1. Polymers are used to make fabrics.

Table 1 shows some properties of two polymers.

Table 1

Property	Polymer J	Polymer K
Density in g/cm^3	0.9	1.4
Melting point in °C	165	260
Flame resistance	Poor	Good
Water absorption	Low	High

(a)　Polymer fabrics are used to make firefighter uniforms.

Complete **Table 2** by deciding for each property whether polymer J or polymer K is best for firefighter uniforms.

Use **Table 1**.

Density has been completed for you.

Tick **three** boxes.

Table 2

Property	Polymer J	Polymer K
Density in g/cm^3	✓	
Melting point in °C		
Flame resistance		
Water absorption		

(2)

(b) A firefighter uniform made from polymer **J** has a mass of 6.0 kg

Calculate the mass of a uniform of the same size made from polymer **K**.

Use **Table 1** and the equation:

$$\text{mass of uniform made from polymer } \mathbf{K} = \frac{\text{density of polymer } \mathbf{K}}{\text{density of polymer } \mathbf{J}} \times 6.0$$

_____

_____

_____

Mass of uniform made from polymer **K** = _____ kg

(2)

(c) Polymers **J** and **K** are both thermosoftening polymers.

Polymer **L** is a thermosetting polymer.

Why would polymer **L** be better than polymers **J** and **K** for firefighter uniforms?

Tick **one** box.

Polymer **L** burns easily ☐

Polymer **L** does not biodegrade ☐

Polymer **L** will not melt ☐

(1)

Polymers **J** and **K** are made from crude oil.

In the past, firefighter uniforms were made from wool.

Wool is obtained from sheep.

(d)   Why are many fabrics made from polymers instead of wool?

Tick **one** box.

Polymers are man-made   ☐

Polymers are more hard-wearing   ☐

Wool is more easily available   ☐

Wool is more flame resistant   ☐

(1)

(e)   Why is wool more sustainable than polymers **J** and **K** for making firefighter uniforms?

_____

_____
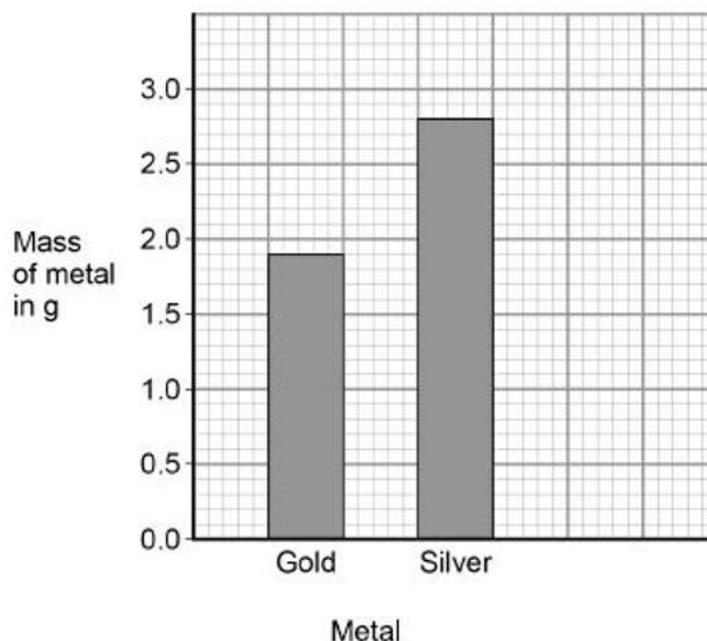
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_____

(2)
(Total 8 marks)

2.   A 9 carat gold ring is made from a mixture of metals.

The table below shows the mass of different metals in the ring.

The mass of the ring is 5.0 g

Metal	Mass of metal in g
Gold	1.9
Silver	2.8
Coppe	

(a)   Plot the data for copper from the table above on the graph below.

                                                                                    (2)

(b)   The cost of gold is £30 per gram.

Calculate the cost of the gold used in the 9 carat gold ring.

Use the table above.

_____

_____

Cost of gold = £_____

                                                                                    (1)

(c)   Rings can be made from 22 carat gold.

