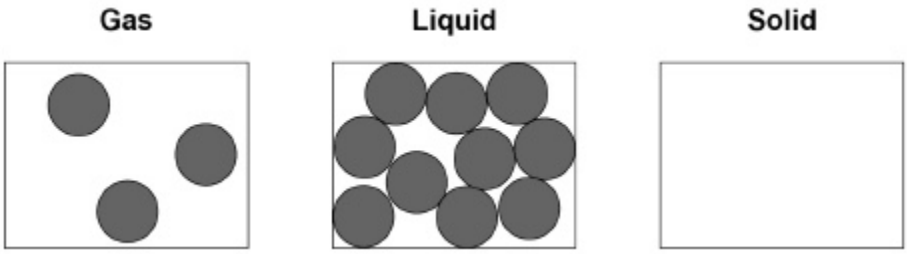
1 The diagram shows a model of the particles in a gas and in a liquid.



(a) Complete the diagram to show the arrangement of particles of the same substance as a solid.

(2)

(b) What is the name of the process when a substance changes from a gas to a liquid?

Tick **one** box.

Condensing ☐

Evaporating ☐

Freezing ☐

Melting ☐

(1)

(c) The substance in the diagram has a:

- melting point of 98 °C
- boiling point of 883 °C

What is the state of the substance at 20 °C?

Tick **one** box.

Gas ☐ Liquid ☐ Solid ☐

(1)

(d) What type of change is a change of state?

Tick **one** box.

- Chemical ☐
- Kinetic ☐
- Permanent ☐
- Physical ☐

(1)

(e) Which **two** statements are correct about the particles when a liquid turns into a gas?

Tick **two** boxes.

- Particles are bigger ☐
- Particles are lighter ☐
- Particles have more chemical energy ☐
- Particles have more kinetic energy ☐
- Particles move faster ☐

(2)

(f) Which **two** quantities are needed to calculate the energy required to turn a liquid into a gas with no change in temperature?

Tick **two** boxes.

- Mass of the liquid ☐
- Specific heat capacity of the gas ☐
- Specific latent heat of vaporisation ☐
- Time the liquid is heated ☐

(2)

(g) A mass of 2.0 kg of water is heated.

The temperature increase of the water is 80 °C

The specific heat capacity of water is 4200 J / kg °C

Calculate the change in thermal energy when the water is heated.

Use the equation:

change in thermal energy = mass × specific heat capacity × temperature change

_____

_____

_____

Change in thermal energy = _____ J

(2)

(Total 11 marks)

2 Water exists as ice, water or steam.

(a) Complete the sentences.

Choose the answers from the box.

ice	**steam**	**water**

The particles are arranged in a regular pattern in _____ .

The particles are close together but not in a pattern in _____ .

The particles move quickly in all directions in _____ .

(2)

(b) Which will have the most internal energy?

Tick **one** box.

1 kg of ice ☐

1 kg of steam ☐

1 kg of water ☐

(1)

(c) Which will have the lowest density?

Tick **one** box.

Ice ☐

Steam ☐

Water ☐

(1)

The image shows an iceberg floating in the sea.

(d) The iceberg has a mass of 11 200 kg

The volume of the iceberg is 12.0 m^3

Calculate the density of the iceberg.

Use the equation:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

_____

_____

Density = _____ kg/m^3

(2)

(e) Explain why the iceberg will melt.

(2)

(Total 8 marks)

3 A student wanted to determine the density of the irregular shaped object shown in **Figure 1**

Figure 1

(a) Plan an experiment that would allow the student to determine the density of the object.

(6)

(b) Another student did a similar experiment.

He determined the density of five common plastic materials.

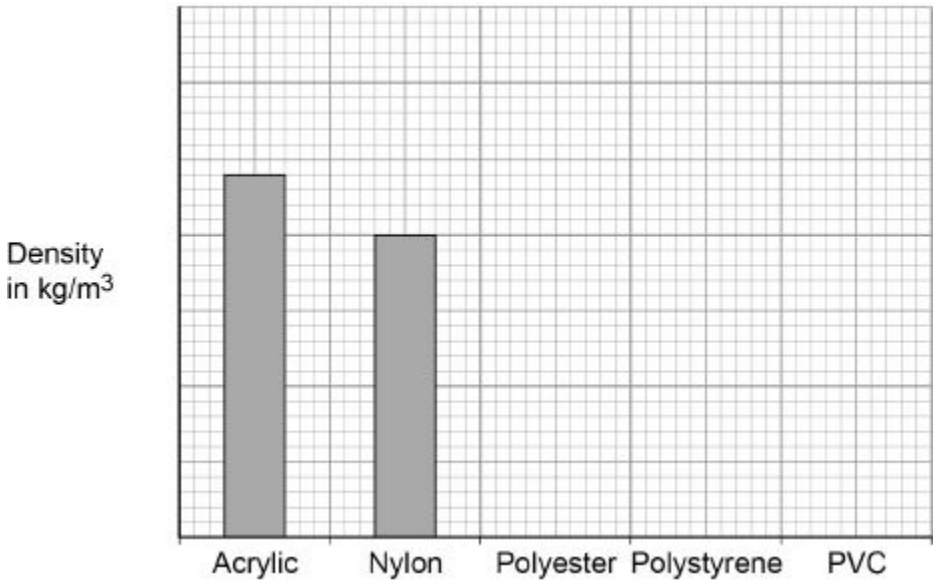
Table 1 shows the results.

