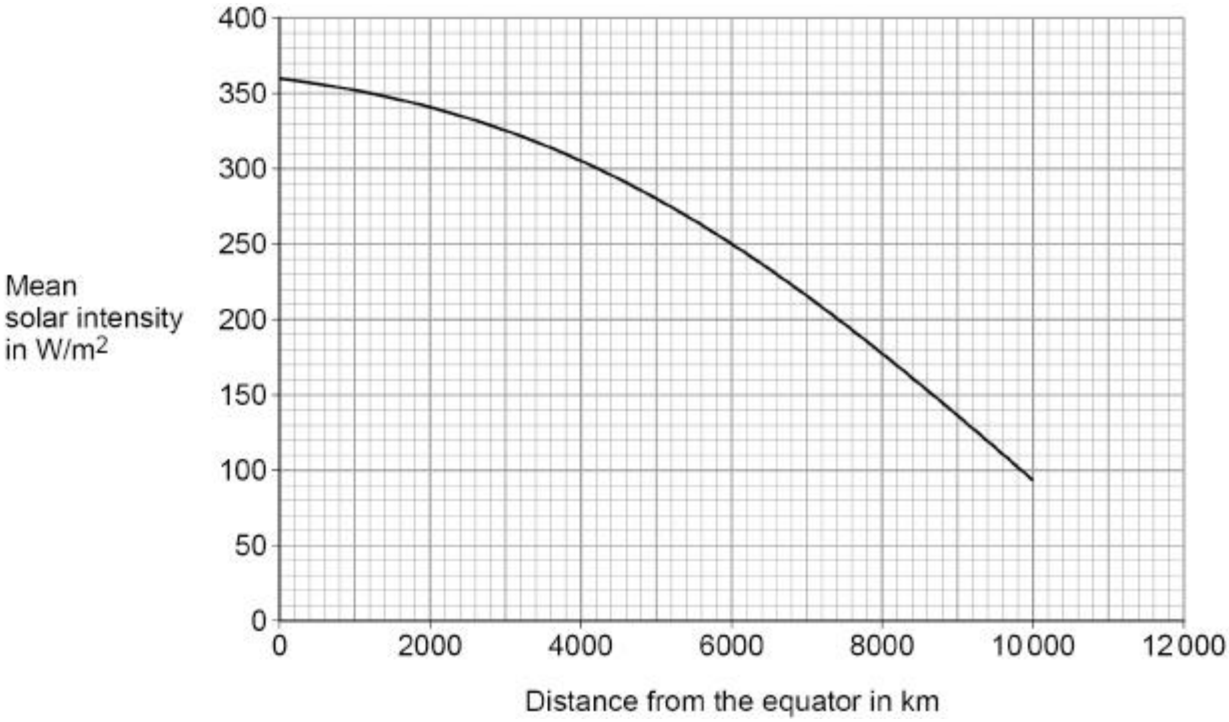
P1 Energy - Conservation and dissipation Homework task 1

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

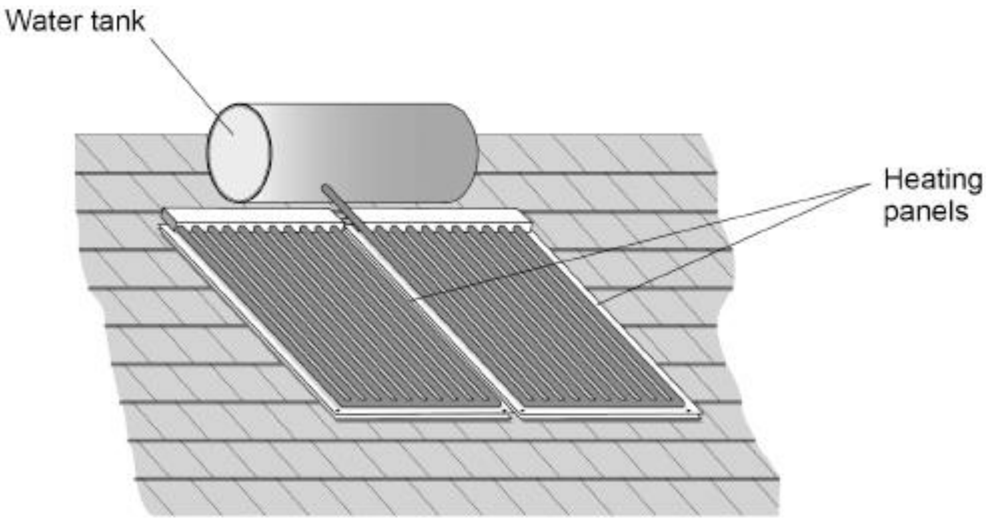
(1)

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.

____

____

(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:

useful power output = efficiency × total power input

___

___

___

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.

___

___

(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.

____

____

____

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.

___

___

___ **(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.

___

___

___

___

___

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.

___

___

___

___

(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.

____

(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 ____

____

2 ____

____

(2)

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

____

____

____

____

(2)

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

mass of boat = 8000 kg

Calculate the speed of the boat.

____

____

____

____

____

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.

