

Name of the Student: _____

Max. Marks : 20 Marks

Time : 20 Minutes

Q1.

- (a) Explain what is meant by a reversed heat engine.

(2)

- (b) The coefficient of performance of a heat pump is given by

$$COP_{hp} = \frac{Q_H}{Q_H - Q_C}$$

Explain the term Q_H with reference to a heat pump used to provide heating in a building.

(1)

- (c) An ideal heat engine of efficiency 0.50 is reversed to operate as a heat pump working between the same temperature limits.
Determine the coefficient of performance of the heat pump.

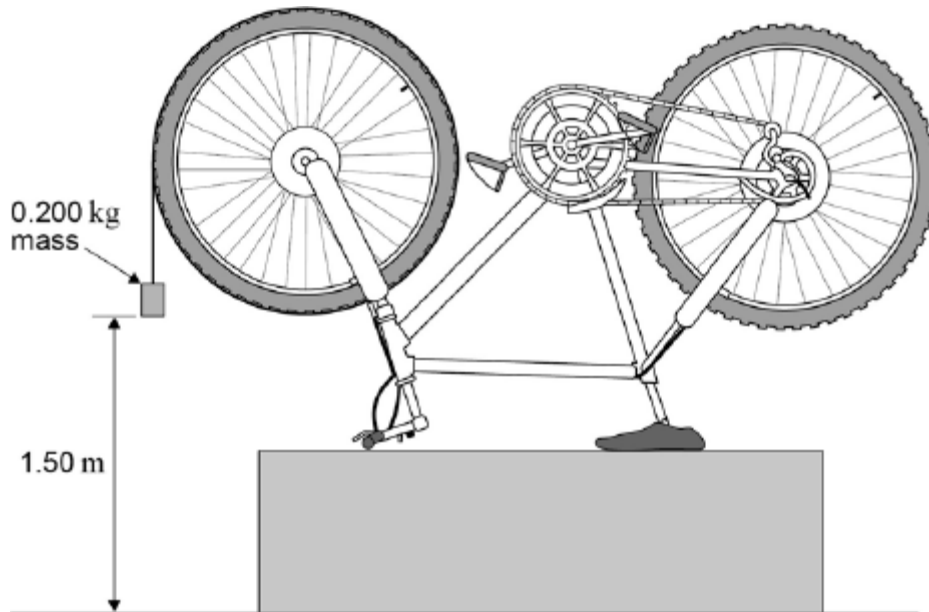
COP_{hp} _____

(2)

(Total 5 marks)

Q2.

The figure below shows an experiment to determine the moment of inertia of a bicycle wheel. One end of a length of strong thread is attached to the tyre. The thread is wrapped around the wheel and a 0.200 kg mass is attached to the free end. The wheel is held so that the mass is at a height of 1.50 m above the floor. The wheel is released and the time taken for the mass to reach the floor is measured.



- (a) State the energy transfers that take place from the moment the wheel is released until the mass hits the floor.

(2)

- (b) Calculations based on the measurements made show that at the instant the mass hits the floor:

- the speed of the mass is 2.22 m s^{-1}
- the wheel is rotating at 6.73 rad s^{-1}
- the wheel has turned through an angle of 4.55 rad from the point of release.

A separate experiment shows that a constant frictional torque of $7.50 \times 10^{-3} \text{ N m}$ acts on the wheel when it is rotating.

By considering the energy changes in the system, show that the moment of inertia of the wheel about its axis is approximately 0.1 kg m^2 .

(3)

(c) When the mass hits the floor the thread is released from the wheel.

Calculate the angle turned through by the wheel before it comes to rest after the thread is released.

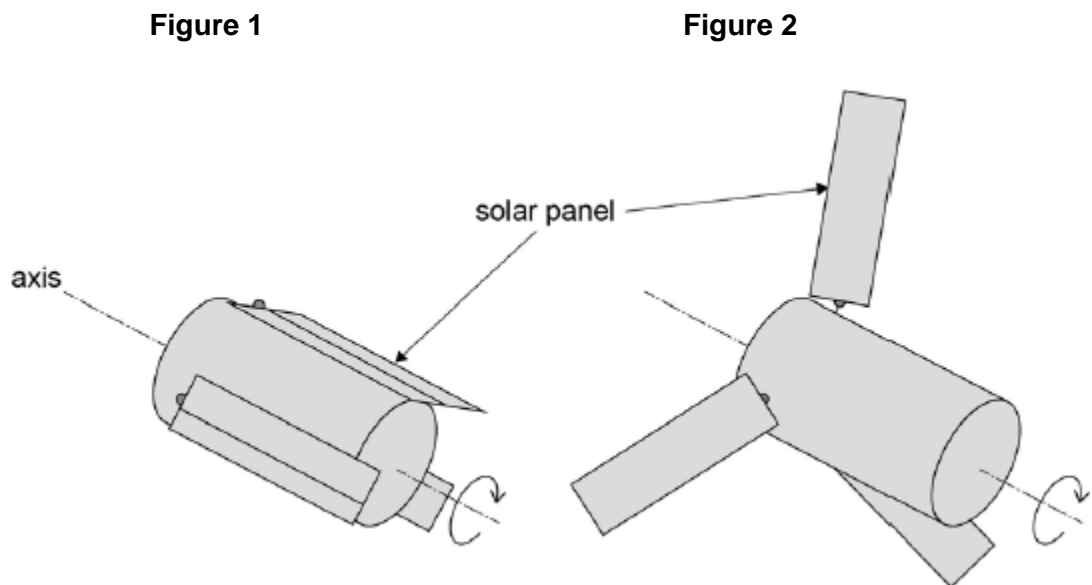
angle = _____ rad

(2)

(Total 7 marks)

Q3.

Figure 1 shows a satellite with three solar panels folded in close to the satellite's axis for the journey into space in the hold of a cargo space craft.



Just before it is released into space, the satellite is spun to rotate at 5.2 rad s^{-1} . Once released, the solar panels are extended as shown in **Figure 2**.

moment of inertia of the satellite about its axis with panels folded = 110 kg m^2

moment of inertia of the satellite about its axis with panels extended = 230 kg m^2

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

(1)

- (b) The total mass of the satellite is 390 kg and the solar panels each have a mass of 16 kg.

State what is meant by moment of inertia and explain why extending the solar panels changes the moment of inertia of the satellite by a large factor.

(3)

- (c) Calculate the angular momentum of the satellite when it is rotating at 5.2 rad s^{-1} with the solar panels folded. State an appropriate unit for your answer.

angular momentum = _____ unit _____

(2)

- (d) Calculate the angular speed of the satellite after the solar panels have been fully extended.

angular speed = _____ rad s^{-1}

(2)

(Total 8 marks)