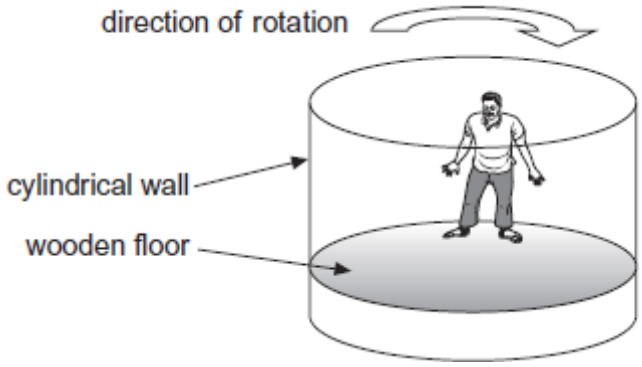
Name of the Student:_____
Max. Marks : 24 Marks **Time : 24 Minutes**

Q1.

Figure 1 shows a fairground ride called a Rotor. Riders stand on a wooden floor and lean against the cylindrical wall.

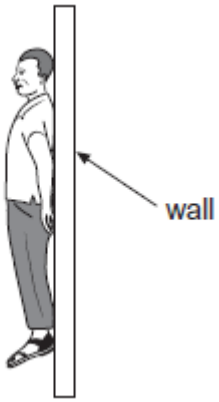
Figure 1



The fairground ride is then rotated. When the ride is rotating sufficiently quickly the wooden floor is lowered. The riders remain pinned to the wall by the effects of the motion. When the speed of rotation is reduced, the riders slide down the wall and land on the floor.

(a) (i) At the instant shown in **Figure 2** the ride is rotating quickly enough to hold a rider at a constant height when the floor has been lowered.

Figure 2



Draw onto **Figure 2** arrows representing all the forces on the rider when held in this position relative to the wall.
Label the arrows clearly to identify all of the forces.

(3)

(ii) Explain why the riders slide down the wall as the ride slows down.

_____

_____

_____

(2)

A Rotor has a diameter of 4.5 m. It accelerates uniformly from rest to maximum angular velocity in 20 s.
The total moment of inertia of the Rotor and the riders is 2.1×10^5 kg m^2.

(b) (i) At the maximum speed the centripetal acceleration is 29 m s^{-2}.

Show that the maximum angular velocity of a rider is 3.6 rad s^{-1}.

(2)

(ii) Calculate the torque exerted on the Rotor so that it accelerates uniformly to its maximum angular velocity in 20 s.
State the appropriate SI unit for torque.

torque _____ SI unit for torque _____

(3)

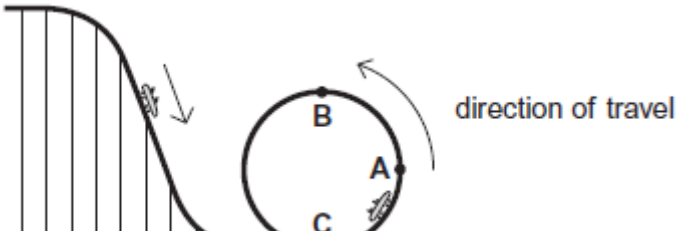
(iii) Calculate the centripetal force acting on a rider of mass 75 kg when the ride is moving at its maximum angular velocity.
Give your answer to an appropriate number of significant figures.

centripetal force _____ N

(1)

(c) **Figure 3** shows the final section of a roller coaster which ends in a vertical loop. The roller coaster is designed to give the occupants a maximum acceleration of 3g. Cars on the roller coaster descend to the start of the loop and then travel around it, as shown.

Figure 3



(i) At which one of the positions marked **A**, **B** and **C** on **Figure 3** would the passengers experience the maximum reaction force exerted by their seat?
Circle your answer below.

A **B** **C**

(1)

(iii) Explain why the maximum acceleration is experienced at the position you have chosen.

_____

_____

_____

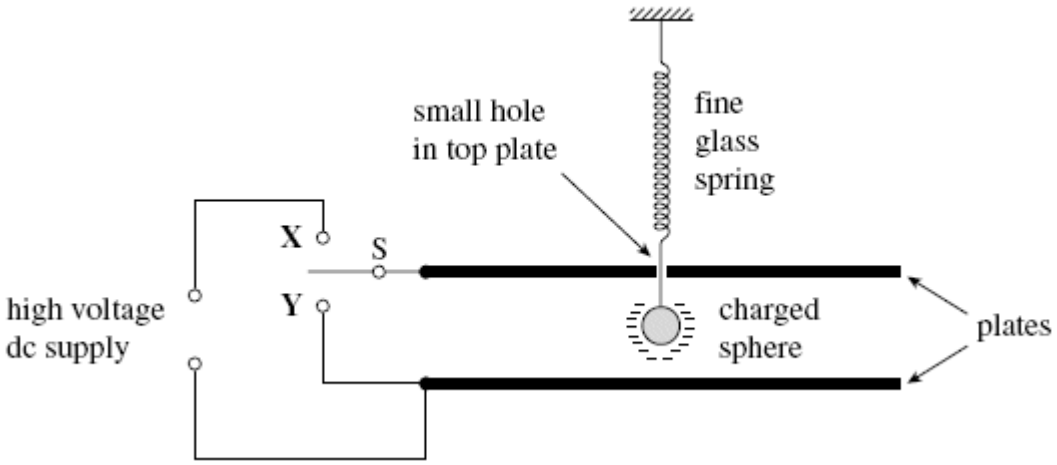
_____

(2)

(Total 14 marks)

Q27.

A small negatively charged sphere is suspended from a fine glass spring between parallel horizontal metal plates, as shown in the figure below.



(a) Initially the plates are uncharged. When switch S is set to position **X**, a high voltage dc supply is connected across the plates. This causes the sphere to move vertically upwards so that eventually it comes to rest 18 mm higher than its original position.

(i) State the direction of the electric field between the plates.

_____

(1)

(ii) The spring constant of the glass spring is 0.24 N m^{-1}. Show that the force exerted on the sphere by the electric field is 4.3×10^{-3} N.

(1)

(iii) The pd applied across the plates is 5.0 kV. If the charge on the sphere is -4.1×10^{-8} C, determine the separation of the plates.

answer = _____ m

(3)

(b) Switch S is now moved to position **Y**.

(i) State and explain the effect of this on the electric field between the plates.

_____

_____

_____

_____

(2)

(ii) With reference to the forces acting on the sphere, explain why it starts to move with simple harmonic motion.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)