1 **(a)** Explain, in terms of molecules, why it is possible to compress a gas, but not a liquid.

.....

.....

.....

..... [2]

(b) Two containers made of insulating material contain the same volume of water at room temperature. The containers do not have lids. The volume of liquid in each container gradually decreases.

(i) After a certain time, the temperature of the water has decreased to below room temperature.

Explain, in terms of molecules, why the temperature has decreased.

.....

.....

.....

..... [2]

(ii) One of the containers is wide and shallow. The other container is narrow and deep.

Predict which container has the greater rate of cooling. Explain your answer.

.....

.....

..... [2]

[Total: 6]

2 **(a)** The source of solar energy is the Sun.

Tick the box next to those resources for which the Sun is also the source of energy.

- ☐ coal
- ☐ geothermal
- ☐ hydroelectric
- ☐ nuclear
- ☐ wind [2]

(b) Fig. 4.1 shows a solar water-heating panel on the roof of a house.

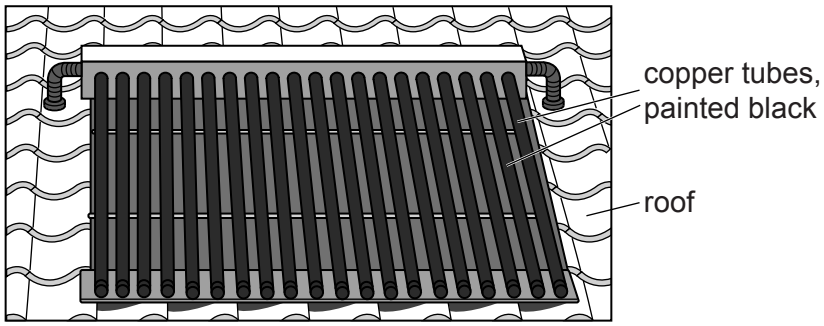

Fig. 4.1

Cold water flows into the copper tubes, which are heated by solar radiation. Hot water flows out of the tubes and is stored in a tank.

(i) Explain why the tubes are made of copper and are painted black.

.....

.....

.....[2]

(ii) In 5.0 s, 0.019 kg of water flows through the tubes. The temperature of the water increases from 20 °C to 72 °C. The specific heat capacity of water is 4200 J / (kg °C).

Calculate the thermal energy gained by the water in 5.0 s.

thermal energy = ...[3]

(iii) The efficiency of the solar panel is 70%.

Calculate the power of the solar radiation incident on the panel.

power = ...[2]

[Total: 9]

3 **(a)** State what is meant by the *specific heat capacity* of a substance.

.....

.....

..... [2]

(b) A student carries out an experiment to find the specific heat capacity of aluminium. He uses an electric heater and a thermometer, inserted into separate holes in an aluminium block.

The following data are obtained.

mass of aluminium block = 2.0 kg
power of heating element = 420 W
time of heating = 95 s
initial temperature of block = 19.5 °C
final temperature of block = 40.5 °C

Calculate the value of the specific heat capacity of aluminium given by this experiment.

specific heat capacity = ... [4]

(c) In the experiment in **(b)**, no attempt is made to prevent loss of thermal energy from the surfaces of the block.

Suggest two actions the student could take to reduce the loss of thermal energy from the surfaces of the block.

1. .....

2. .....
[2]

[Total: 8]

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4 A liquid-in-glass thermometer has a linear scale and a range of 120 °C.

(a) State what is meant by a *linear scale*.

.....

.....[1]

(b) The highest temperature that this thermometer can measure is 110 °C.

State the lowest temperature that it can measure.

lowest temperature = ...[1]

(c) A second liquid-in-glass thermometer has the same range but it has a greater sensitivity.

Suggest **two** ways in which the second thermometer might differ from the first.

1. .....

2. .....
[2]

(d) A thermometer has a bulb that is painted white and is shiny.

It is placed in boiling water for several minutes. It is then removed from the water and is held in air.

