MP170/180 Problem Sheet 8
Circular Motion and Simple Harmonic Motion

Circular Motion

1. A car travels at constant speed around a horizontal circular corner of radius 5 m.

   (a) Given that the car just starts to skid if its speed is 12 km/h, find the frictional force acting on the car.

   (b) Assuming the same frictional force is acting, calculate the car's smallest possible turning radius if the speed is 30 km/h.

   (c) Calculate the turning radius for the car travelling at 12 km/h in wet conditions where the frictional force is halved.

2. A car travels on a rough banked curved road of radius 200 m with velocity v where the road is inclined at an angle of 15° to the horizontal. If the coefficient of friction between the road and the car is $1/4$, find the value of v if

   (a) the car is just about to slip **up** the road;

   (b) the car is just about to slip **down** the road.

3. A particle of mass 1 kg is attached to one end of an elastic spring of natural length 1 m and modulus of elasticity 50 N. The other end is fastened to a point on a smooth horizontal table. If the spring and particle describe circles on the table at 60 revolutions per minute, find the extension of the spring.

Simple Harmonic Motion

4. A particle undergoes simple harmonic motion about a point O with period 0.5 s. The distance between the extremes of the motion is 0.4 m.

   (a) Identify both the frequency and the angular frequency of the oscillatory motion.

   (b) Find the maximum speed of the particle during the oscillatory motion.

   (c) Find the maximum acceleration of the particle during the oscillatory motion.

5. A particle undergoes simple harmonic motion about a point O. When the particle is 4 m from the central point its speed is 3 m/s. When it is 3 m from its central position its speed is 6 m/s.

   (a) Find the amplitude of the motion.

   (b) Find the period of the motion.

   (c) Find the maximum speed achieved during the motion.

   (d) Find the speed of the particle when it is 1 m from the centre of motion.

6. A light elastic string of natural length 2.5 m and modulus of elasticity 15 N is stretched between two points A and B which are 3 m apart on a smooth horizontal table. A particle of mass 3 kg is attached to the mid-point of the string. The particle is initially pulled towards B by 8 cm and released from rest.

   (a) Show that the particle undergoes simple harmonic oscillations and identify both the angular frequency and the period of these oscillations.

   (b) Find an expression for the displacement of the particle from A valid for all times.

   (c) Find the time taken by the particle to travel a distance of 1 cm from its starting point.