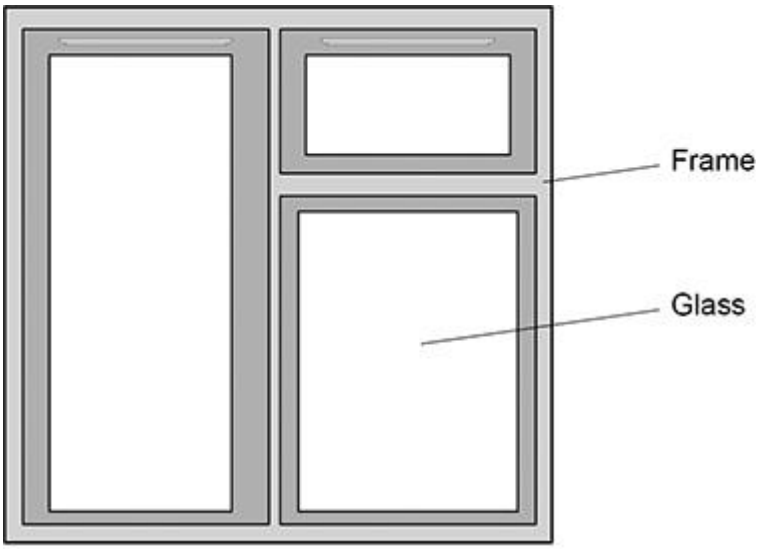
All questions are for separate science students only

Q1.

This question is about substances used to make windows and window frames.

Figure 1 shows a window.

Figure 1



(a) Glass is made by heating sand with **two** other materials.

Which **two** other materials are used to make glass?

Tick (✓) **two** boxes.

Clay	☐
Graphite	☐
Limestone	☐
Sodium carbonate	☐
Sodium hydroxide	☐

(2)

Window frames need to be:
- easy to install
- resistant to damage.

The polymers poly(chloroethene) and HDPE are used to make window frames.

Table 1 shows information about poly(chloroethene) and HDPE.

Table 1

Property	Poly(chloroethene)	HDPE
Density in g/cm^3	1.4	0.92
Relative strength	72	25

(b) Suggest **one** advantage of using poly(chloroethene) compared with HDPE to make window frames.

Give **one** reason for your answer.

Use **Table 1**.

Advantage _____

_____

Reason _____

_____

(2)

(c) Suggest **one** advantage of using HDPE compared with poly(chloroethene) to make window frames.

Give **one** reason for your answer.

Use **Table 1**.

Advantage _____

_____

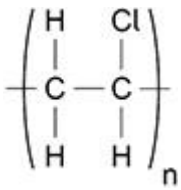
Reason _____

_____

(2)

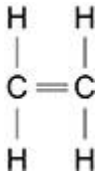
(d) **Figure 2** shows the displayed structural formula of poly(chloroethene).

Figure 2



Which monomer is used to make poly(chloroethene)?

Tick (✓) **one** box.



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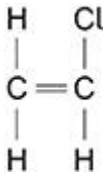

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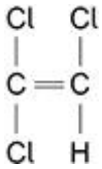
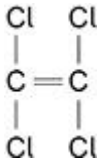


☐



☐

(1)

(e) Chlorine gas is used to produce poly(chloroethene).

Describe a test to identify chlorine gas.

Give the result of the test.

Test _____

_____

Result _____

_____

(2)

(f) Wood can be used instead of polymers to make window frames.

- Polymers are unreactive.
- Polymers are produced from crude oil.
- Wood breaks down in wet conditions.
- Wood is produced from trees.

Suggest **one** advantage of using polymers and **one** advantage of using wood to make window frames.

Advantage of polymers _____

_____

Advantage of wood _____

_____

(2)

Window frames can also be made from an alloy of aluminium.

(g) 6.00 kg of the alloy is used to make a window frame.

Table 2 shows the mass of each element in 6.00 kg of the alloy.

Table 2

Element	Mass in kg
Aluminium	5.94
Magnesium	0.04
Silicon	0.02

Calculate the percentage of aluminium in 6.00 kg of the alloy.

_____

_____

Percentage of aluminium = _____%

(2)

(h) Why is an alloy used instead of pure aluminium to make window frames?

_____

_____

(1)

(Total 14 marks)

Q2.

