# CHAPTER 6 TEST REVIEW -- MARKSCHEME

**1.** B
**2.** A
**3.** B
**4.** B
**5.** D
**6.** D
**7.** B
**8.** D
**9.** C
**10.** A
**11.** A
**12.** **C**
**13.** **C**
**14.** (a) the force exerted per unit mass;
on a point (small) mass; 2

(b) (i) use of $g = \frac{F}{m}$ and $F = G\frac{Mm}{R^2}$;

combine to get $g = G\frac{M}{R^2}$; 2

(ii) $M = \frac{gR^2}{G}$;

substitute to get $M = 1.9 \times 10^{27}$ kg; 2

**15.** **a** From energy conservation: $\frac{1}{2}mv^2 = mgL$ so $v = \sqrt{2gL}$, ✓

$v = \sqrt{2 \times 9.8 \times 2.0} = 6.26 \approx 6.3\ \text{m s}^{-1}$. ✓

**b** $a = \frac{v^2}{L} = \frac{6.26^2}{2.0} = 19.6 \approx 20\ \text{m s}^{-2}$. ✓

**c** Weight vertically downwards. ✓

Larger arrow for tension upwards. ✓

**d** **i** A particle is in equilibrium if it moves with constant velocity. ✓

This particle moves on a circle and so cannot be in equilibrium. ✓

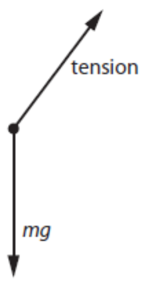
**ii** $T - mg = \frac{mv^2}{L}$ ✓

$T = \frac{mv^2}{L} + mg = \frac{5.0 \times 6.26^2}{2.0} + 5.0 \times 9.8 = 147 \approx 150\ \text{N}$ ✓

(or better: $T = \frac{mv^2}{L} + mg = \frac{m \times 2gL}{L} + mg = 3mg = 3 \times 5.0 \times 9.8 = 147 \approx 150\ \text{N}$)

**16.** **a** Correct arrows for tension. ✓

Correct arrow for weight. ✓




**b** A particle is in equilibrium if it moves with constant velocity. ✓

This particle moves on a circle and so cannot be in equilibrium. ✓

**c** **i** The vertical component of the tension equals the weight and so $T\cos\theta = mg$, i.e. $T = \frac{mg}{\cos\theta}$. ✓

The horizontal component of the tension is $T\sin\theta$ and $T\sin\theta = m\frac{v^2}{r} = m\frac{v^2}{L\sin\theta}$ ✓

Combining gives the answer $v = \sqrt{\frac{gL\sin^2\theta}{\cos\theta}}$.

**ii** The angular and linear speeds are related by $v = \omega r = \omega L\sin\theta$. ✓

So $\omega = \frac{\sqrt{\frac{gL\sin^2\theta}{\cos\theta}}}{L\sin\theta}$. ✓

Which is the answer $\omega = \sqrt{\frac{g}{L\cos\theta}}$.

**d i** $v = \sqrt{\dfrac{9.8 \times 0.45 \times \sin^2 60°}{\cos 60°}} = 2.57 \approx 2.6 \text{ m s}^{-1}$ ✓

**ii** $\theta = \sqrt{\dfrac{9.8}{0.45 \times \cos 60°}} = 6.5997 \approx 6.6 \text{ rad s}^{-1}$ ✓

**e i** The air resistance force will reduce the speed of the ball. ✓

**ii** A graph of $\dfrac{\sin^2\theta}{\cos\theta}$ shows that because the speed decreases, the angle will also decrease. ✓

**iii** The cosine of the angle will increase and hence the angular speed will decrease. ✓

(**Note:** These questions are best answered by considering the total energy of the ball:

$$E = \frac{1}{2}mv^2 + mgh = \frac{1}{2}m\frac{gL\sin^2\theta}{\cos\theta} + mgL(1-\cos\theta) = \frac{1}{2}mgL\left(\frac{\sin^2\theta + 2\cos\theta - 2\cos^2\theta}{\cos\theta}\right)$$

The air resistance will reduce the total energy; graphing the total energy as a function of angle $\theta$ shows that for the energy to decrease the angle must decrease.)

**17.** **a** Calling this distance $x$ we have that:

$$\frac{G16M}{x^2} = \frac{GM}{(d-x)^2}$$ ✓

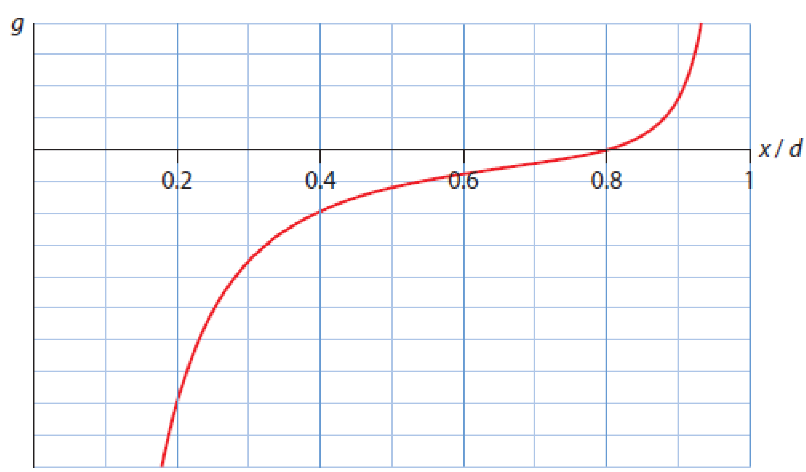
$16(d-x)^2 = x^2$ or $4(d-x) = \pm x$ ✓

Only the plus sign gives a positive distance and so $x = \dfrac{4d}{5}$. ✓

**b** Correct sign. ✓

Correct intersection. ✓

(The negative of this graph is also acceptable)



**c** **i** The force is zero. ✓

**ii** The force from the larger mass will be larger because the particle will be closer to it. ✓ Hence the net force will be directed towards the large mass. ✓

**d** It will move to the left. ✓

With increasing speed and increasing acceleration. ✓