1 **(a)** X and Y are liquid-in-glass thermometers. The scale of each thermometer starts at 0 °C.

X has a large range, good linearity and high sensitivity.
Y has a small range, poor linearity and low sensitivity.

Explain what is meant by

(i) the difference in their *ranges*,

.....

.....

(ii) the difference in their *linearities*,

.....

.....

(iii) the difference in their *sensitivities*.

.....

.....

[3]

(b) A thermocouple is used to measure the temperature of a small volume of liquid.

(i) Draw and label a sketch of the arrangement.

[3]

(ii) The temperature of the liquid is changing rapidly.

Explain why the thermocouple is able to respond quickly to this rapid change.

.....

.....

.....[2]

[Total: 8]

2 **(a)** State two examples of physical properties that vary with temperature and that may be used for the measurement of temperature.

1. .....

2. .....

[2]

(b) When first manufactured, a liquid-in-glass thermometer has no scale markings.

(i) Describe the procedure needed to determine

1. the position on the thermometer of the lower fixed point,

.....

.....

.....

2. the position on the thermometer of the upper fixed point.

.....

.....

.....

[3]

(ii) Explain why

1. the graduations marked on the thermometer between the fixed points are spaced equally,

.....

.....[1]

2. the expansion of the glass of the thermometer is ignored.

.....

.....[1]

[Total: 7]

3 **(a)** Fig. 1.1 shows a liquid-in-glass thermometer.

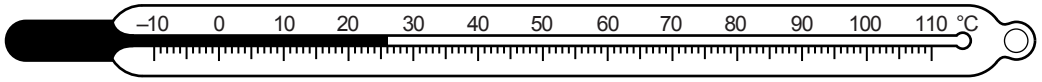

Fig. 1.1

(i) In the process of making the thermometer, the scale divisions were spaced equally.

What assumption was made about the liquid?

.....

..... [1]

(ii) Suggest **two** changes to the thermometer that would require the spacing of the scale divisions to be larger.

1. .....

2. .....
[2]

(iii) As a result of the changes in **(ii)**, what other change is needed to enable the thermometer to be used for the same temperature range?

..... [1]

(b) The expansion of a liquid is an example of a physical property that may be used to measure temperature.

State **two** other physical properties that may also be used to measure temperature.

1. the ..... of .....

2. the ..... of .....
[2]

[Total: 6]

4 **(a)** The following are three statements about boiling.

- A liquid boils at a fixed temperature.
- During boiling, vapour can form at any point within the liquid.
- Without a supply of thermal energy, boiling stops.

Complete the following equivalent statements about evaporation.

- A liquid evaporates at .....

  ..... .
- Du ing evaporation .....

  ..... .
- Without a supply of thermal energy, evaporation ..... .

[3]

(b) A pan containing water boiling at 100 °C is standing on an electrically heated hot-plate. In 20 minutes, 0.075 kg of water is lost as steam. The specific latent heat of vaporisation of water is 2.25×10^6 J / kg.

(i) Calculate the energy used in converting 0.075 kg of boiling water to steam.

energy = ... [2]

(ii) The hot-plate operates at 240 V, 0.65 A.

Calculate the energy supplied to the hot-plate in 20 minutes.

energy = ... [2]

(iii) Suggest why the answers to **(b)(i)** and **(b)(ii)** are not the same.

.....

..... [1]

[Total: 8]

5 **(a)** Define the *specific heat capacity* of a substance.

.....

..... [2]

(b) Fig. 4.1 shows a cylinder of aluminium heated by an electric heater.

