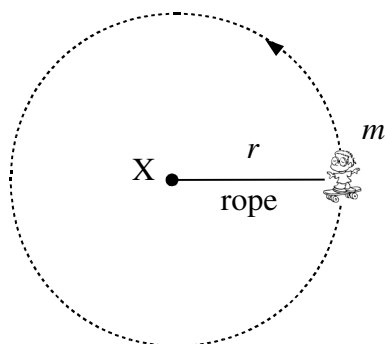


Circular Motion, Gravitation and Satellites

1. The Earth travels around the Sun in a roughly circular path at a constant speed.
- a) Explain how the Earth can be accelerating, even though its speed is not changing. /2
- b) Identify the force causing the Earth's acceleration. /1

2. An skateboarder of mass $m = 60$ kg is attached to a rope, and is moving with uniform circular motion. The length of the rope attached to the skateboarder is $r = 10$ m, as shown in the diagram below. The period of the skateboarder's circular motion about point X is 6.28 s.

Ignore any effects of gravity or friction.



- a) Identify the force that is causing the centripetal acceleration of the skateboarder. /1
- b) Show that the magnitude of the tension F in the rope is given by $F = \frac{4\pi^2 mr}{T^2}$. /3
- c) Hence calculate the magnitude of the tension in the rope. /2
3. The curves on many roads carrying high-speed traffic are banked.
- a) With the aid of a diagram, explain how banking a curve decreases the reliance upon friction between the tyres and the road. /4
- b) Hence show that the relationship between the banking angle, the speed of a car and the radius of the curve when no centripetal acceleration is provided by friction can be given by $\tan \theta = \frac{v^2}{rg}$. /3
4. Two satellites are orbiting different planets, but both with the same radius of orbit around their planet. Satellite 1 is orbiting Planet 1 with speed 1552 ms^{-1} . Planet 2, which Satellite 2 is orbiting, has four times the mass of Planet 1.
- a) Using proportionality, determine the orbital speed of Satellite 2 around Planet 2. /3
- b) Explain why the centre of a satellite's orbit must coincide with the centre of mass of the planet. Assume the satellite's orbit around the planet is circular. /2
5. Explain the advantage of launching low-altitude equatorial-orbit satellites in a west-to-east direction. /2
6. State and explain whether a geosynchronous (geostationary) orbit or a low-altitude polar orbit would be more appropriate for a meteorology and surveillance satellite. /2