Q1.

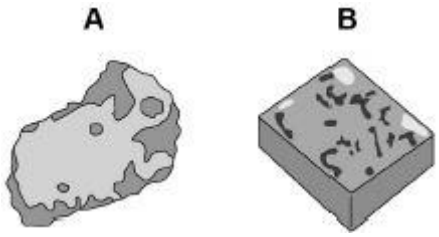
Two large semi-precious stones are discovered.

A student is asked to find out what material each of the two stones is made of.

The student does this by determining the density of the material of each stone.

Figure 1 shows the two stones.

Figure 1



(a) The student wants to measure the volume of stone **A**. Stone **A** cannot be measured using a metre rule as the stone is an irregular shape.

Describe how the student could determine the volume of stone **A** by putting it into water.

_____

_____

_____

_____

_____

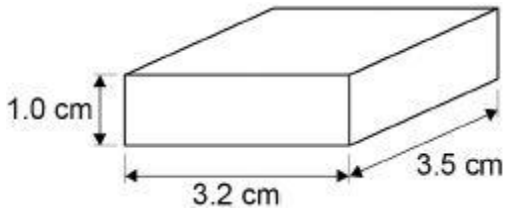
_____

(3)

The student makes measurements of stone **B** using a metre rule.

The measurements of stone **B** are shown **in Figure 2**.

Figure 2



(b) Which piece of equipment could the student use to get a more accurate measurement of the length of stone **B**?

Tick **one** box.

Electronic balance ☐

Microscope ☐

Newtonmeter ☐

Vernier callipers ☐

(1)

(c) Use the following equation to calculate the volume of stone **B** in cm^3

volume = length × width × height

_____

_____

Volume = _____ cm^3 **(1)**

(d) The mass of stone **B** is 56 grams.

Use your answer from part **(c)** to calculate the density of stone **B** in g/cm^3

Use the following equation.

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

_____

_____

_____

_____

Density = _____ g/cm^3 **(2)**

(e) The student calculates the density of the material stone **A** is made of as 5.2 g/cm^3

The student looks up the density of some materials in a text book.

Figure 3 shows this information.

Figure 3

Material	Density in g/cm^3
Amber	1.1 – 1.2
Cubic Zirconia	5.5 – 5.9
Garnet	3.8 – 3.9
Haematite	5.1 – 5.3

What material is stone **A** made of? **(1)**

Tick **one** box.

- Amber ☐
- Cubic Zirconia ☐
- Garnet ☐
- Haematite ☐

(Total 8 marks)

Q2.

This question is about solids and liquids.

(a) Describe **two** ways the arrangement of particles in a solid is different from the arrangement of particles in a liquid.

You should answer in terms of the particle model.

1. _____

_____

2. _____

_____

(2)

Liquid water can freeze to form solid ice.

Grit is spread on roads to reduce the formation of ice.

Grit contains a mixture of salt and sand.

(b) Explain why less ice is formed when salt is spread on roads.

_____

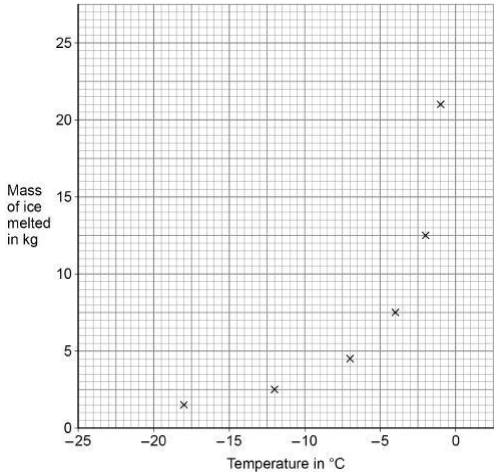
_____

_____

_____

(2)

The graph below shows the mass of ice melted by 1 kg of grit at different temperatures.



(c) Draw a line of best fit on the chart above.

(1)

(d) Predict the mass of ice that 1 kg of grit would melt at −20 °C

Use the graph above.

Mass of ice = _____ kg **(1)**

(e) Describe the effect of changing temperature on the mass of ice that 1 kg of grit can melt.