Table 1

Plastic material	**Density in kg/m^3**
Acrylic	1200
Nylon	1000
Polyester	1380
Polystyrene	1040
PVC	1100

Figure 2 shows the results plotted in a bar chart.

Figure 2



Complete **Figure 2**

You should:

- Write the correct scale on the y-axis.
- Draw the bars for polyester, polystyrene and PVC.

(4)

(c) The student is given a piece of a different plastic material.

The student determined the density of the material three times.

Table 2 shows the results.

Table 2

	Density in kg/m^3
1	960
2	1120
3	1040

Determine the uncertainty in the student's results.

_____

_____

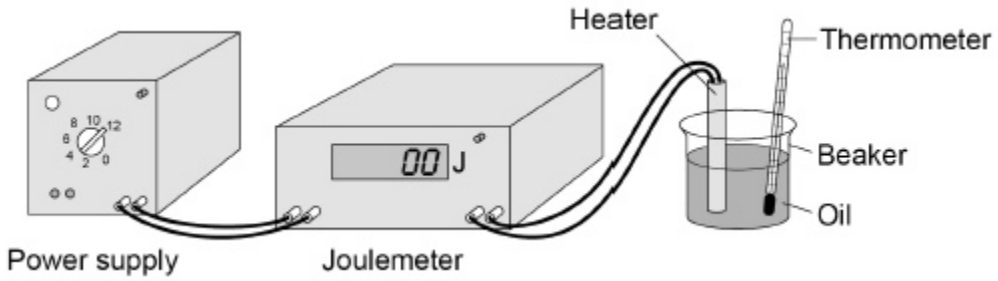
Uncertainty = _____ kg/m^3

(2)

(Total 12 marks)

4 Students investigated the specific heat capacity of different oils.

The diagram shows the equipment used.



This is the method used.

1. Put 200 g of an oil in a beaker.
2. Record the temperature of the oil.
3. Switch on the heater.
4. After 5 minutes, record the temperature of the oil and the reading on the joulemeter.
5. Repeat steps 1–4 with different oils.

(a) Give **one** variable the students controlled in the investigation.

_____

(1)

The table shows the students' results for one oil.

Temperature at start in °C	Temperature after 5 minutes in °C
21	68

(b) What is the resolution of the thermometer used in the investigation?

Resolution = _____ °C

(1)

The students calculated the specific heat capacity of the oil as 2100 J/kg °C

The correct value for the specific heat capacity of the oil is 1630 J/kg °C

(c) Calculate the percentage difference between the two values.

_____

_____

_____

_____

Percentage difference = _____ %

(2)

(d) Suggest **two** improvements the students could make to obtain a more accurate value for the specific heat capacity.

1. _____

_____

2. _____

_____

(2)

(e) A company is considering what metal to use to make saucepans.

They use data about the:

- cost of each metal
- specific heat capacity of each metal.

Suggest **two** other properties the company needs to consider when deciding which metal to use.

1. _____

_____

2. _____

_____

(2)

(Total 8 marks)

5 Solid, liquid and gas are three different states of matter.

(a) Describe the difference between the solid and gas states, in terms of the arrangement and movement of their particles.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) What is meant by ‘specific latent heat of vaporisation’?

_____

_____

_____

_____

(2)

(c) While a kettle boils, 0.018 kg of water changes to steam.

Calculate the amount of energy required for this change.

Specific latent heat of vaporisation of water = 2.3×10^6 J / kg.