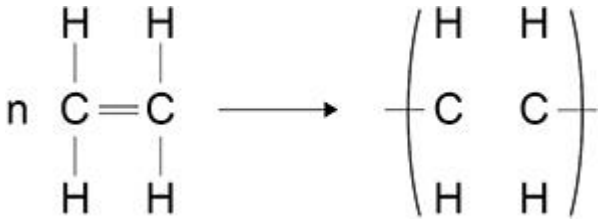
This question is about poly(ethene) and polyesters.

(a) Poly(ethene) is produced from ethene.

Figure 1 shows part of the displayed structural formula equation for the reaction.

Complete **Figure 1**.

Figure 1



(2)

(b) Poly(ethene) is a thermosoftening polymer.

Suggest why poly(ethene) is easier to recycle than thermosetting polymers.

_____

_____

_____

_____

(2)

(c) Ethene produces different forms of poly(ethene).

How can different forms of poly(ethene) be produced from ethene?

_____

_____

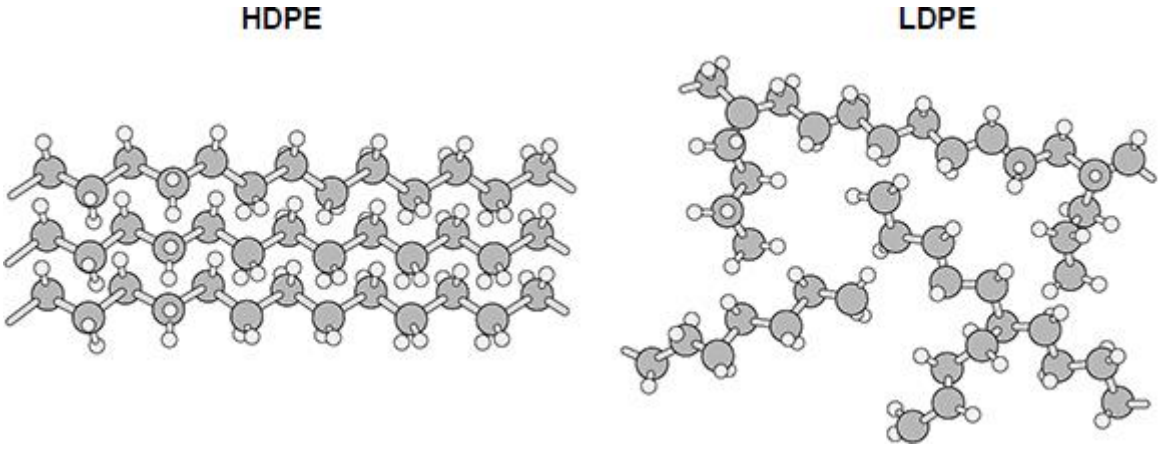
(1)

(d) Two different forms of poly(ethene) are:

- high density poly(ethene) (HDPE)
- low density poly(ethene) (LDPE).

Figure 2 represents part of the structures of HDPE and LDPE.

Figure 2



Explain why HDPE has a higher density than LDPE.

_____

_____

_____

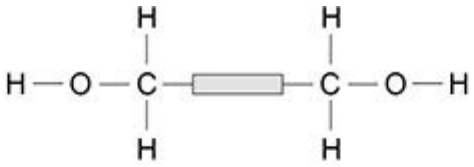
_____

(2)

Figure 3 shows three monomers, **A**, **B** and **C**.

Monomer **A** can react with monomer **B** and with monomer **C** to produce polyesters.

Figure 3



Monomer **A**

Monomer **B**

Monomer **C**

(e) Draw a circle on **Figure 3** around an alcohol functional group.

(1)

(f) Complete the table below to show the formula of the small molecule produced when:

- monomer **A** reacts with monomer **B**
- monomer **A** reacts with monomer **C**.

Reacting monomers	**Formula of small molecule produced**
A and **B**	
A and **C**	

(1)

(Total 9 marks)

Q3.

This question is about copper and alloys of copper.

Solders are alloys used to join metals together.

Some solders contain copper.

The table below shows information about three solders, **A**, **B** and **C**.

Solder	Melting point in °C	Metals in solder
A	183	tin, copper, lead
B	228	tin, copper, silver
C	217	tin, copper, silver

(a) Solder **B** and solder **C** are now used more frequently than solder **A** for health reasons.

