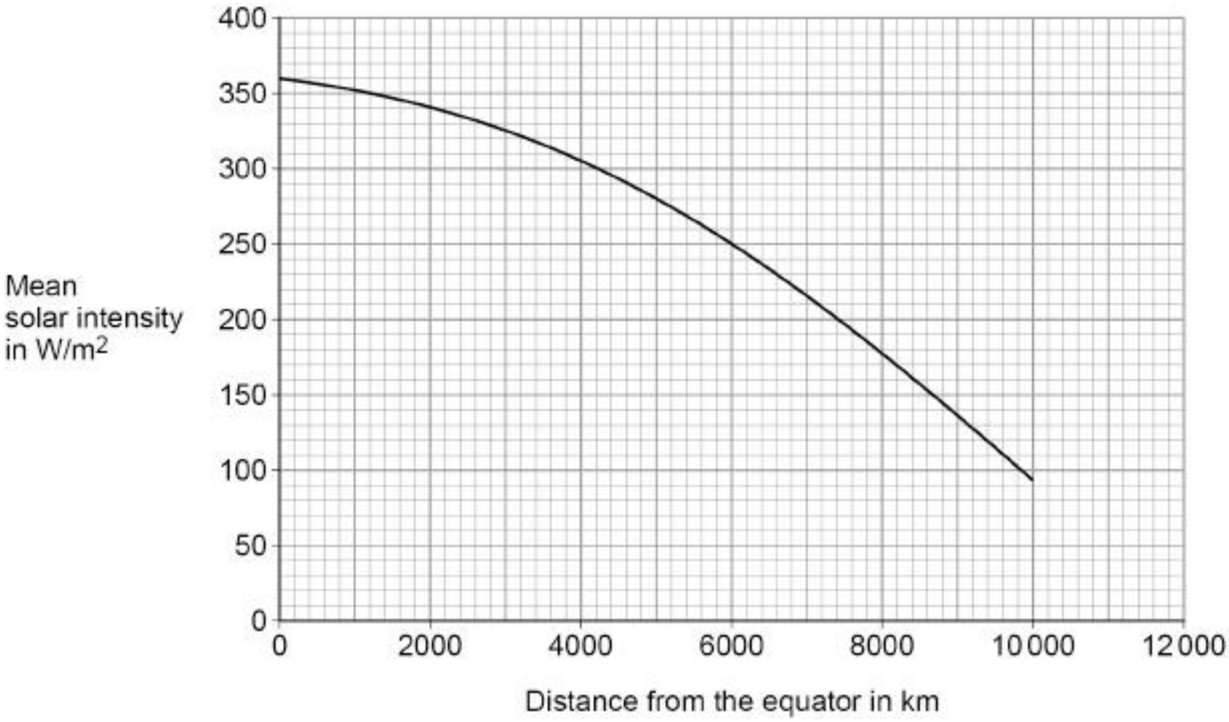
P1 Energy Conservation and dissipation Homework task 1

Q1.

Solar intensity is a measure of the radiation received from the Sun at the surface of the Earth.

Figure 1 shows how the mean solar intensity changes with the distance from the equator.

Figure 1



(a) The city of Athens is 4200 km from the equator.

What is the mean solar intensity in Athens?

Mean solar intensity = _______________ W/m^2

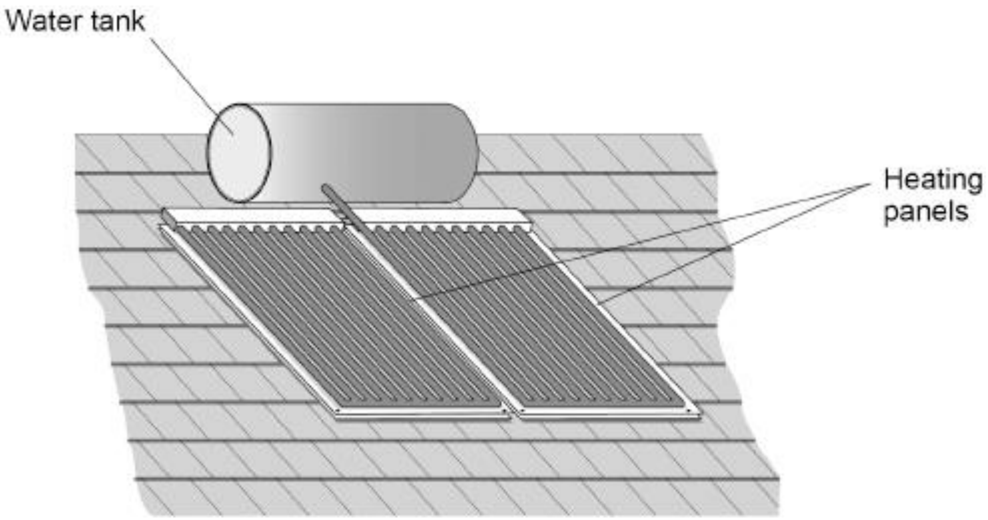
(1)

