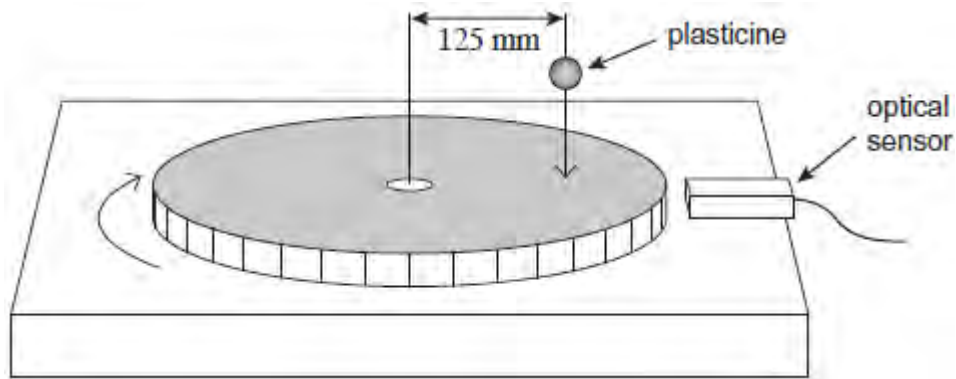**Q1.** A student carries out an experiment to determine the moment of inertia of a turntable. The diagram shows the turntable with a small lump of plasticine held above it. An optical sensor connected to a data recorder measures the angular speed of the turntable.

The turntable is made to rotate and then it rotates freely. The lump of plasticine is dropped from a small height above the turntable and sticks to it. Results from the experiment are as follows.

mass of plasticine = 16.0 g
radius at which plasticine sticks to the turntable = 125 mm
angular speed of turntable immediately before plasticine is dropped = 3.46 rad s^{-1}
angular speed of turntable immediately after plasticine is dropped = 3.31 rad s^{-1}

The student treats the plasticine as a point mass.

(a)   Explain why the turntable speed decreases when the plasticine sticks to it.

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(3)

(b)   Use the results of the experiment to determine the moment of inertia of the turntable.

Give your answer to an appropriate number of significant figures.

moment of inertia .... kg m^2

(3)

(c) (i) Calculate the change in rotational kinetic energy of the turntable and plasticine from the instant before the plasticine is dropped until immediately after it sticks to the turntable.

change in kinetic energy .... J

(2)

(ii) Explain the change in rotational kinetic energy.

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....
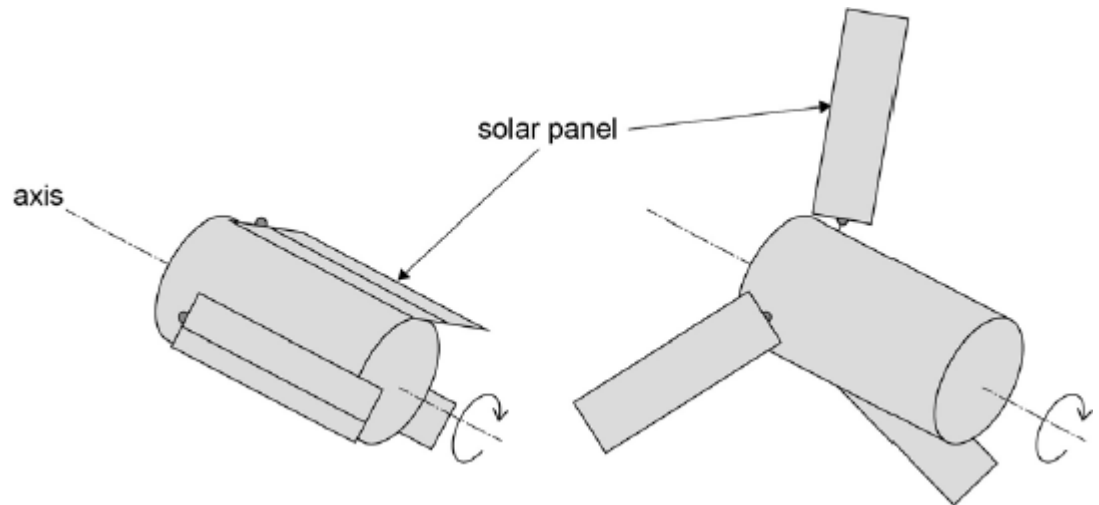
(1)
(Total 9 marks)

Q2. 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.