The ratio of the mass of gold in 22 carat gold compared to 9 carat gold is 22 :9

Calculate the mass of gold in a 22 carat gold ring of mass 5.0 g

Use the table above.

_____

_____

_____

Mass of gold = _____ g

                                                                                    (2)

(d)   Pure gold is 24 carats.

Suggest **two** reasons why silver and copper are mixed with gold to make 9 carat gold rings.

1. _____

_____

2. _____

_____

(2)

(e)   Copper is obtained from copper ores or by recycling copper.

• Copper ores are non-renewable.

• Copper ores can be obtained by mining.

• Some scrap copper goes to landfill sites.

Give **three** reasons why we should use recycled copper instead of copper from copper ores.

1. _____

_____

2. _____

_____

3. _____

_____

(3)
(Total 10 marks)

3. The figure below shows six test tubes a student set up to investigate the rusting of iron.

This is the method used for each test tube.

1. Measure the mass of the nail using a balance.
2. Leave the nail in the test tube for 6 days.
3. Measure the mass of the nail after 6 days.
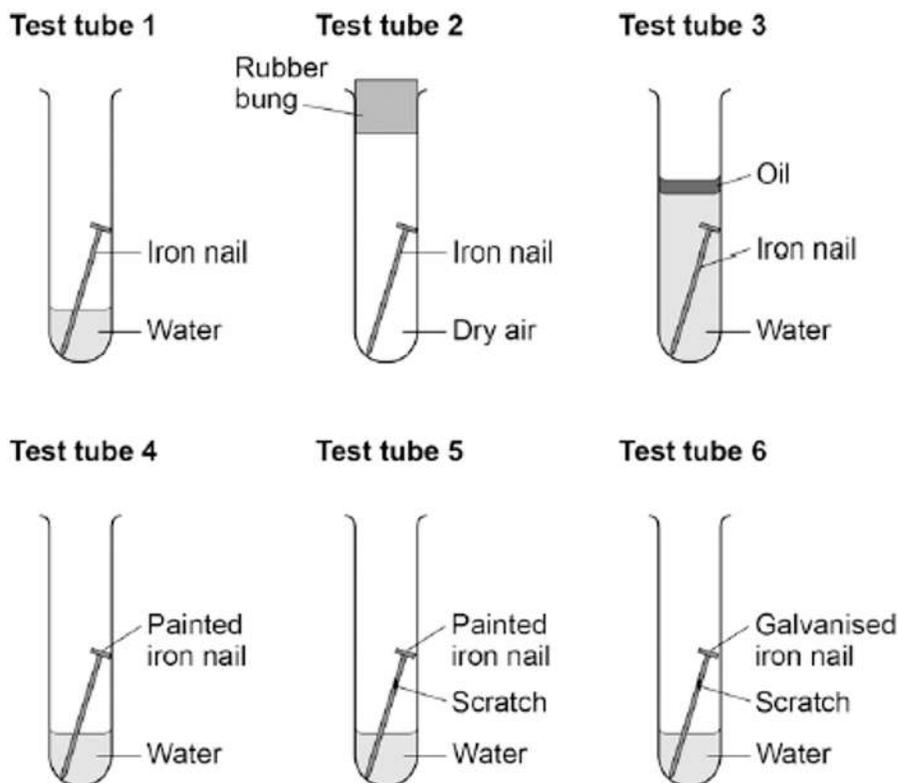
The table below shows the student's measurements.

Test tube	Mass of nail in g	Mass of nail after 6 days in g
1	8.45	8.91
2	8.46	8.46
3	8.51	8.51
4	9.65	9.65
5	9.37	9.45
6	9.79	9.79

(a) What is the resolution of the balance the student used?

Tick **one** box.

1×10^{-3} g ☐

1×10^{-2} g ☐

1×10^{-1} g ☐

1×10^{2} g ☐

(1)

(b) Calculate the difference in percentage increase in mass after 6 days of the nail in test tube **1** and the nail in test tube **5**.

Give your answer to **three** significant figures.

