Circular Motion

Rotational Motion

1. What is the angular velocity for a floppy disk, rotating at 5 revolutions per second? *(31rad s^{-1})*

2. What is the angular velocity of the second hand of a clock? *(0.105rad s^{-1})*

3. What is the angular velocity of the Earth spinning on its axis? *(7.3×10^{-5}rad s^{-1})*

4. A bicycle with wheels of radius 0.35m travels along at a steady speed of 5.0ms^{-1}.
   (a) How many revolutions does each wheel make per second? *(2.3)*
   (b) What is the angular velocity of the wheels? *(14rad s^{-1})*

5. What is the speed of the tip of a second hand, length 20cm, on a wall clock? *(0.021ms^{-1})*

6. What is the speed (due to rotation of the Earth) of point on the equator of the Earth? (radius of Earth = 6400km) *(465ms^{-1})*

7. What is the speed (due to rotation of the Earth) of Oslo, which is at latitude 60ºN on the Earth? *(233ms^{-1})*

Force for Circular Motion

1. A car, mass 800kg, drives round roundabout in a circle radius 20m at a steady speed of 5.0ms^{-1}. What is the size of the resultant horizontal force between the road and the tyres? *(1000N)*

2. Mars orbits the Sun with a period of 687 days at a distance of 2.3×10^{11}m. The mass of Mars is 6.4×10^{23}kg.
   (a) What is the angular speed of Mars in its orbit? *($1.06\times10^{-7} rad\ s^{-1}$)*
   (b) What is the centripetal acceleration of Mars? *($2.6\times10^{-3} ms^{-2}$)*
   (c) What is the force exerted by the Sun on Mars? *($1.65\times10^{21} N$)*

3. A girl of mass 50kg swings on the end of a rope. At the lowest point of the arc, her centre of mass is 4.0m from the point of suspension and her speed is 5.0ms^{-1}.
   (a) What is the centripetal force acting? *(310N)*
   (b) What is the tension in the rope? *(800N)*

4. A skateboarder, mass 50kg, is looping a loop of radius 1.2m. In order to stay in contact with the track, the contact force with the track must be greater than zero. At a particular speed, when the skateboarder is at the top of the loop (as shown in the diagram) the contact force just becomes zero.

   (a) What is the resultant force acting on him at this point? *(490N)*
   (b) What is his speed? *($3.4 ms^{-1}$)*
   (c) Why is his mass irrelevant to the answer to (b)?

5. If the radius of a rotating space station is 200m, what period of rotation would be needed to produce artificial 'acceleration of gravity' equivalent to that on Earth? *(28s)*

6. On a trip from the Earth to Mars, it is planned to acclimatise the crew to the strength of gravity on the surface of Mars (0.38×that on the surface of Earth). This is done by tethering the crew compartment to a very massive burnt-out booster rocket stage and making the compartment circle it. The length of the tether is 340m. You can assume that the burnt-out booster rocket is stationary. At what speed rate must the crew compartment travel? *($36 ms^{-1}$)*