$$

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

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

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

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

$$N = \frac{mg}{\cos \theta} = \frac{1000(9.81)}{\cos 42} = 1.35 \times 10^4 \text{ N}$$

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 provide centripetal force

$$mg = \frac{mv^2}{r} \rightarrow v = \sqrt{rg} = \sqrt{0.25 \times 9.81} = 1.57 \text{ m s}^{-1}$$

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

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

$$9.81(h) = 9.81(2 \times 0.25) + \frac{1}{2}(1.57^2) \rightarrow h = 0.63 \text{ m}$$