____

____

____

____

Change in height = _______________ m

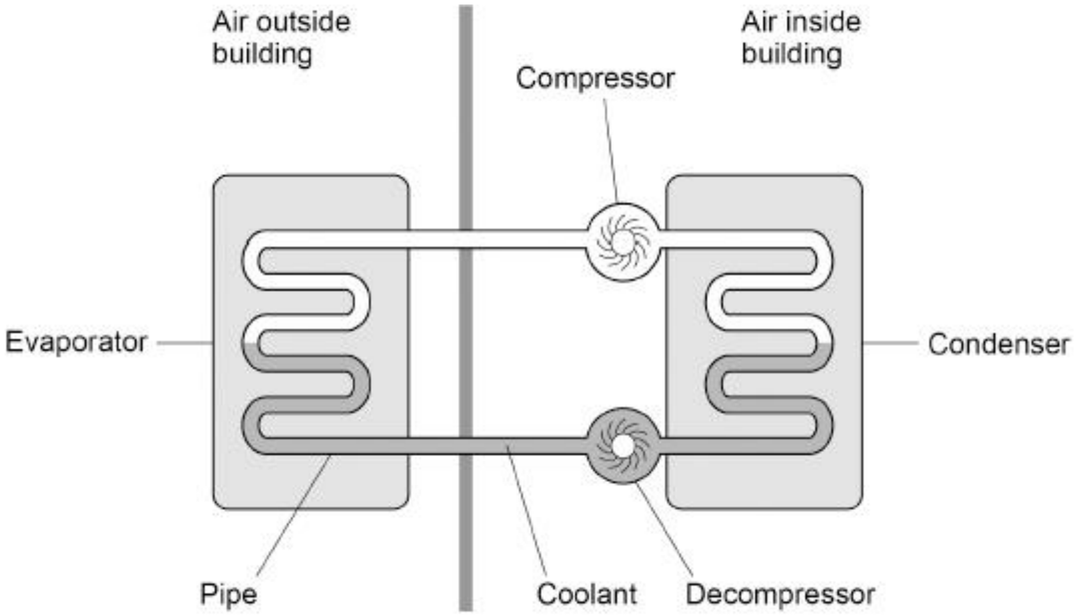
(3)

(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.

____

____

____

____

(2)

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

____

(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.

___

___

___

___

(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.

____

____

____

____

____

____

____

____

____

____

____

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.

____

____

____

____

(3)

(Total 15 marks)

Mark schemes

Q1.

(a) 300 (W/m^2)

1

(b) (cities closer to the equator) receive a greater solar intensity

allow (cities closer to the equator) receive more radiation/energy

ignore they get more sunshine

ignore they are hotter

1

(c) carbon dioxide

1

(d) 0.61 × 1100

1

671 (W)

allow 670 (W)

1

(e) larger heating panels have a greater input power

allow larger heating panels have a greater input energy (per second)

1

(f) the energy required to increase the temperature of 1kg of water by 1 °C

1

(g) 8 400 000 = 80 × 4200 × Δθ

1

$\Delta\theta = \frac{8400000}{80 \times 4200}$

1

Δθ = 25 (°C)

1

(h) thermal insulation decreases the rate of energy transfer

1

(i) B

1

[12]

Q2.

(a) <u>chemical</u> energy of coal decreases

1

<u>kinetic</u> energy of train increases

*allow **1** mark only for the energy of the coal decreases **and** the energy of the train increases* *allow 1 mark only for chemical energy (of the coal) is transferred to kinetic energy (of the train)*

1

(b) $P = \frac{E}{t}$

1

(c) $8000 = \frac{E}{3600}$

1

E = 8000 × 3600

1

E = 28 800 000 (J)

1

(d) to allow a comparison to be made between steam engines and horses

1

(because) people would know the (typical) power output of a horse (in the 18th century)

1

[8]

Q3.

(a) solar

allow biofuel / biodiesel allow wave power

1

(b) sometimes there is no wind (but the battery can still be charged using the generator)

allow if the generator breaks then the turbine can still generate electricity

1

when there is wind less fuel is burned

allow a disadvantage of burning fossil fuel

1

(c) carbon dioxide

1

increases global warming

OR

sulfur dioxide or NOx emissions (1)

increases acid rain (1)

OR

particulates or NOx emissions (1)

can harm living organisms (1)

allow increases the greenhouse effect

1

(d) 81 kJ = 81 000 J

1

81000 = 0.5 × 8000 × v^2

allow a correct substitution using an incorrectly/not converted value of energy

1

$$v = \sqrt{\frac{81\,000}{0.5 \times 8000}}$$

allow a correct re-arrangement using an incorrectly/not converted value of energy

1

v = 4.5 (m/s)

allow a correct calculation using an incorrectly/not converted value of energy

1

(e) 19600 = 8000 × 9.8 × Δh

1

$$\Delta h = \frac{19\,600}{8000 \times 9.8}$$

1

Δh = 0.25 m

1

[12]

Q4.

(a) the kinetic energy (and the potential energy) of the particles increases

allow the speed of the particles increases

1

so the internal energy increases because it is the sum of kinetic and potential energy (of the particles)

1

(b) latent heat (of vaporisation)

allow specific latent heat (of vaporisation)

1

(c) stays the same

1

(d) more collisions per second

1

a greater force per collision

1

(e) $0.875 = \frac{\text{useful output energy transfer}}{1\,560\,000}$

allow a correct substitution using incorrectly/not converted values of efficiency and/or energy

1

useful output energy transfer = 1 365 000(J)

this answer only

the equation

efficiency = $\frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$

must have been used to score subsequent marks

1

1 365 000 = 125 × c × (22.1–11.6)

allow a correct substitution using their calculated value of useful output energy

1

$c = \frac{1\,365\,000}{125 \times 10.5}$

allow a correct re-arrangement using their value of useful output energy

1

c = 1040 (J/kg °C)

allow a correct calculation using with their value of useful output energy

1

c = 1.04 × 10^3 (J/kg °C)

this mark can only be awarded for a calculation using the correct equations

1

(f) the advertisement has ignored the energy input from the surrounding air

1

so the total energy input is greater than the energy supplied from the electricity

an answer that the total energy input comes from the electricity supply and the air outside the building gains the first two marking points

1

the efficiency must be less than 100%

1

[15]