Fig. 4.1 shows how the thermometer reading changes during the next 8 minutes.

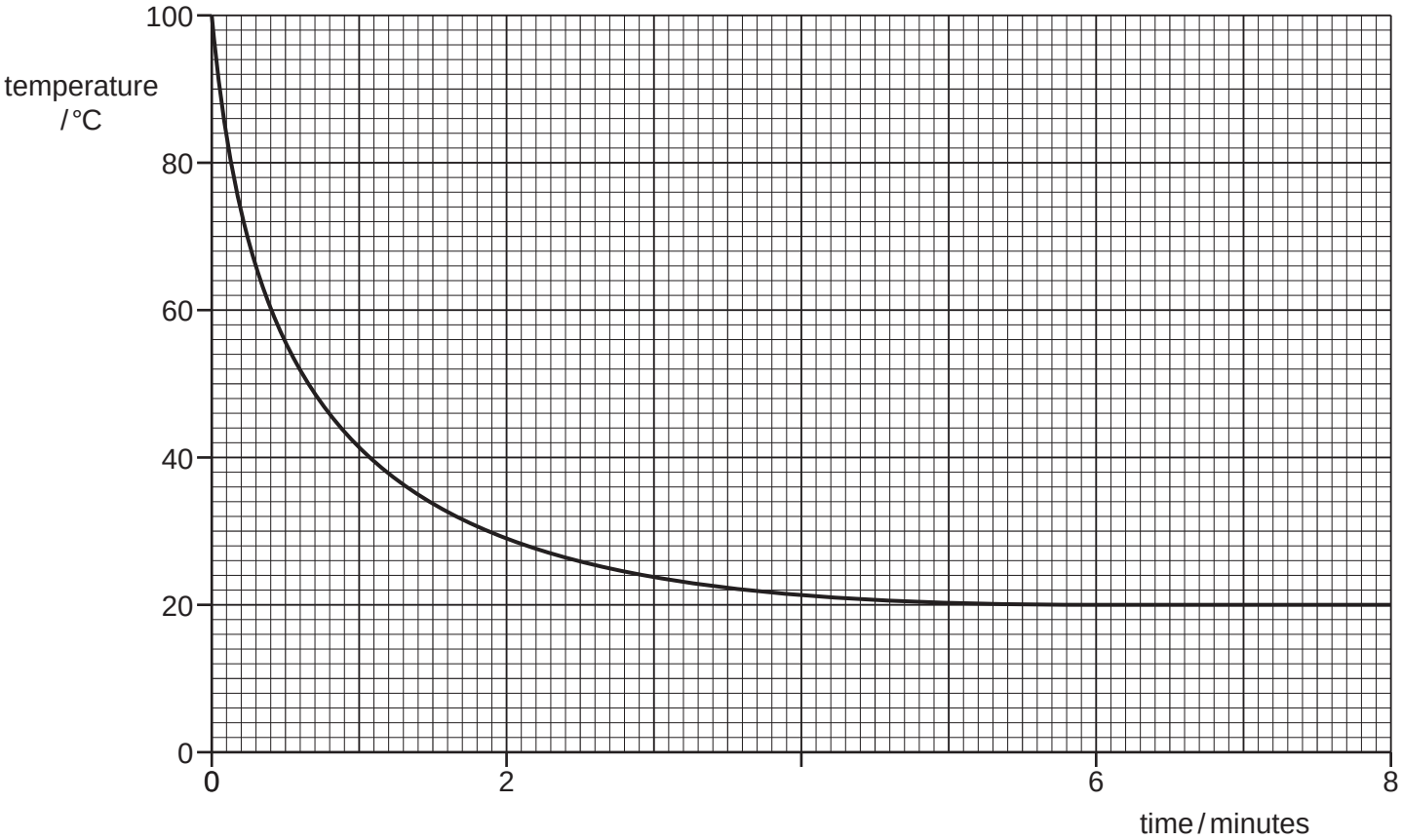

Fig. 4.1

The bulb of this thermometer is now re-painted so that it has a matt, black surface.

