18 Marking scheme: Worksheet (A2)

1 **a** $\theta = \dfrac{30}{360} \times 2\pi = \dfrac{\pi}{6} \approx 0.52$ rad [1]

b $\theta = \dfrac{210}{360} \times 2\pi \approx 3.7$ rad [1]

c $\theta = \dfrac{0.05}{360} \times 2\pi \approx 8.7 \times 10^{-4}$ rad [1]

2 **a** $\theta = \dfrac{1.0}{2\pi} \times 360 = 57.3° \approx 57°$ [1]

b $\theta = \dfrac{4.0}{2\pi} \times 360 \approx 230°$ [1]

c $\theta = \dfrac{0.15}{2\pi} \times 360 \approx 8.6°$ [1]

3 **a** 88 days is equivalent to 2π radians.

$\theta = \dfrac{44}{88} \times 2\pi = \pi$ rad [1]

b $\theta = \dfrac{1}{88} \times 2\pi \approx 0.071$ rad (4.1°) [1]

4 **a** Friction between the tyres and the road. [1]

b Gravitational force acting on the planet due to the Sun. [1]

c Electrical force acting on the electron due to the positive nucleus. [1]

d The (inward) contact force between the clothes and the rotating drum. [1]

5 **a** $\omega = \dfrac{v}{r} = \dfrac{150}{20000}$ [1]

$\omega = 7.5 \times 10^{5}$ rad s^{-1} [1]

b $a = \dfrac{v^2}{r}$ [1]

$a = \dfrac{150^2}{20\,000}$ [1]

$a = 1.125$ m s$^{-2} \approx 1.1$ m s^{-2} [1]

c $F = ma = 80 \times 1.125$ [1]

$F = 90$ N [1]

6 **a** **i** Time $= \dfrac{8.2}{10} = 0.82$ s [1]

ii Distance = circumference of circle $= 2\pi \times 0.80 = 5.03$ m ≈ 5.0 m [1]

iii speed $= \dfrac{\text{distance}}{\text{time}} = \dfrac{5.03}{0.82}$ [1]

speed, $v = 6.13$ m s$^{-1} \approx 6.1$ m s^{-1} [1]

iv $a = \dfrac{v^2}{r}$ [1]

$a = \dfrac{6.13^2}{0.80}$ [1]

$a = 47$ m s^{-2} [1]

v $F = ma = 0.090 \times 47$ [1]

$F \approx 4.2$ N [1]

b The tension in the string. [1]

c The stone describes a circle, therefore the angle between the velocity and the acceleration (or centripetal force) must be 90°. [1]

7 a i speed = $\dfrac{\text{distance}}{\text{time}}$

speed $v = \dfrac{2\pi r}{T} = \dfrac{2\pi \times 0.12}{1.6}$ [1]

$v = 0.471$ m s^{-1} ≈ 0.47 m s^{-1} [1]

ii $F = ma = \dfrac{mv^2}{r}$ [1]

$F = \dfrac{0.300 \times 0.471^2}{0.12}$ [1]

frictional force ≈ 0.55 N [1]

b Frictional force = $0.7mg$ [1]

$0.7mg = \dfrac{mv^2}{r}$ [1]

$v = \sqrt{0.7gr} = \sqrt{0.7 \times 9.81 \times 0.12}$ [1]

speed = 0.908 m s^{-1} $\approx$ 0.91 m s^{-1} [1]

8 a Kinetic energy at **B** = loss of gravitational potential energy from **A** to **B**

$\dfrac{1}{2}mv^2 = mgh$ or $v = \sqrt{2gh}$ [1]

$v = \sqrt{2 \times 9.81 \times 5.2} = 10.1$ m s^{-1} ≈ 10 m s^{-1} [1]

b i $a = \dfrac{v^2}{r}$ [1]

$a = \dfrac{10.1^2}{16}$ [1]

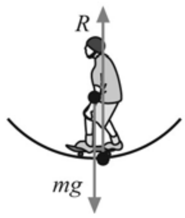
$a = 6.38$ m s^{-2} ≈ 6.4 m s^{-2} [1]

ii Net force = ma

$R - mg = ma$ [1]

$R = mg + ma = m(a + g) = 70(6.38 + 9.81)$ [1]

$R \approx 1.1 \times 10^3$ N [1]



9 **a** $R \cos 20° = W = 840 \times 9.8$ [1]

$R = \dfrac{840 \times 9.8}{\cos 20°} = 8760\ \text{N}$ [1]

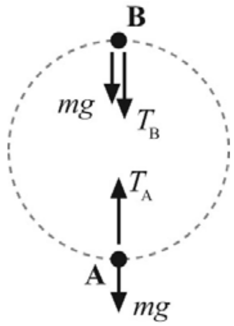
b $R \sin 20° = \text{centripetal force} = \dfrac{mv^2}{r}$ [1]

$r = \dfrac{mv^2}{R}$ [1]

$r = \dfrac{840 \times 32^2}{8760 \sin 20°}$ [1]

$r = 287\ \text{m} \approx 290\ \text{m}$ [1]

10 **n**et force $= \dfrac{mv^2}{r}$



net force $= \dfrac{0.120 \times 4.0^2}{0.80} = 2.4\ \text{N}$ [2]

weight W of stone $= mg = 0.120 \times 9.81 = 1.18\ \text{N} \approx 1.2\ \text{N}$ [1]

At the top: $W + T_B = 2.4$ so $T_B = 2.4 - 1.2 = 1.2\ \text{N}$ [1]

At the bottom: $T_A - W = 2.4$ so $T_A = 2.4 + 1.2 = 3.6\ \text{N}$ [1]

ratio $= \dfrac{T_A}{T_B} = \dfrac{3.6}{1.2} = 3.0$ [1]