Name of the Student:_____
Max. Marks : 16 Marks **Time : 16 Minutes**

Q1.

(a) State the law of conservation of angular momentum.

_____

_____

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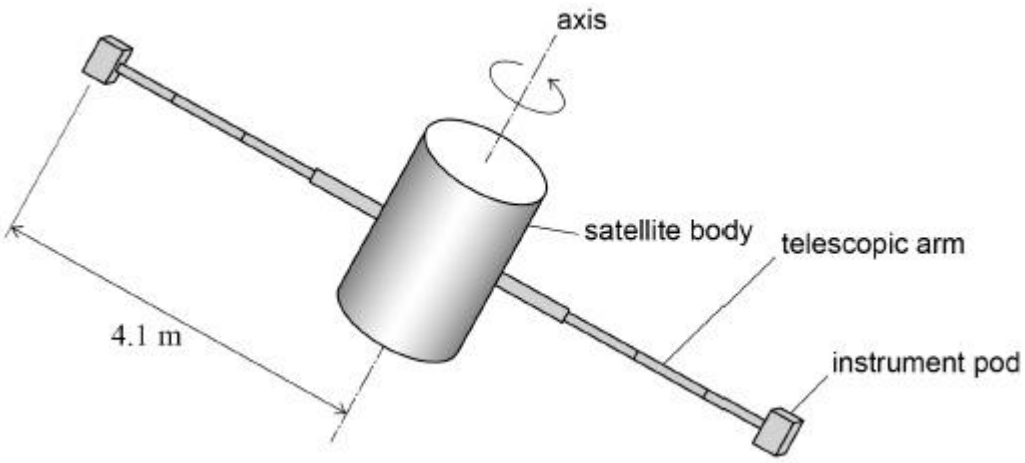
_____

(1)

(b) The diagram shows an orbiting satellite fitted with two small instrument pods attached to the ends of telescopic arms. The arms can be extended or retracted by a motor in the body of the satellite.



With the telescopic arms fully extended, the centre of mass of each instrument pod is at a radius of 4.1 m from the axis of rotation.

moment of inertia of satellite body about axis = 71 kg m2

mass of each instrument pod = 5.0 kg

The mass of the telescopic arms is negligible.

Show that the total moment of inertia of the satellite with the arms fully extended is 240 kg m^2

(2)

(c) The satellite is initially rotating slowly about its axis with the arms fully extended. The arms are slowly retracted so that the instrument pods move closer to the body of the satellite.

State and explain the change in the angular speed of the satellite as the arms are retracted.

(3)

(d) The satellite is initially rotating at 1.3 rad s^{-1} with the telescopic arms fully extended. When fully retracted the instrument pods are at a radius of 0.74 m from the axis. The satellite contains sensitive equipment that may be damaged if the rotational speed exceeds 4.2 rad s^{-1}

Deduce whether the arms can be retracted fully without the satellite exceeding its maximum permitted angular speed.

(3)
(Total 9 marks)

Q2.

(a) State **one** function of a flywheel.

(1)

(b) A student does an experiment to determine the frictional torque acting at the bearings of a steel flywheel. The flywheel has a radius of 0.075 m and is perfectly balanced.

The student places a small magnet of mass 0.020 kg at point **A** on the circumference of the

flywheel on a horizontal line through the axis of rotation as shown in **Figure 1a**. The student releases the flywheel. The flywheel first comes to rest when it has moved through an angle of 3.00 rad (172°), with the magnet now in position **B** as shown in **Figure 1b**.

Figure 1a

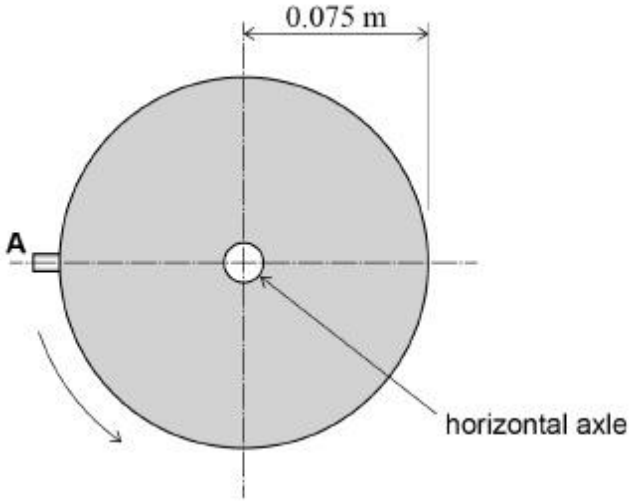
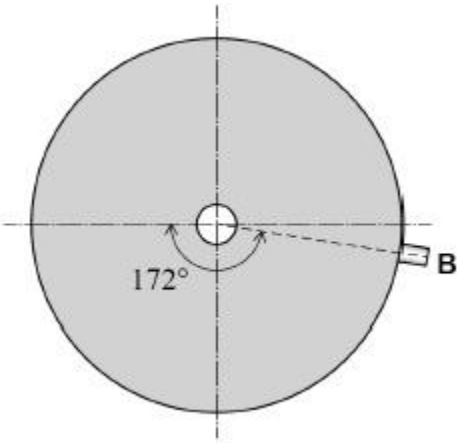


Figure 1b



The loss in gravitational potential energy of the magnet equals the work done against the frictional torque acting at the bearings.

Show that the frictional torque is about 7×10^{-4} N m

(3)

(c) The student goes on to determine the moment of inertia of the flywheel.
The magnet is removed and the flywheel is made to spin. Measurements show that the flywheel makes 573 rotations as its angular speed reduces uniformly from 25.0 rad s^{-1} to zero. Assume the frictional torque at the bearings is constant and the same as in question (b).

Determine the moment of inertia of the flywheel about its axis of rotation.

moment of inertia = _____ kg m^2

(3)

(Total 7 marks)