Suggest **one** reason why.

Use the table above.

_____

_____

(1)

(b) Suggest **one** reason why solders **B** and **C** have different melting points.

Use the table above.

_____

_____

(1)

Copper can be obtained by:

- processing copper ores
- recycling scrap copper.

(c) Suggest **three** reasons why recycling scrap copper is a more sustainable way of obtaining copper than processing copper ores.

1 _____

_____

2 _____

_____

3 _____

_____

(3)

Copper is extracted from low-grade ores by phytomining.

(d) Describe how copper is extracted from low-grade ores by phytomining.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(e) Phytomining has **not** been widely used to extract copper.

Suggest **two** reasons why.

1 _____

_____

2 _____

_____

(2)

(Total 11 marks)

Q4.

This question is about alloys.

Bronze and brass are both alloys which contain copper.

(a) Bronze is an alloy of copper and one other metal.

What is the other metal in bronze?

Tick (✓) **one** box.

Aluminium	☐
Tin	☐

Zinc ☐

(1)

(b) Give **one** use of brass.

_____

_____

(1)

Alloys of gold are used to make jewellery.

(c) The proportion of gold in an alloy is measured in carats:

- pure gold is 24 carat
- 50% gold is 12 carat.

The table below shows information about two gold rings, **A** and **B**.

A and **B** contain only gold and silver.

Complete below the table below.

Gold ring	**Carat**	**Mass of metal in grams**	
		gold	silver
A		7	7
B	18	9	

(2)

(d) Suggest **two** reasons why alloys of gold are used instead of pure gold to make jewellery.

1 _____

_____

2 _____

_____

(2)

Steels are alloys of iron.

(e) Spoons are made of stainless steel.

Spoons:

- are washed after use
- must not wear away quickly.

Suggest **one** reason why stainless steel is suitable for making spoons.

_____

_____

(1)

(f) Steel horseshoes are shaped to fit the feet of horses.

Which type of steel is most easily shaped into horseshoes?

Tick (✓) **one** box.

High carbon steel	☐
Low carbon steel	☐
Stainless steel	☐

(1)

(Total 8 marks)

Q5.

This question is about materials used to make plates.

Plates are made from ceramics, paper or poly(propene).

(a) Paper plates are biodegradable and recyclable.

Which stage of a life cycle assessment (LCA) would contain this information?

Tick (✓) **one** box.

Disposal at the end of useful life	☐
Extracting and processing raw materials	☐
Manufacturing and packaging	☐
Use and operation during lifetime	☐

(1)

(b) Which **two** processes are used to make ceramic plates?

Tick (✓) **two** boxes.

Forming a composite ☐

Galvanising with zinc ☐

Heating in a furnace ☐

Melting sand and boron trioxide ☐

Shaping wet clay ☐

(2)

Poly(propene) is produced from an alkene.

(c) Complete the sentences.

The name for very large molecules such as poly(propene) is _____.

The name of the alkene used to produce poly(propene) is _____.

(2)

(d) The alkene needed to make poly(propene) is produced from crude oil.

Which **two** processes are used to produce this alkene from crude oil?

Tick (✓) **two** boxes.

Chromatography ☐

Cracking ☐

Fermentation ☐

Fractional distillation ☐

Quarrying ☐

(2)

(e) What type of bond joins the atoms in a molecule of poly(propene)?

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

(1)

The table below shows information about two polymers used to make plates.

Polymer	Effect of heating the polymer
A	does not melt
B	melts at 50 °C

(f) What type of polymer is polymer **A**?

Use the table above.

_____

_____

(1)

(g) Why does polymer **A** behave differently to polymer **B** when heated?

You should refer to crosslinks in your answer.

_____

_____

(1)

(Total 10 marks)

Q6.

This question is about materials used to make food plates.

Food plates are made from paper, polymers or ceramics.

The table below shows information about plates of the same diameter made from each of these materials.

Food plate material		
Paper	**Polymers**	**Ceramics**

Raw material	Wood	Crude oil	Mined clay
Number packaged in 10 dm^3 cardboard box	500	100	50
Average number of times used	1	400	1000
Biodegradable?	Yes	No	No
Recyclable?	Yes	Yes	No

(a) The table above does **not** show information about energy usage.