Use the graph above.

_____

_____

_____

_____

(2)

(f) Grit is spread on roads when low temperatures are expected.

Some roads are built with temperature sensors in the surface.

The sensors indicate when to spread grit on the roads.

Suggest **one** advantage of having temperature sensors in roads rather than relying on weather forecasts.

_____

_____

(1)

(Total 9 marks)

Q3.

The figure below shows a sealed balloon containing helium.

(a) The balloon is squashed so its volume decreases.

No helium enters or leaves the balloon.

What happens to the density of the helium in the balloon?

_____

_____

(1)

(b) The volume of the balloon is 14 000 cm^3

The density of the helium in the balloon is 0.180 kg/m^3

Calculate the mass of helium in the balloon

1 $cm^3 = 1 \times 10^{-6}$ m^3

_____

_____

_____

_____

_____

_____

_____

_____

Mass = _____ kg

(4)

(c) Explain how a decrease in temperature inside the balloon can change the volume of the balloon.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 9 marks)

Q4.

Ice cream is made by cooling a mixture of liquid ingredients until they freeze.

(a) Which statement describes the motion of the particles in solid ice cream?

Tick (✓) **one** box.

They are stationary. ☐

They move freely. ☐

They vibrate about fixed positions. ☐

(1)

(b) How do the kinetic energy and the potential energy of the particles change as a liquid is cooled and frozen?

Tick (✓) **one** box.

Kinetic energy	**Potential energy**	
Decreases	Decreases	☐
Decreases	Does not change	☐

Does not change	Decreases	☐
Does not change	Does not change	☐

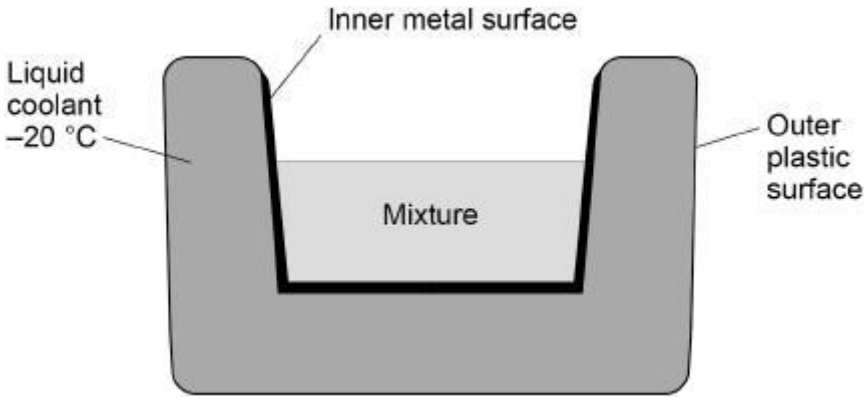
(1)

The diagram below shows a bowl used for making ice cream.

The walls of the bowl contain a liquid coolant.

The bowl is cooled to –20 °C before the mixture is put in the bowl.

The bowl causes the mixture to cool down and freeze.



(c) Explain why the different thermal conductivities of metal and plastic are important in the design of the bowl.

Metal _____

_____

_____

_____

Plastic _____

_____

_____

_____

(4)

(d) The liquid coolant has a freezing point below –20 °C

Explain **one** other property that the liquid coolant should have.

_____

_____

_____

_____

(2)

(e) The initial temperature of the mixture was +20 °C. The mixture froze at –1.5 °C.

A total of 165 kJ of internal energy was transferred from the mixture to cool and freeze it.

specific heat capacity of the mixture = 3500 J/kg °C

specific latent heat of fusion of the mixture = 255 000 J/kg

Calculate the mass of the mixture.

Give your answer to 2 significant figures.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Mass (2 significant figures) = _____ kg

(6)

(Total 14 marks)

Q1.