_____

_____

_____

_____

_____

_____

_____

_____

Difference in percentage increase in mass = _____ %

(4)

(c) Use the results of the student's investigations to draw conclusions about the factors affecting the rusting of iron. Include an evaluation of the effectiveness of different coatings at preventing the rusting of iron.

_____

_____

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_____

_____

_____

(6)

(d) Rust is hydrated iron(III) oxide.

Complete the word equation for the reaction.

_____ + _____ + _____ → hydrated iron(III) oxide

(2)
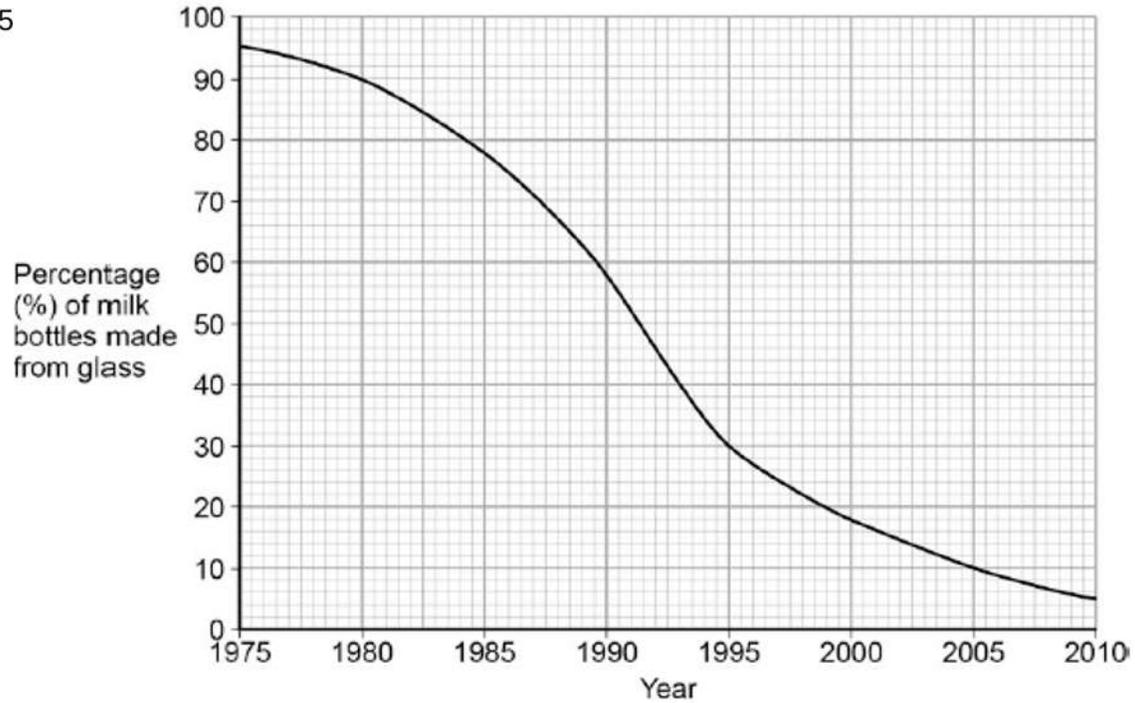**(Total 13 marks)**

4. Plastic and glass can be used to make milk bottles.

The figure below shows the percentage of milk bottles made from glass between 1975

(a) Plot the points and draw a line on the figure above to show the percentage of milk bottles made from materials **other** than glass between 1975 and 2010.

(3)

(b) The table below gives information about milk bottles.

	Glass milk bottle	Plastic milk bottle
Raw materials	Sand, limestone, salt	Crude oil
Bottle material	Soda-lime glass	HD poly(ethene)
Initial stage in production of bottle material	Limestone and salt used to produce sodium carbonate.	Production of naphtha fraction.
Maximum temperature in production process	1600 °C	850 °C
Number of times bottle can be used for milk	25	1
Size(s) of bottle	0.5 dm^3	0.5 dm^3, 1 dm^3, 2 dm^3, 3 dm^3
Percentage (%) of recycled material used in new bottles	50 %	10 %

Evaluate the production and use of bottles made from soda-lime glass and those made from HD poly(ethene).

Use the information given and your knowledge and understanding to justify your choice of material for milk bottles.