Suggest **two** pieces of information about energy usage which would help to produce a complete life cycle assessment (LCA) for the three food plate materials.

1 _____

_____

2 _____

_____

(2)

(b) Evaluate the use of these materials for making food plates.

You should use features of life cycle assessments (LCAs).

Use the table above.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) Describe how ceramic food plates are produced from clay.

_____

_____

_____

_____

(2)

(Total 8 marks)

Q7.

Figure 1 shows a surfer on a surfboard.

Figure 1

Some surfboards are made from addition polymers.

Addition polymers are made from small alkene molecules.

(a) Which type of bonding is present in small alkene molecules?

Tick (✓) **one** box.

Covalent ☐

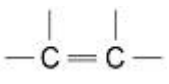
Ionic ☐

Metallic ☐

(1)

(b) What is the functional group in these small alkene molecules?

Tick (✓) **one** box.


☐

—COOH ☐

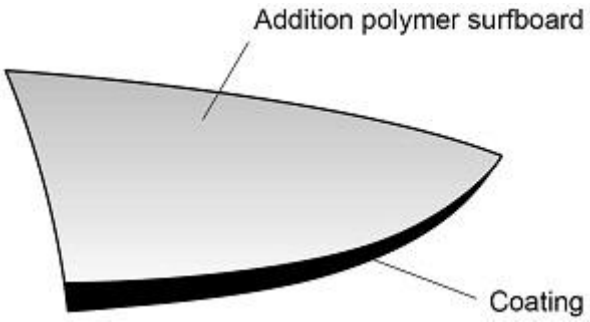
—OH ☐

(1)

Figure 2 shows the structure of part of an addition polymer surfboard.

The outer surface of the surfboard is coated.

Figure 2



The coating is made from soda-lime glass fibres surrounded by a plastic.

(c) What type of material is the coating of the surfboard?

Tick (✓) **one** box.

Alloy ☐

Ceramic ☐

Composite ☐

Nanotube ☐

(1)

(d) Complete the sentence.

Choose answers from the box.

air	**ammonia**	**copper**
	limestone	**sand**

The materials used to make the soda-lime glass fibres are sodium carbonate,

_____ and _____

(2)

(e) Suggest **two** reasons why surfboards are coated.

1 _____

_____

2 _____

_____

(2)

Some surfboards are made from wood.

The following table contains information about the materials in an addition polymer surfboard and a wooden surfboard.

	Addition polymer surfboard	**Wooden surfboard**
Relative strength	14	38
Cost (£ per m^3)	140	390
Density (kg/m^3)	50	150
Disposal at end of life	Difficult to recycle	Can be used as fuel

(f) Suggest **two** advantages and **two** disadvantages of using addition polymers rather than wood to make surfboards.

Use the table.

Advantages of addition polymers _____

_____

_____

_____

Disadvantages of addition polymers _____

_____

_____

_____

(4)

(g) Calculate the volume of wood in a wooden surfboard of mass 5.25 kg

Use the table above and the equation:

$$\text{Density in kg/m}^3 = \frac{\text{Mass in kg}}{\text{Volume in m}^3}$$

_____

_____

_____

_____

Volume = _____ m^3

(3)

(Total 14 marks)

Q8.

This question is about the corrosion of metals.

The corrosion of iron is called rusting.

(a) Plan an investigation to show that both water and air are needed for iron to rust.

You should include the results you expect to obtain.

Use apparatus and materials from the list:

- test tubes
- stoppers
- iron nails
- tap water
- boiled water
- drying agent
- oil.

(6)

A student investigated how the mass of three iron nails, **A**, **B** and **C**, increased after rusting.

The table shows the student's results.

Nail	Mass of nail before rusting in g	Mass of nail after rusting in g	Increase in mass of nail in g
A	1.22	1.30	0.08
B	1.25	1.36	**X**
C	1.24	1.33	0.09

(b) Calculate X in the table.

X = _____ g

(1)

(c) Calculate the mean increase in mass of the three iron nails, **A**, **B** and **C**.

Use the table above and your answer to part (b).

Mean increase in mass = _____ g

(1)

(Total 8 marks)

Q9.

Figure 1 shows a surfer on a surfboard.

Figure 1

Surfboards are made from polymers.

Surfboards have a poly(styrene) core and an outer skin.