(a) (use a) displacement / eureka can filled with water

1

collect the water that is displaced (by the stone)

1

measure volume of water with a measuring cylinder

1

or

(use a) measuring cylinder of water (1)

take a start and end level of the water (in the measuring cylinder) (1)

allow idea of measure how far water has risen from original level

calculate volume of water rise (1)

(b) Vernier callipers

1

(c) 11.2 (cm^3)

allow 11

1

(d) $\frac{56}{11.2}$

*allow ecf from part **(c)***

1

5(.0)(g/cm^3)

1

*an answer of 5(.0) scores **2** marks*

(e) haematite

1

[8]

Q2.

(a) any **two** from:
(in a solid)

allow converse

- regular arrangement / pattern (of particles / spaces)
- particles are packed close(r) together

allow each particle touches nearest neighbour

- particles in a fixed position

allow particles are moving less in a solid

2

(b) a mixture is formed

allow a solution is formed

1

(which) has a lower melting point

allow (which) has a lower freezing point

1

alternative approach:

(mixture) has a lower melting point (1)

allow (mixture) has a lower freezing point

(so) temperature of surroundings / air / road is not cold enough to keep mixture / ice frozen (1)

(c) line of best fit

ignore extrapolation

1

(d) answer consistent with their line

*allow ecf from **(c)***

if no line drawn allow value between 1.0 and 1.5 (kg)

1

(e) any **two** from:

- more ice is melted (by 1 kg of grit) at higher temperatures

  allow converse
- increasingly more ice is melted at higher temperatures
  or
  gradient increases at higher temperatures

  allow the relationship is not linear / proportional
- use of pairs of values that show more ice is melted at higher temperatures

  allow a tolerance of +/- ½ a small square

2

(f) any **one** from:

- road temperature not air temperature
- actual temperature (rather than prediction)

  allow weather forecasts are (often) inaccurate
- specific to a small area
- avoids wasting grit

  allow reference to cost of grit
- fewer accidents

  allow reference to safety

1

[9]

Q3.

(a) (density) increases

1

(b)

an answer of 0.00252 (kg)

or

*0.0025 (kg) scores **4** marks*

(14 000 cm^3 =) 0.014 (m^3)

conversion of cm^3 to m^3

1

$$0.180 = \frac{m}{0.014}$$

1

mass = 0.180 × 0.014

1

mass = 0.00252 (kg)

allow correct answer in standard form 2.5(2) x 10^{-3} (kg)

*allow a maximum **3** marks for using an incorrectly / not converted volume*

1

(c) decrease in kinetic energy of particles
or
decrease in speed / velocity of particles

1

(therefore) inside wall is hit less frequently
or
inside wall is hit with less force

1

(which) decreases pressure inside

1

(but) outside pressure remains constant so decreases the volume inside the balloon

1

[9]

Q4.

(a) they vibrate about fixed positions.

1

(b) kinetic energy decreases potential energy decreases

1

(c) metal: has a high thermal conductivity

1

which increases the rate of energy transfer from the mixture

allow ice cream for mixture

1

plastic: has a low thermal conductivity

1

which reduces the rate of energy transfer from the surroundings (to the liquid

coolant at –20°C)

ignore references to insulation throughout

1

(d) a high specific heat capacity

1

so it can absorb a large amount of energy with only a small temperature change

1

(e) 165 kJ = 165000 J

1

$\Delta E = m \times 3500 \times 21.5$
and
$\Delta E = m \times 255000$

1

$165000 = 75250\ m + 255000\ m$
or
$165000 = 330250\ m$

this mark may be awarded if E is incorrectly/not converted

1

$m = \frac{165000}{75250 + 255000}$
or

this mark may be awarded if E is incorrectly/not converted

1

$m = \frac{165000}{330250}$

allow an answer consistent with their value of E

m = 0.499621 (kg)

1

m = 0.50 (kg)

this answer only

If no marks awarded other than the first marking point:

either

*165 000 = m × 3500 × 21.5 scores **1** mark*

*m = 2.192… scores **1** mark*

*m = 2.2 (kg) scores **1** mark.*

these marks may be awarded if E is incorrectly/not converted

or

*165 000 = m × 255 000 scores **1** mark*

*m = 0.647 scores **1** mark*

*m = 0.65kg scores **1** mark.*

these marks may be awarded if E is incorrectly/not converted

1

[14]