The procedure is repeated.

(i) On Fig. 4.1, sketch a second line to suggest how the reading of the re-painted thermometer changes during the 8 minutes. [2]

(ii) Tick **one** of the boxes to show how painting the bulb black affects the linearity of the scale, the range and the sensitivity of the thermometer.

- ☐ The linearity, the range and the sensitivity all change.
- ☐ Only the linearity and the range change.
- ☐ Only the linearity and the sensitivity change.
- ☐ Only the range and the sensitivity change.
- ☐ Only the linearity changes.
- ☐ Only the range changes.
- ☐ Only the sensitivity changes.
- ☐ None of these properties changes.

[1]

[Total: 7]

5 **(a)** State what is meant by the *specific latent heat of fusion* (*melting*) of a substance.

.....

.....[2]

(b) Ice cubes of total mass 70 g, and at 0 °C, are put into a drink of lemonade of mass 300 g.

All the ice melts as 23 500 J of thermal energy transfers from the lemonade to the ice. The final temperature of the drink is 0 °C.

(i) Calculate the specific latent heat of fusion for ice.

specific latent heat of fusion = ...[2]

(ii) The thermal energy that causes the ice to melt is transferred from the lemonade as it cools. The loss of this thermal energy causes the temperature of the 300 g of the lemonade to fall by 19 °C.

Calculate the specific heat capacity of the lemonade.

specific heat capacity = ...[2]

(iii) The melting ice floats on top of the lemonade.

Explain the process by which the lemonade at the bottom of the drink becomes cold.

.....

.....

.....[2]

[Total: 8]

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6 **(a)** Puddles of water form on a path after rainfall on a windy day.

In terms of molecules, state and explain how the rate of evaporation of the puddles is affected by

(i) a reduction of wind speed,

.....

.....

.....

..... [2]

(ii) an increase of water temperature.

.....

.....

.....

..... [2]

(b) Fig. 5.1 shows two puddles.

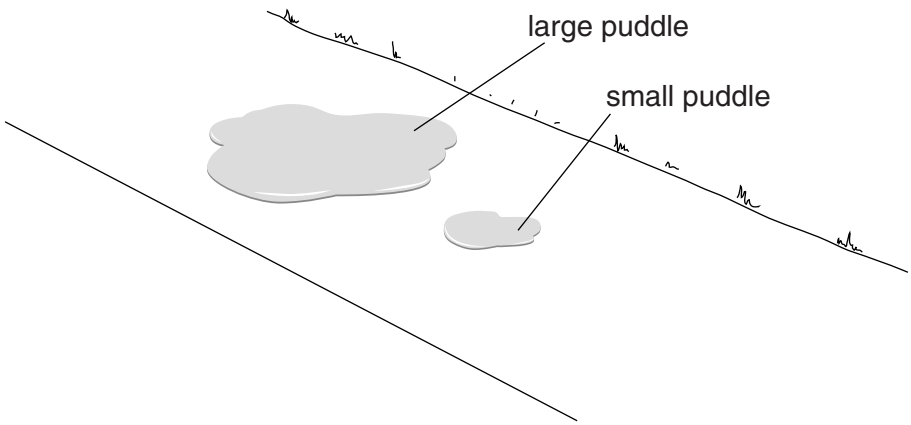

Fig. 5.1

State and explain how the rate of evaporation from the large puddle compares to that from the small puddle under the same conditions.

.....

.....

.....

..... [2]

(c) Describe an experiment to demonstrate the difference between good and bad emitters of infra-red radiation. You may include a diagram to help your description. State what readings should be taken.

.....

.....

.....

.....

.....

.....[3]

[Total: 9]

7 During both boiling and evaporation, liquid water is converted into water vapour.

The rate at which the mass of **boiling** water decreases depends only on the rate at which the water is gaining thermal energy.