(a) **Figure 2** shows the displayed structural formula of poly(styrene).

Figure 2

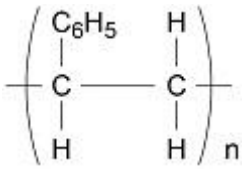
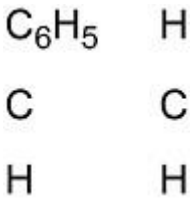


Figure 3 shows an incomplete displayed structural formula of the monomer styrene.

Complete **Figure 3**.

Figure 3



(2)

The outer skin of surfboards contains a polyester.

Two monomers, **A** and **B**, are needed to make the polyester.

Figure 4 shows how these two monomers are represented.

Figure 4

(b) Name the functional group in monomer **B**.

_____

(1)

(c) Monomers **A** and **B** join together to produce a polyester and a small molecule.

Name the small molecule.

_____

(1)

(d) Why does this type of polyester melt when it is heated?

_____

_____

_____

_____

(2)

The outer skin of surfboards is a composite material.

The composite material contains glass fibres surrounded by a polyester.

(e) Draw **one** line from each material to the description of that material.

Material	Description of the material
	Hydrocarbon
Glass fibres	Matrix
	Monomer
Polyester	Polypeptide
	Reinforcement

(2)

(f) The outer skin makes the surfboard more expensive.

Suggest **two** reasons why an outer skin is added to the poly(styrene) core.

1 _____

_____

2 _____

_____

(2)

(Total 10 marks)

Q10.

This question is about the corrosion of metals.

The corrosion of iron is called rusting.

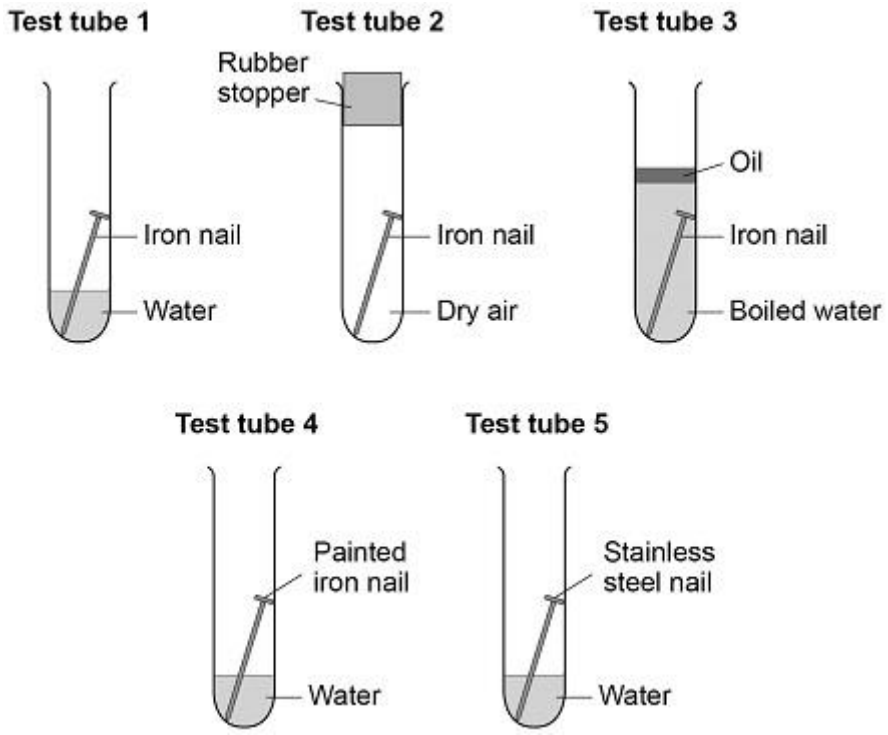
(a) A student investigated the rusting of iron.

This is the method used.

1. Set up the test tubes as shown in the figure below.

2. Leave the test tubes for 1 week.

3. Examine the nails for signs of rust.



Explain what would happen to the nails in each of the test tubes.

(5)

(b) Magnesium is fixed to some steel ships.

Explain how this prevents the steel from rusting.

(2)

(c) Explain why aluminium window frames do **not** corrode after they are made.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q11.

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?

_____

_____

_____

_____

(2)

(Total 8 marks)

Q12.