_____

_____

_____

_____

_____

_____

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_____

_____   _____

(6)

(Total 9 marks)

5. This question is about metals and alloys.

(a)   Explain how electricity is conducted in a metal.

To gain full marks you must include a description of the structure and bonding of a metal.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b)   Describe how the structure of an alloy is different from the structure of a pure metal.

_____

_____

_____

_____

(2)

(c)   Alloys are used to make dental braces and coins.

    (i)   Nitinol is an alloy used in dental braces.

       Why is Nitinol used in dental braces?

       _____

       _____

(1)

    (ii)   Suggest **one** reason why coins are not made of pure copper.

       Do **not** give cost as a reason.

       _____

       _____

(1)

    (iii)   Some coins are made from an alloy of aluminium.

       Complete the sentence.

       Aluminium is manufactured by the electrolysis of a molten mixture of cryolite

       and _____ .

(1)

    (iv)   Banks keep coins in poly(ethene) bags. These bags are made from low density poly(ethene).

       High density poly(ethene) can also be made from the same monomer.

       How can the same reaction produce two different products?

       _____

       _____

(1)

(d)   Give **two** reasons why instrumental methods of analysis are used to detect impurities in metals.

_____

_____

_____

(1)
(Total 11 marks)

6. (a) PEX is a material that is used as an alternative to copper for hot water pipes.
PEX is made from poly(ethene).

(i) Describe how ethene forms poly(ethene).

_____

_____

_____

_____

(2)

(ii) PEX is a shape memory polymer. What property does a shape memory polymer have?

_____

_____

(1)

(iii) The simplified structures of poly(ethene) and PEX are shown.
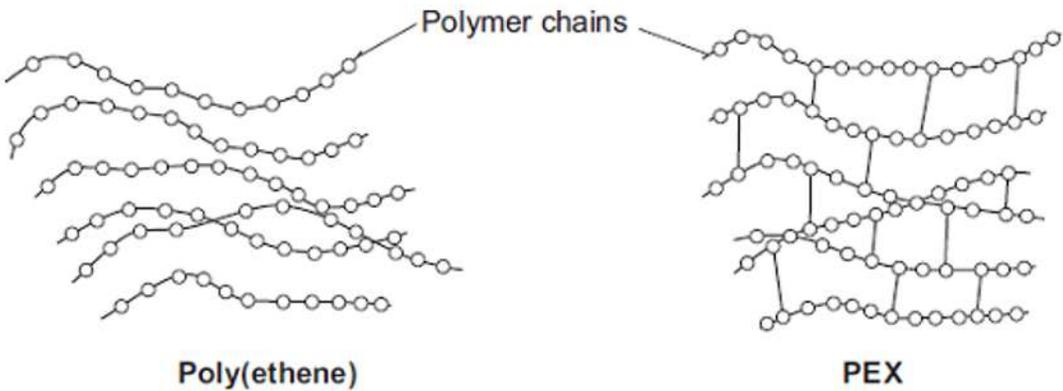
Poly(ethene)   PEX

Poly(ethene) is a thermoplastic that softens easily when heated.
Suggest and explain how the structure of PEX changes this property.

_____

_____

_____

_____

_____

_____

(3)

(b) Copper is a suitable material to use for hot water pipes.
PEX is now used as an alternative material for hot water pipes.

Copper is extracted from its ore by a series of processes.

1   The low-grade copper ore is powdered and concentrated.

2   The concentrated powdered copper ore is blown into a furnace with air to produce impure, molten copper. (This furnace is heated to 1100 °C using a hydrocarbon fuel.)

3   Oxygen is blown into the impure, molten copper to remove any sulfur. The molten copper is cast into rectangular slabs.

4   The final purification of copper is done by electrolysis.

PEX is made from crude oil by a series of processes:

•   fractional distillation of crude oil

•   cracking of naphtha fraction

•   polymerisation of ethene

•   conversion of poly(ethene) into PEX.

Use the information above and your knowledge and understanding to suggest possible environmental advantages of using PEX instead of copper for hot water pipes.

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_____   _____

(4)
(Total 10 marks)