(a) The specific latent heat of vaporisation of water is 2.3×10^6 J/kg. Thermal energy is supplied to boiling water in a kettle at a rate of 460 W.

Calculate the mass of water that is boiled away in 180 s.

mass = ... [2]

(b) The rate at which the mass of **evaporating** water decreases depends on other factors.

(i) State two of these factors.

1. .....

2. .....
[2]

(ii) State two other ways in which evaporation is different from boiling.

1. .....

2. .....
[2]

[Total: 6]

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1 **(a)** Explain, in terms of molecules, why it is possible to compress a gas, but not a liquid.

.....

.....

.....

..... [2]

(b) Two containers made of insulating material contain the same volume of water at room temperature. The containers do not have lids. The volume of liquid in each container gradually decreases.

(i) After a certain time, the temperature of the water has decreased to below room temperature.

Explain, in terms of molecules, why the temperature has decreased.

.....

.....

.....

..... [2]

(ii) One of the containers is wide and shallow. The other container is narrow and deep.

Predict which container has the greater rate of cooling. Explain your answer.

.....

.....

..... [2]

[Total: 6]

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2 The Sun is a large sphere of high temperature gas. An extremely large quantity of energy radiates from the Sun into space every second.

(a) A process releases energy inside the Sun and its temperature stays high.

State the name of this process.

..... [1]

(b) A gardener stores water in a large, cylindrical metal drum. The drum is painted black and has no lid. On a bright, sunny day, the water evaporates quickly and the water level in the drum falls.

(i) Suggest how, by using a drum of a different shape, the gardener can reduce the quantity of water lost by evaporation.

.....

..... [1]

(ii) The gardener is told that, by painting the drum white, he can reduce the quantity of radiation absorbed and so reduce the rate of evaporation.

Describe an experiment to show that black surfaces are better absorbers of radiation than white surfaces. You may include a diagram.

.....

.....

.....

.....

..... [4]

[Total: 6]

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3 **(a)** Two students hang out identical T-shirts to dry at the same time in the same neighbourhood. The only difference between the drying conditions is that one T-shirt is sheltered from any wind and the other is in a strong breeze, as shown in Fig. 6.1.

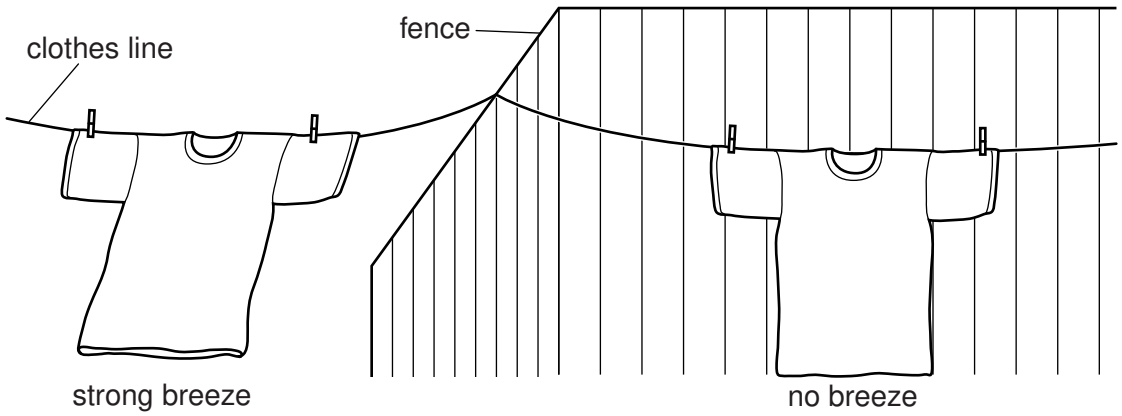

Fig. 6.1

State and explain, in terms of water molecules, the difference between the drying times of the T-shirts.

.....