_____

_____

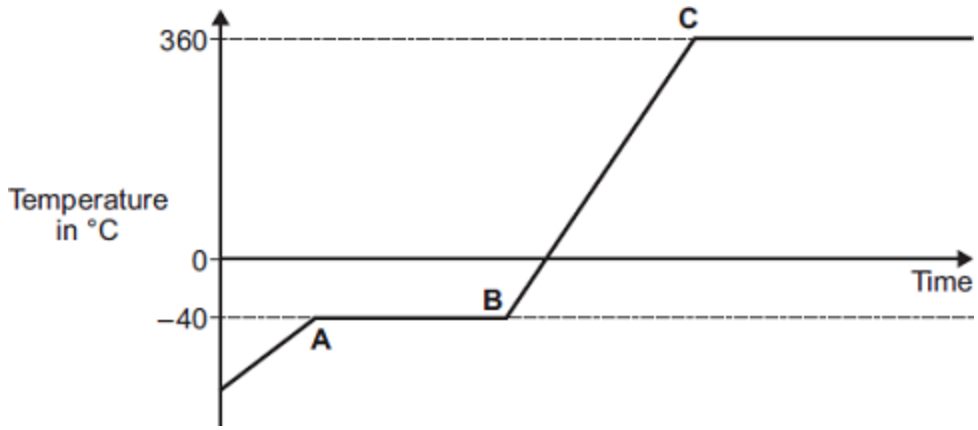
_____

Energy required = _____ J

(2)

(d) The graph shows how temperature varies with time for a substance as it is heated.

The graph is **not** drawn to scale.



Explain what is happening to the substance in sections **AB** and **BC** of the graph.

Section **AB** _____

_____

_____

_____

_____

Section **BC** _____

_____

_____

_____

_____

(4)

(Total 12 marks)

1

(a) (approximate same size particles as each other and as liquid and gas) touching

*do **not** accept particles that overlap*

1

regular arrangement (filling the square)

1

(b) condensing

1

(c) solid

1

(d) physical

1

(e) particles have more kinetic energy

1

particles move faster

1

(f) mass of the liquid

1

specific latent heat of vaporisation

1

(g) 2 × 4 200 × 80

1

672 000 (J)

*an answer of 672 000 (J) scores **2** marks*

1

[11]

2

(a) ice
water
steam

*allow **1** mark for 1 or 2 correct answers*

2

(b) 1 kg of steam

1

(c) steam

1

(d) ρ = 11 200 / 12.0

1

ρ = 933 (kg/m^3)

*an answer of 933 (kg/m^3) scores **2** marks*

1

(e) the internal energy of the iceberg increases

allow there is a temperature difference between ice and water / air

1

because

therefore

energy is transferred from the sea/water to the ice(berg)

1

[8]

3 (a) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- measure mass
- use a top pan balance or scales

- part fill a measuring cylinder with water
- measure initial volume
- place object in water
- measure final volume
- volume of object = final volume − initial volume

- fill a displacement / eureka can with water
- water level with spout
- place object in water
- collect displaced water
- measuring cylinder used to determine volume of displaced water

- use of:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

(b) all *y*-axis values correct (minimum of 3)

*allow **1** mark for two correct values*

2

all bars drawn to the correct height

*allow **1** mark for two correct bars*
allow ± ½ small square

2

(c) $\frac{(1120 - 960)}{2}$

ignore + and / or − signs

1

= 80 (kg/m^3)

*an answer of 160 scores **1** mark*

1

*an answer of 80 scores **2** marks*

[12]

4 (a) mass of oil

or

time the heater was turned on

1

(b) 1 (°C)

1

(c) $\frac{470}{1630} \times 100$

28.8 (%)

1

or

$\frac{470}{2100} \times 100$

22.4 (%)

1

(d) insulate the beaker

or

add a lid

1

use a smaller heater

or

submerge heater fully in oil

1

(e) any **two** from:

- density / mass (of the metal)
- reactivity (of the metal)
- toxicity (of the metal)
- strength / hardness (of the metal)
- thermal conductivity (of the metal)
- corrosion resistance (of the metal)

2

[8]

5 (a) **solid**

<u>particles</u> vibrate about fixed positions

1

closely packed

accept regular

1

gas

<u>particles</u> move randomly

accept particles move faster

accept freely for randomly

1

far apart

1

(b) amount of energy required to change the state of a substance from liquid to gas (vapour)

1

unit mass / 1 kg

dependent on first marking point

1

(c) 41000 **or** 4.1×10^4 (J)

accept

41400 or 4.14×10^4

correct substitution of

$0.018 \times 2.3 \times 10^6$ *gains* ***1*** *mark*

2

(d) **AB**

changing state from solid to liquid / melting

1

at steady temperature

dependent on first ***AB*** *mark*

1

BC

temperature of liquid rises

1

until it reaches boiling point

dependent on first ***BC*** *mark*

1

[12]