Uniform Circular Motion Worksheet

SOLUTIONS

1.

a) $a = \frac{v^2}{r} = \frac{8.33^2}{100} = 0.694 \text{ ms}^{-2}$

Its centripetal acceleration is 0.694 ms^{-2} towards the centre of the circle of motion (perpendicular to the direction of motion is also an acceptable direction)

b) $a = \frac{v^2}{r} = \frac{8.33^2}{70} = 0.99 \text{ ms}^{-2}$

Its centripetal acceleration is 0.99 ms^{-2} towards the centre of the circle of motion

c) The friction of the tyres on the road is providing the centripetal force.

$a = 0.694 \text{ ms}^{-2}$ (found in part a)

$F = ma = 1200 \times 0.694 = 832\text{N}$

The centripetal force is 832 N towards the centre of the circle of motion

2.

a) They are the same (centripetal acceleration depends only on speed and radius).

b) Archibald (since he is heavier).

3.

a) $r = 3.84 \times 10^8 \text{ m}$ $T = 27.3 \text{ days} = 27.3 \times 24 \times 60 \times 60 \text{ seconds} = 2.36 \times 10^6 \text{ s}$

$v = \frac{2\pi r}{T} = \frac{2 \times \pi \times 3.84 \times 10^8}{2.36 \times 10^6} = 1.02 \times 10^3 \text{ ms}^{-1}$ (3 s.f.)

b) $a = \frac{v^2}{r}$

$= \frac{(1.02 \times 10^3)^2}{3.84 \times 10^8} = 2.72 \times 10^{-3} \text{ ms}^{-2}$

Its centripetal acceleration is $2.72 \times 10^{-3} \text{ ms}^{-2}$ towards the Earth

c) The gravity of the Earth

4.

a)

(i) Yes (ii) Yes (iii) No

b) (iii) Not constant velocity because velocity has direction and this is changing.

5.

a) $m = 2.00 \text{ kg}$ $r = 0.800 \text{ m}$ $F = 250 \text{ N}$

$F = ma$ and $a = \frac{v^2}{r}$

$\therefore F = \frac{mv^2}{r}$ $\therefore mv^2 = Fr$ $\therefore v^2 = \frac{Fr}{m}$

$\therefore v = \sqrt{\frac{Fr}{m}} = \sqrt{\frac{250 \times 0.800}{2.00}} = 10 \text{ ms}^{-1}$

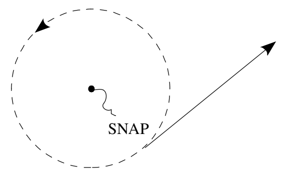
It can travel up to 10.0 ms^{-1}

b) $v = \frac{2\pi r}{T}$ $\therefore Tv = 2\pi r$

$\therefore T = \frac{2\pi r}{v} = \frac{2 \times \pi \times 0.800}{10.0} = 0.503 \text{ s}$

Takes 0.503 seconds to do one rotation so it will take $0.503 \times 5 = 2.51$ s to do five rotations.

c) The mass will fly off in a straight line on a tangent:



6. No, it is the force of the string pulling on your hand as a result of Newton's third law. The string is pulling the mass, which means the mass pulls the string in reaction. The string is attached to your hand, so you feel the it pulling as a reaction to you pulling it (so the mass doesn't fly off).

7.

a)

$\tan\theta = \frac{v^2}{rg}$

$\therefore \theta = \tan^{-1}\left(\frac{v^2}{rg}\right) = \tan^{-1}\left(\frac{25^2}{300 \times 9.8}\right) = 12°$ (2 s.f.)

b) The horizontal component of the normal force.