.....

.....

.....

..... [2]

(b) Fig. 6.2 shows another occasion when a student hangs out two identical T-shirts to dry next to each other on a line. One T-shirt is folded double as shown in Fig. 6.2.

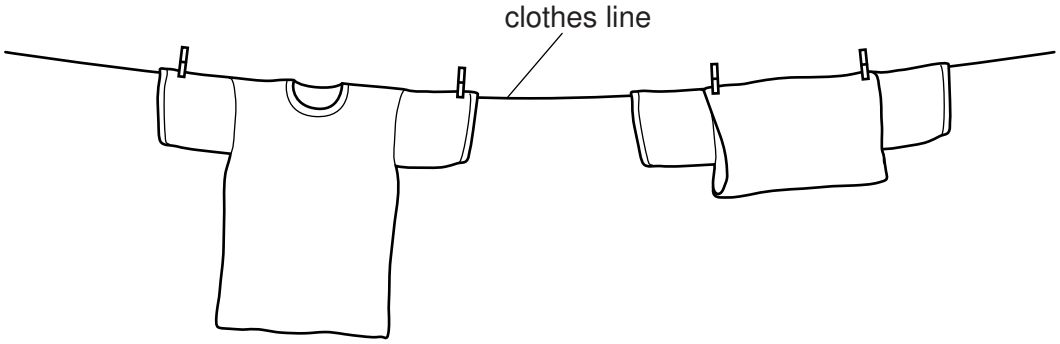

Fig. 6.2

State and explain, in terms of water molecules, the difference between the drying times of the T-shirts.

.....

.....

.....

.....

..... [2]

(c) A runner in a hot country feels cooler if she pours water over her hair to keep it wet, even when the water is at the same temperature as the air around her.

Explain, in terms of a change of state of water, why she feels cooler.

.....

.....

.....

..... [2]

[Total: 6]

4 Fig. 4.1 shows apparatus that could be used to measure the specific latent heat of ice.

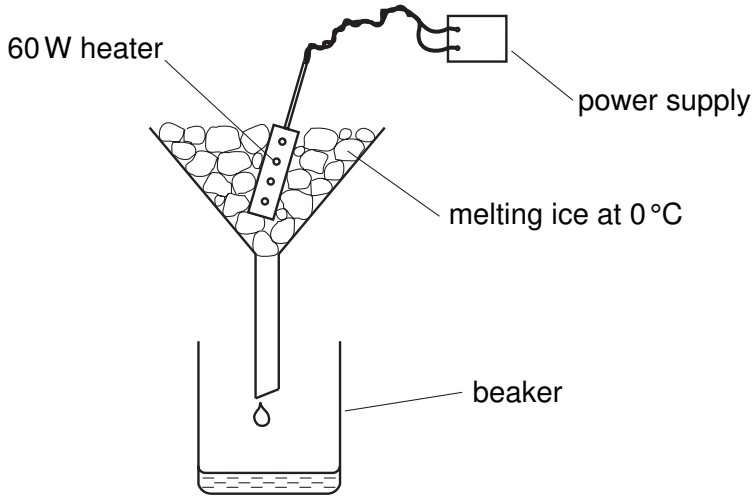

Fig. 4.1

(a) Describe how you would use the apparatus. You may assume that ice at 0 °C and a stopwatch are available. State all the readings that would be needed at each stage.

.....

.....

.....

.....

..... [4]

(b) In an experiment, 120 g of ice at 0 °C is to be melted. The specific latent heat of ice is 340 J/g. Assume that all the energy from the heater will be used to melt the ice.

Calculate the expected time for which the 60 W heater is switched on.

expected time = ... [2]

(c) When the experiment is carried out, the ice melts in slightly less time than the expected time.

(i) State one reason why this happens.

.....

..... [1]

(ii) Suggest one modification to the experiment that would reduce the difference between the experimental time and the expected time.

.....

..... [1]

[Total : 8]