Practice Question Set For A-Level
Subject : Physics
Paper-3 Topic: Section B (Section 11_ Engineering Physics)

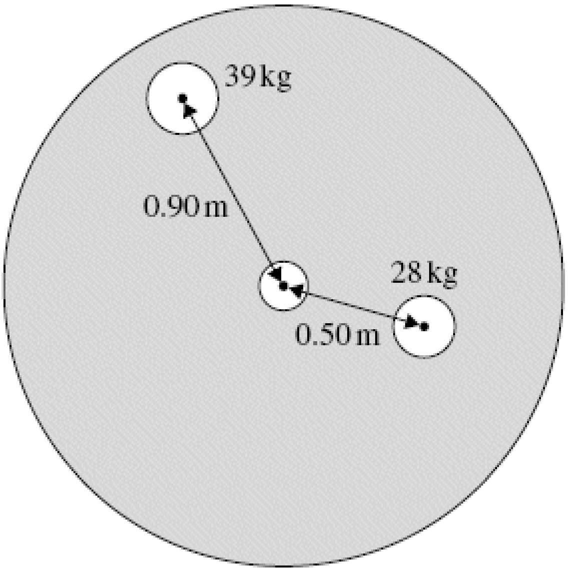
Merit Minds
www.merit-minds.com
Exam Preparation and Free Resources

Name of the Student:____

Max. Marks : 23 Marks **Time : 23 Minutes**

Q1.

(a) A playground roundabout has a moment of inertia about its vertical axis of rotation of 82 kg m^2. Two children are standing on the roundabout which is rotating freely at 35 revolutions per minute. The children can be considered to be point masses of 39 kg and 28 kg and their distances from the centre are as shown in the figure below.



(i) Calculate the total moment of inertia of the roundabout and children about the axis of rotation. Give your answer to an appropriate number of significant figures.

answer = ______________________ kg m^2

(3)

(ii) Calculate the total rotational kinetic energy of the roundabout and children.

answer = ______________________ J

(2)

(b) The children move closer to the centre of the roundabout so that they are both at a distance of 0.36 m from the centre. This changes the total moment of inertia to 91 kg m^2.

(i) Explain why the roundabout speeds up as the children move to the centre of the roundabout.

____

____

____

____

(2)

(ii) Calculate the new angular speed of the roundabout. You may assume that the frictional torque at the roundabout bearing is negligible.

answer = ______________________ rad s^{-1}

(2)

(iii) Calculate the new rotational kinetic energy of the roundabout and children.

answer = ______________________ J

(1)

(c) Explain where the increase of rotational kinetic energy of the roundabout and children has come from.

____

____

____

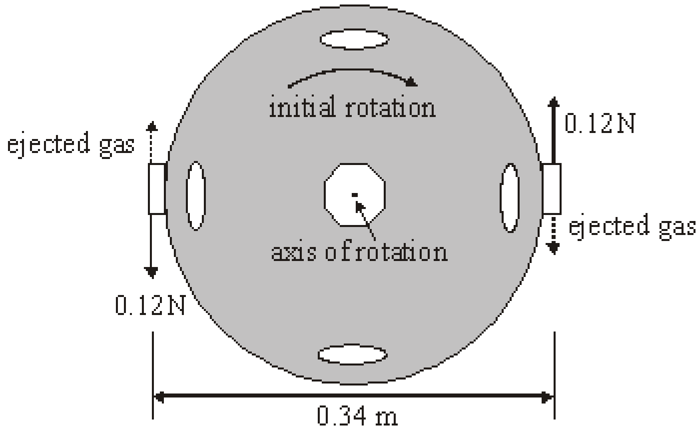
(1)

(Total 11 marks)

Q2.

The figure below shows a remote-control camera used in space for inspecting space stations. The camera can be moved into position and rotated by firing 'thrusters' which eject xenon gas at high speed. The camera is spherical with a diameter of 0.34 m.

In use, the camera develops a spin about its axis of rotation. In order to bring it to rest, the thrusters on opposite ends of a diameter are fired, as shown in the figure below.



(a) When fired, each thruster provides a constant force of 0.12 N.

(i) Calculate the torque on the camera provided by the thrusters.

____

____

(ii) The moment of inertia of the camera about its axis of rotation is 0.17 kg m^2. Show that the angular deceleration of the camera whilst the thrusters are firing is 0.24 rad s^{-2}.