           Figure 1   **Figure 2**

solar panel

axis

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 m²

moment of inertia of the satellite about its axis with panels extended = 230 kg m²

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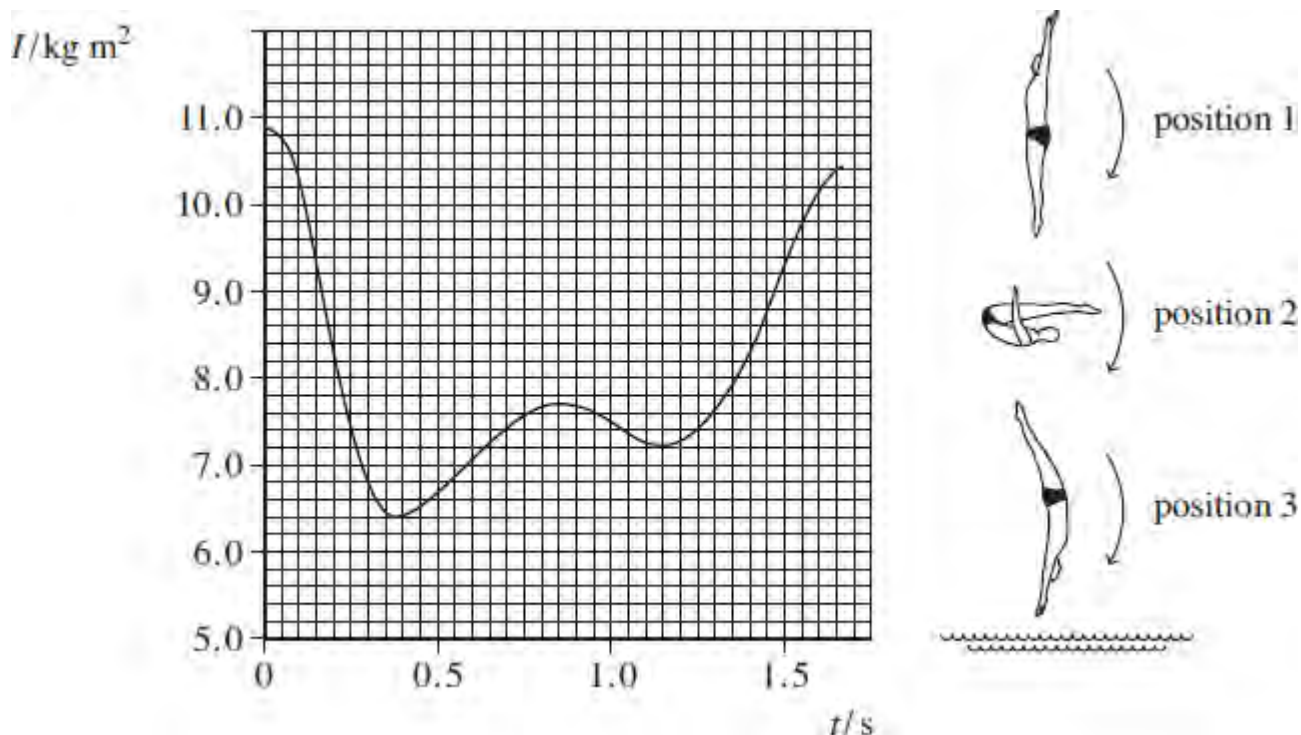
(d) Calculate the angular speed of the satellite after the solar panels have been fully extended.

angular speed = ...rad s^{-1}

(2)
(Total 8 marks)

Q3. The graph below shows how the moment of inertia *I* of a diver performing a reverse dive varies with time *t* from just after he has left the springboard until he enters the water.

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The diver starts with his arms extended above his head (position 1), and then brings his legs towards his chest as he rotates (position 2). After somersaulting in mid-air, he extends his arms and legs before entering the water (position 3).

(a)   Explain how moving the legs towards the chest causes the moment of inertia of the diver about the axis of rotation to decrease.

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(2)

(b)   (i)   Explain in terms of angular momentum why the angular velocity of the diver varies during the dive.

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(2)

(ii)   Describe how the angular velocity of the diver varies throughout the dive.

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(1)

(c)   At time $t = 0$ the angular velocity of the diver is 4.4 rad s^{-1} and his moment of inertia about the axis of rotation is 10.9 kg m^2.

With reference to the graph above calculate the maximum angular velocity of the

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diver during the dive.

angular velocity .... rad s^{-1}

(3)
(Total 8 marks)