This question is about alloys of copper.

(a) Complete the sentence.

Choose the answer from the box.

aluminium	**iron**	**magnesium**	**tin**

Bronze is an alloy of copper and _____.

(1)

Brass is an alloy of copper and zinc.

The table shows the percentage by mass of copper and zinc in two types of brass.

Type of brass	**Percentage (%) by mass**	
	Copper	**Zinc**
Red brass	90	10
Yellow brass	**X**	30

(b) Calculate value **X** in the table above.

_____

Percentage by mass **X** = _____ %

(1)

(c) Calculate the mass of copper in 1100 g of red brass.

_____

_____

Mass = _____ g

(2)

(d) What is meant by an alloy?

_____

_____

(1)

(e) Brass contains layers of atoms which can slide over each other.

Explain why red brass is softer than yellow brass.

Use the table above and your own knowledge.

_____

_____

_____

_____

(2)

(f) Some musical instruments are made of brass.

Parts of these instruments can be gold plated.

What is the carat number of pure gold?

Tick (✓) **one** box.

9 ☐ **18** ☐ **22** ☐ **24** ☐

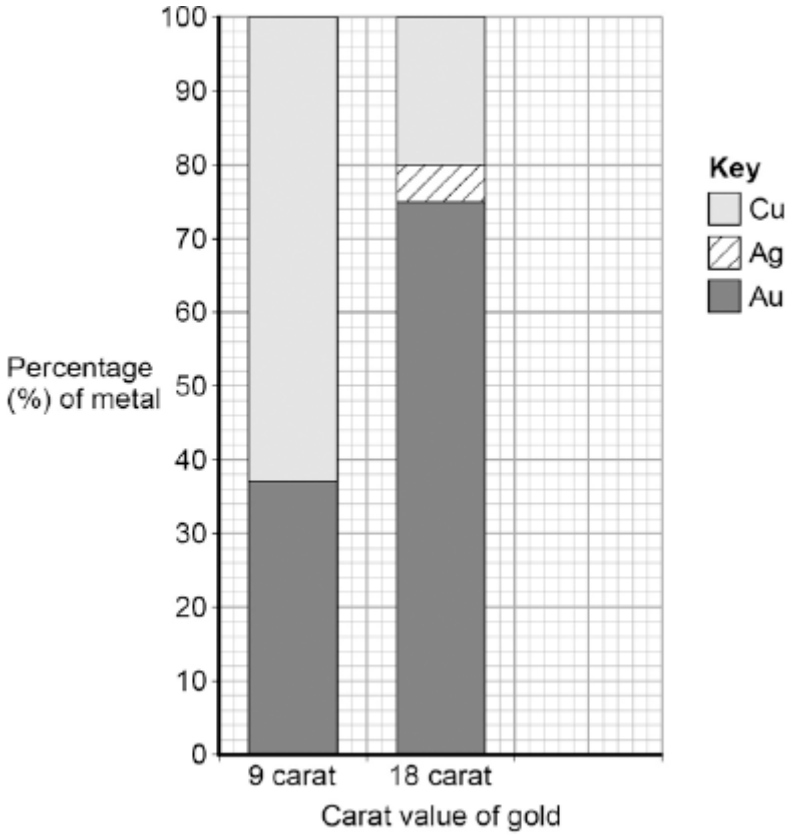
(1)

(Total 8 marks)

Q13.

Gold is mixed with other metals to make jewellery.

The figure below shows the composition of different carat values of gold.



(a) What is the percentage of gold in 12 carat gold?

Tick **one** box.

12 % ☐ **30 %** ☐ **50 %** ☐ **80 %** ☐

(1)

(b) Give the percentage of silver in 18 carat gold.

Use the figure above to answer this question.

Percentage = _____ %

(1)

(c) Suggest **two** reasons why 9 carat gold is often used instead of pure gold to make jewellery.