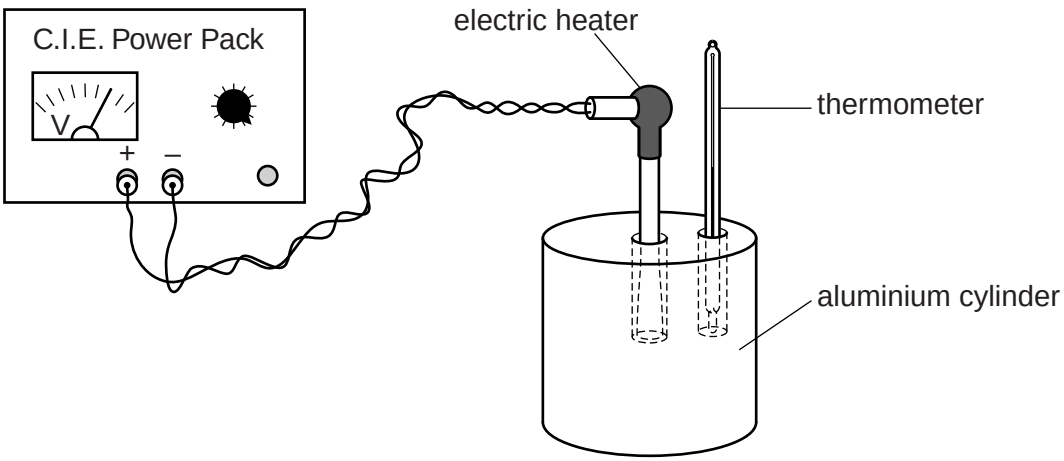

Fig. 4.1

The mass of the cylinder is 800 g. The heater delivers 8700 J of thermal energy to the cylinder and the temperature of the cylinder increases by 12 °C.

(i) Calculate a value for the specific heat capacity of aluminium.

specific heat capacity = ... [2]

(ii) Calculate the thermal capacity (heat capacity) of the aluminium cylinder.

thermal capacity = ... [2]

(c) State and explain a method of improving the accuracy of the experiment.

.....

.....

..... [2]

[Total: 8]

6 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 $2.3 \times 10^6 \text{ J/kg}$. 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]

7 The liquids in five liquid-in-glass thermometers A, B, C, D and E expand linearly with temperature. All the thermometers have scales marked in °C. Fig. 6.1 accurately represents the scales of these five thermometers.

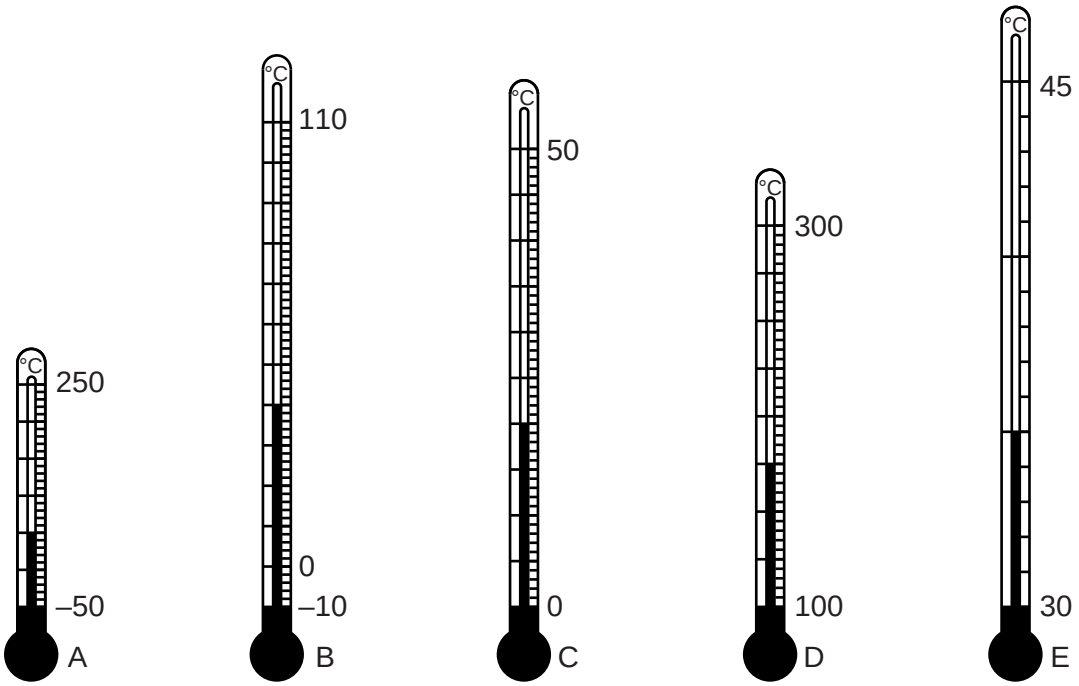

Fig. 6.1

(a) **(i)** Use information from the scales of the thermometers in Fig. 6.1 to state which thermometer has the greatest range.

..... [1]

(ii) State and explain which thermometer has the greatest sensitivity.

.....

..... [1]

(b) Suggest two design features that would cause a liquid-in-glass thermometer to have a large sensitivity.

1. .....

2. .....

[2]

(c) The distance on thermometer B between the 110 °C mark and the −10 °C mark is 18 cm.

Calculate the length of the liquid thread above the −10 °C mark when the temperature recorded by B is 70 °C.

length = ... [2]

[Total: 6]