____

____

(3)

(b) The initial rotational speed of the camera is 0.92 rad s^{-1}. Calculate

(i) the time for which the thrusters have to be fired to bring the camera to rest,

____

____

____

(ii) the angle turned through by the camera whilst the thrusters are firing. Express your answer in degrees.

____

____

____

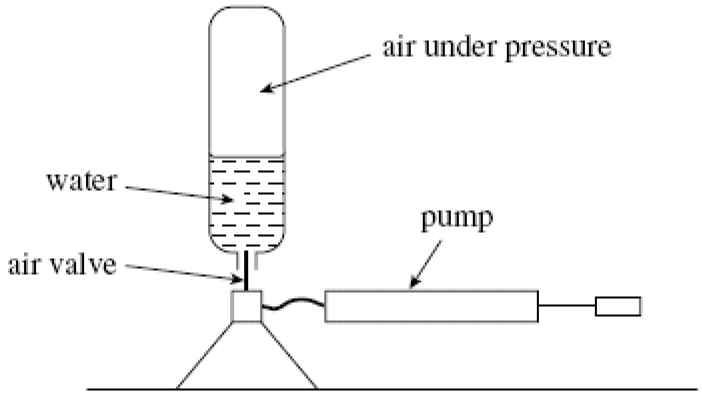
____

(3)

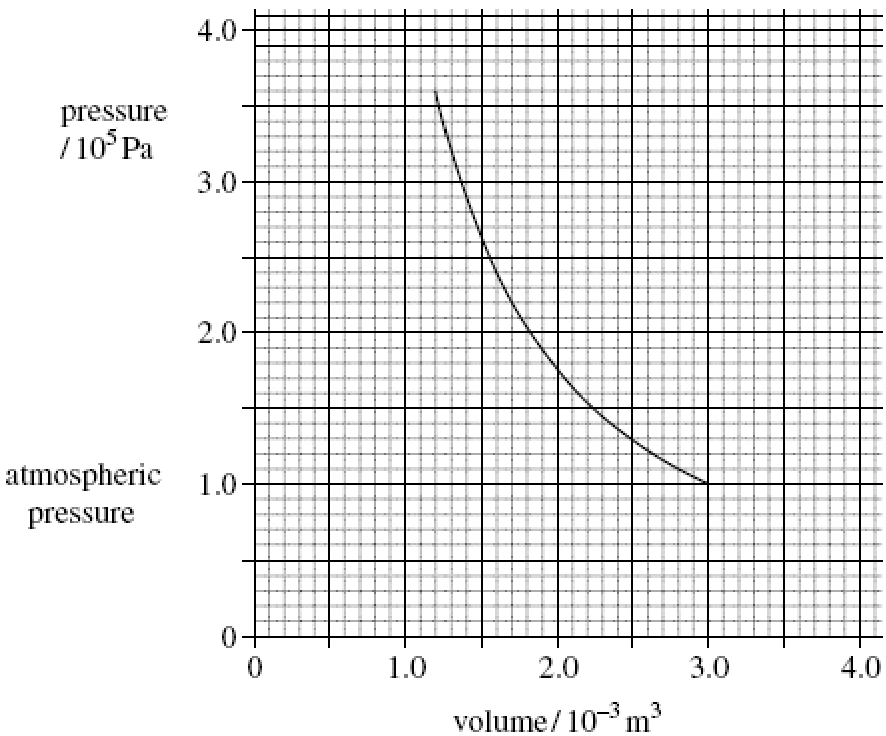
(Total 6 marks)

Q3.

The figure below shows a model rocket for demonstrating the principle of rocket propulsion.
Air is pumped into an upside-down plastic bottle that has been partly filled with water.
When the pressure reaches 3.6×10^5 Pa, (i.e. 2.6×10^5 Pa above atmospheric pressure) the air valve is forced out by the water pressure and the air in the bottle expands. The expanding air forces the water out of the neck of the bottle at high speed; this provides the thrust that lifts the bottle high into the air.



The graph shows the variation of pressure with volume for the air initially in the bottle as it expands from 3.6×10^5 Pa to atmospheric pressure, assuming the expansion is adiabatic.



(a) Use the graph to estimate the work done by the air as it expands from a pressure of 3.6×10^5 Pa to atmospheric pressure.

answer = ______________________ J

(3)

(b) With reference to the graph above, state and explain whether the rocket would have reached the same height if the air had expanded isothermally.

____

____

____

____

____

____

(3)

(Total 6 marks)