1. _____

_____

2. _____

_____

(2)

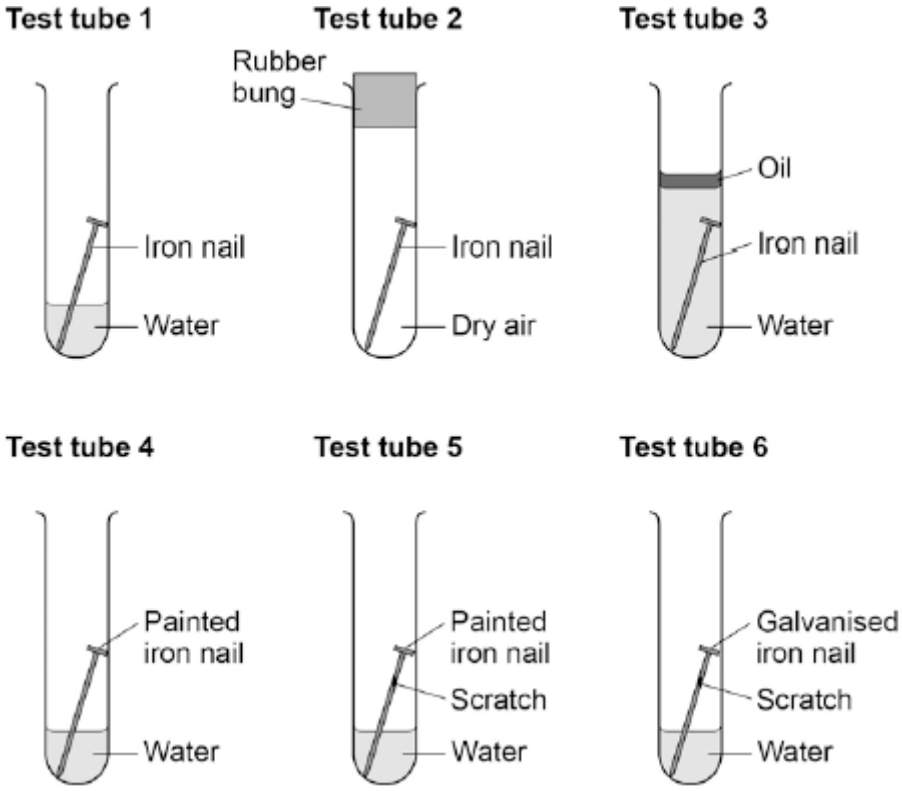
(Total 4 marks)

Q14.

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.

_____

_____

_____

(6)

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

Complete the word equation for the reaction.

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

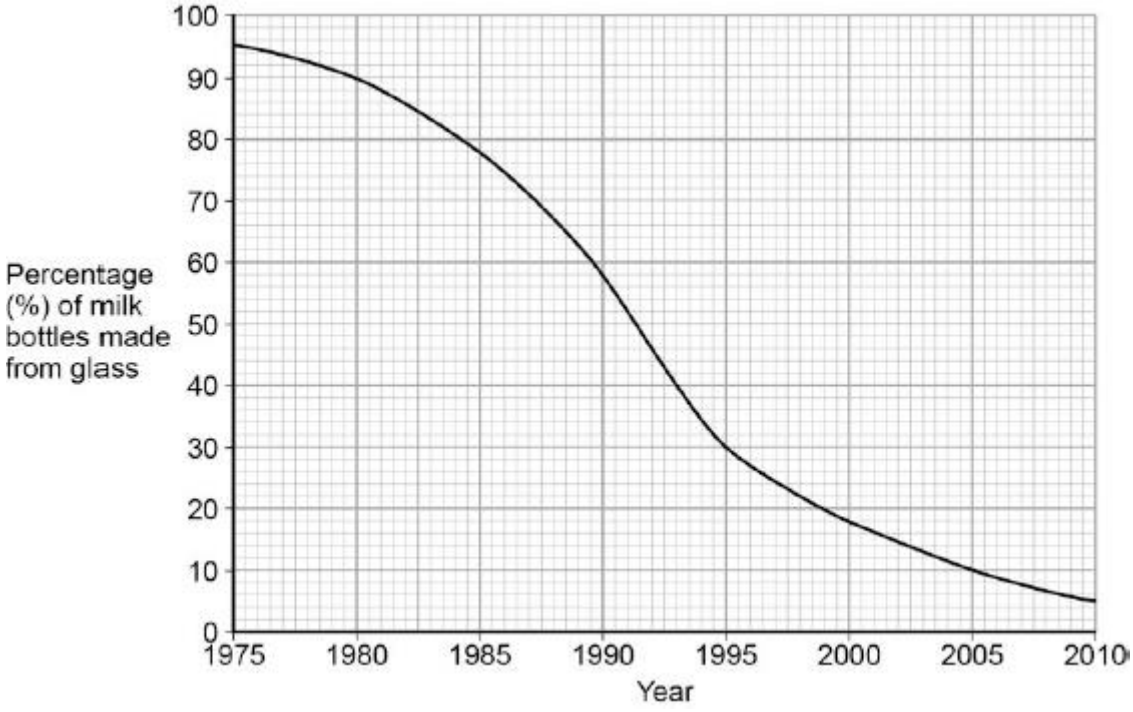
(2)

(Total 13 marks)

Q15.