Solar water heaters use radiation from the Sun to heat water.

The heated water is stored in a water tank.

Figure 2 shows a solar water heater on the roof of a building.

Figure 2



(b) Cities closer to the equator have many more buildings with solar water heaters than cities further away from the equator.

Suggest why.

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(1)

(c) The use of solar water heaters may reduce the need to burn fossil fuels.

Complete the sentence.

Choose the answer from the box.

carbon dioxide	**nitrogen**	**oxygen**

Burning fossil fuels contributes to global warming because there is an increase in the amount of ____________________ in the atmosphere.

(1)

(d) The efficiency of the solar water heater is 0.61

Calculate the useful power output when the total power input to the solar water heater is 1100 W.

Use the equation:

$$\text{useful power output} = \text{efficiency} \times \text{total power input}$$

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Useful power output = ______________ W

(2)

(e) Different solar water heaters have different sized heating panels.

Suggest how the size of the heating panels affects the input power to a solar water heater.

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(1)

(f) Water has a high specific heat capacity.

What is meant by the specific heat capacity of water?

Tick (✓) **one** box.

The energy required to change the state of 1 kg of water from liquid to gas.	☐
The energy required to increase the temperature of 1 kg of water by 1 °C.	☐
The power required to change the state of 1 kg of water from liquid to gas.	☐
The power required to increase the temperature of 1 kg of water by 1 °C.	☐

(1)

(g) The water tank contained 80 kg of water.

The change in thermal energy of the water was 8 400 000 J.

specific heat capacity of water = 4200 J/kg °C

Calculate the temperature change of the water.

Use the Physics Equations Sheet.

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Temperature change = ________________ °C

(3)

(h) The water tank is thermally insulated.

How does thermal insulation affect the rate of energy transfer from the water in the tank?

Tick (✓) **one** box.

Thermal insulation decreases the rate of energy transfer.	☐
Thermal insulation does not change the rate of energy transfer.	☐
Thermal insulation increases the rate of energy transfer.	☐

(1)

(i) The table below shows information about different materials.

Material	Thermal conductivity in arbitrary units
A	3
B	2
C	8
D	4

Which material in the table above is the best thermal insulator?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)
(Total 12 marks)

Q2.

The figure below shows a steam engine pulling a train.

(a) One type of steam engine burns coal as the fuel source.

The energy from the coal is used to accelerate a train.

Describe how the energy stores of the coal and the train change as the train accelerates.

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____ **(2)**

(b) Which equation links energy (*E*), power (*P*) and time (*t*)?

Tick (✓) **one** box.

$E = \frac{P}{t}$ ☐ $P = \frac{E}{t}$ ☐ $P = Et^2$ ☐ $P = \frac{E^2}{t}$ ☐

(1)

(c) A steam engine has a power output of 8000 W.

Calculate the energy output of the steam engine in 3600 seconds.

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Energy output = ____________________ J

(3)

(d) In the 18th century the power output of steam engines was measured in a unit called 'horsepower'.

Suggest why the unit of horsepower was used.

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(2)

(Total 8 marks)

Higher Tier Questions

Q3.

The photograph below shows a sailing boat crossing an ocean.

There is a wind turbine on the boat.

(a) The wind turbine generates electricity to charge a battery on the boat.

Name one **other** renewable energy resource that could be used on the boat to generate electricity.

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(1)

(b) The boat also has a generator that burns a fossil fuel.

The battery can be charged by either the wind turbine **or** the generator.

Give **two** reasons why this is useful.

