11 Solar panels consisting of combinations of photovoltaic cells use energy in the radiation received from the Sun to generate electricity.

(a) An advertisement for solar panels claims that the intensity of radiation from the Sun incident at the top of the Earth's atmosphere is more than 2 kW m^{-2}.

Assess the validity of this claim.

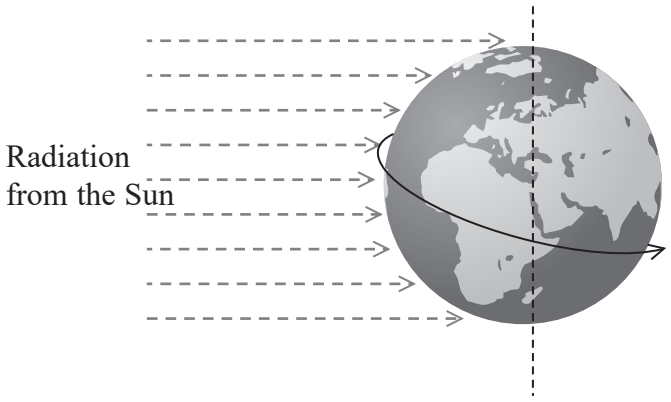
radius of Sun = 6.96×10^8 m

surface temperature of Sun = 5790 K

distance from Sun to Earth = 1.50×10^{11} m

(4)

(b) The average intensity of radiation from the Sun incident at the Earth's surface over a 24-hour period has been determined to be 164 W m^{-2}.



(i) The average intensity of radiation from the Sun at the Earth's surface is much less than the intensity incident at the top of the Earth's atmosphere.

Explain why.

(4)

(ii) It is claimed that the area of solar panels needed to generate 100 GW of power is about 0.5% of the surface area of the Earth.

Assess the validity of this claim.

radius of Earth = 6.4×10^6 m

typical efficiency of solar panels = 25%

(4)

(c) Scientists are developing a space station equipped with large solar panels. The space station would be located in a geostationary orbit. The space station would transfer energy to Earth as microwaves.

(i) A space station in a geostationary orbit is above the equator and has a period of 24 hours.

Explain one advantage of locating the space station in a geostationary orbit.

(2)

(ii) Calculate the height h of the space station above the equator when it is in a geostationary orbit.

mass of Earth = 6.00×10^{24} kg

24 hours = 8.64×10^{4} s

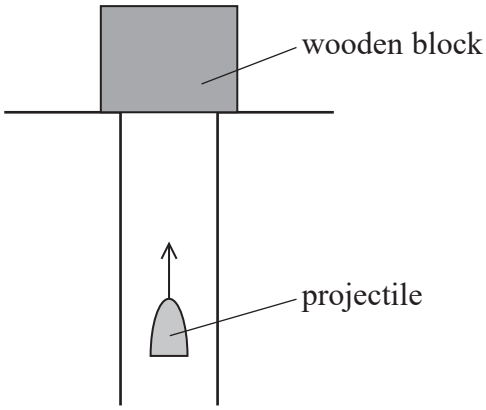
(4)

$h =$ .....

(Total for Question 11 = 18 marks)

TOTAL FOR PAPER = 120 MARKS

7 A projectile of mass 65 g is fired vertically upwards into a stationary wooden block of mass 2.400 kg, as shown.



(a) The projectile becomes embedded in the block. They both move vertically upwards through a vertical displacement of 55 cm before momentarily coming to rest.

Calculate the energy dissipated as the projectile hits the block.

(6)

Energy dissipated = ...

(b) Explain how the principle of conservation of energy applies to this collision.

(2)

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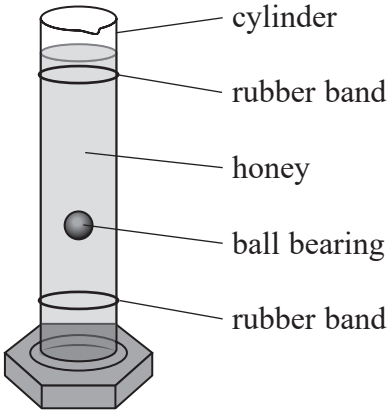
(Total for Question 7 = 8 marks)

10 A student carried out an experiment to determine the viscosity of some honey. He filled a tall glass cylinder with honey as shown, and timed a ball bearing as it fell through the honey.



(a) The student placed rubber bands near the top and bottom of the cylinder. He started a stopwatch when the ball bearing passed the first band and stopped the stopwatch when the ball bearing passed the second band. He repeated this several times to determine a mean time.

Criticise the student's method.

(2)

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(b) The time t for the sphere to fall through a distance of 25.0 cm is shown in the table.

t/s			
6.40	6.35	6.36	6.38

(i) Show that the mean velocity v of the ball bearing is about 0.04 m s^{-1}.

(3)

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(ii) The student had three different types of honey available.

Viscosity η is given by the following expression

$$\eta = \frac{2r^2 g\left(\rho_B - \rho_H\right)}{9v}$$

radius r of ball bearing = 5.50×10^{-3} m
density of ball bearing $\rho_B = 7750\,\text{kg m}^{-3}$
density of honey $\rho_H = 1360\,\text{kg m}^{-3}$

Viscosity (at 20 °C) / Pa s		
Honey A	Honey B	Honey C
10.6	12.5	13.6

Deduce which honey the student used.

(2)

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(Total for Question 10 = 7 marks)