Plastic and glass can be used to make milk bottles.

The figure below shows the percentage of milk bottles made from glass between 1975 and 2010.



(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.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 9 marks)

Q16.

This question is about substances containing carbon atoms.

(a) Diamond is made of carbon atoms.

(i) Diamond is used for tips of drills.

Figure 1 shows a drill.

Figure 1

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Give **one** reason why diamond is used for tips of drills.

_____

_____

(1)

(ii) Diamond nanoparticles can be made.

Use the correct answer from the box to complete the sentence.

hundred	**million**	**thousand**

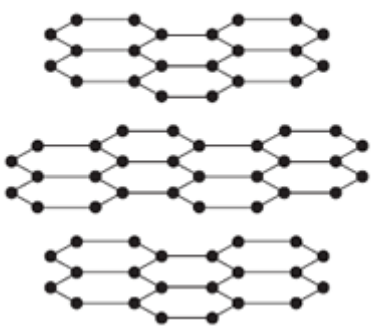
Nanoparticles contain a few _____ atoms.

(1)

(b) Graphite is made of carbon atoms.

Figure 2 shows the structure of graphite.

Figure 2



(i) What type of bonding does graphite have?

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

(1)

(ii) How many carbon atoms does each carbon atom bond to in graphite?

Tick (✓) **one** box.

1 ☐

2 ☐

3 ☐

4 ☐

(1)

(iii) What is a property of graphite?

Tick (✓) **one** box.

Dissolves in water ☐

Has a low melting point ☐

Soft and slippery ☐

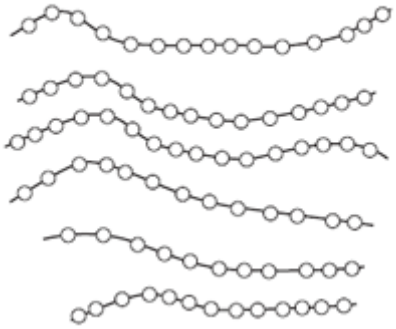
(1)

(c) Poly(ethene) is made of carbon and hydrogen atoms.

Poly(ethene) is a thermosoftening polymer.

Figure 3 shows the structure of a thermosoftening polymer.

Figure 3



(i) Complete the sentence.

Between the polymer chains in a thermosoftening polymer there

are no _____ .

(1)

(ii) Use the correct answer from the box to complete the sentence.

condense	**dissolve**	**melt**

Heating would cause a thermosoftening polymer to

_____ .

(1)

(iii) Many ethene molecules react together to make poly(ethene).

Different types of poly(ethene) can be made by changing the conditions for the reaction.
Suggest **two** conditions that could be changed.

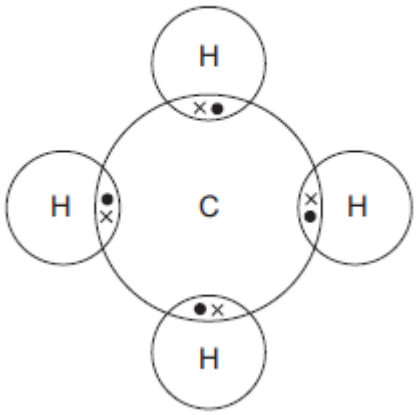
1. _____

2. _____

(2)

(d) **Figure 4** shows how the atoms are bonded in methane.

Figure 4



(i) What is the formula for methane?

Tick (✓) **one** box.

C_4H ☐

CH_4 ☐

C_4H_4 ☐

(1)

(ii) Methane has a low boiling point.

What does methane consist of?

Tick (✓) **one** box.

Charged ions ☐

A giant lattice ☐

Small molecules ☐

(1)

(Total 11 marks)