1 ____

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2 ____

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(2)

(c) Explain **one** environmental impact of using fossil fuels to generate electricity.

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(2)

(d) The kinetic energy of the boat is 81 kJ.

mass of boat = 8000 kg

Calculate the speed of the boat.

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Speed = ________________ m/s

(4)

(e) As the boat passes over a wave, the gravitational potential energy of the boat increases by 19 600 J.

mass of boat = 8000 kg

gravitational field strength = 9.8 N/kg

Calculate the change in height of the centre of mass of the boat as it passes over the wave.

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Change in height = ________________ m

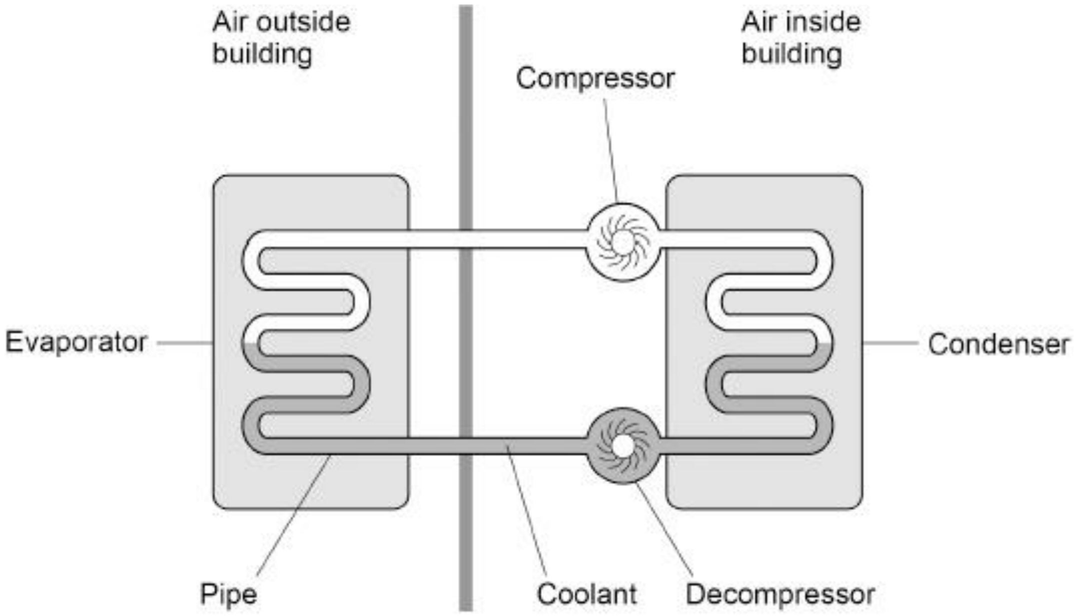
(3)

(Total 12 marks)

Q4.

An air source heat pump transfers energy from the air outside a building to increase the temperature of the air inside the building.

The figure below shows an air source heat pump.



The compressor is connected to the mains electricity supply.

The pipe in the heat pump contains a substance called coolant.

In the evaporator, energy is transferred from the air outside the building to the liquid coolant.

The temperature of the coolant increases and it evaporates.

(a) Explain what happens to the internal energy of the coolant as its temperature increases.

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(2)

(b) What name is given to the energy needed to change the state of the liquid coolant?

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(1)

(c) What happens to the mass of the coolant as it evaporates and becomes a vapour?

Tick (✓) **one** box.

Decreases	☐
Stays the same	☐
Increases	☐

(1)

(d) The compressor increases the density and temperature of the coolant vapour inside the pipe.

Explain why the pressure in the pipe increases.

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(2)

(e) The condenser transfers energy from the coolant to the air in the building.

When the total energy input to the heat pump system is 1560 kJ the temperature of the air in the building increases from 11.6 °C to 22.1 °C.

The efficiency of the heat pump system is 87.5%.

The mass of the air inside the building is 125 kg.

Calculate the specific heat capacity of the air in the building.

Give your answer in standard form.

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Specific heat capacity (standard form) = ________________ J/kg °C

(6)

(f) The air in the building gains 400 J for every 100 J of energy transferred from the mains electricity supply to the compressor.

An advertisement claims that the heat pump system has an efficiency of 400%.

Explain why the advertisement is **not** correct.

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(3)

(Total 15 marks)