AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.1.1 ATOMIC STRUCTURE, SYMBOLS, RELATIVE ATOMIC MASS, CHARGE AND ISOTOPES (PACK 1)

SCORE	PERCENTAGE
/331	%

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Q1.

This question is about mixtures.

(a) Substances are separated from a mixture using different methods.

Draw **one** line from each substance and mixture to the best method of separation.

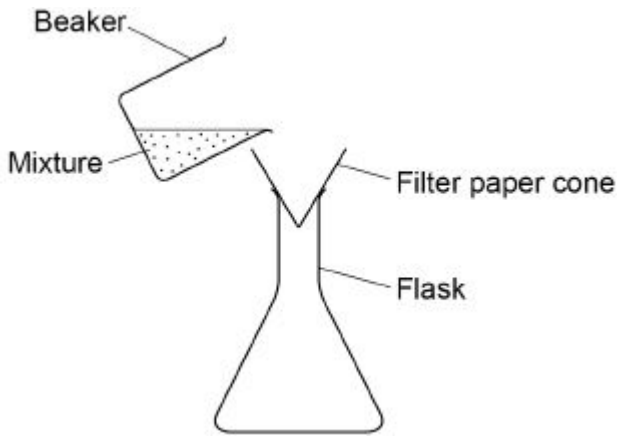
Substance and mixture	Method of separation
	Chromatography
Ethanol from ethanol and water	Crystallisation
Salt from sea water	Electrolysis
The different colours in black ink	Filtration
	Fractional distillation

(3)

(b) A student filters a mixture.

Figure 1 shows the apparatus.

Figure 1



Suggest **one** improvement to the apparatus.

_____

_____

(1)

(c) Complete the sentences.

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Choose answers from the box.

condense	evaporate	freeze	melt	solidify

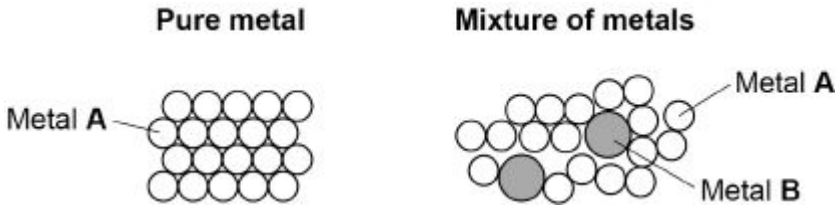
In simple distillation, the mixture is heated to make the liquid _____ .

The vapour is then cooled to make it _____ .

(2)

Figure 2 shows the arrangement of atoms in a pure metal and in a mixture of metals.

Figure 2



(d) Calculate the percentage of metal B atoms in the mixture of metals shown in **Figure 2**.

_____

_____

_____

Percentage of metal **B** atoms = _____ %

(2)

(e) What is a mixture of metals called?

Tick **one** box.

An alloy ☐

A compound ☐

A molecule ☐

A polymer ☐

(1)

(f) Why is the mixture of metals in **Figure 2** harder than the pure metal?

Tick **one** box.

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The atoms in the mixture are different shapes. ☐

The layers in the mixture are distorted. ☐

The layers in the mixture slide more easily. ☐

The mixture has a giant structure. ☐

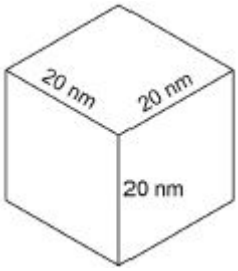
(1)

(g) A nanoparticle of pure metal **A** is a cube.

Each side of the cube has a length of 20 nm.

Figure 3 shows the cube.

Figure 3



What is the volume of the nanoparticle?

Tick **one** box.

20 nm^3 ☐

60 nm^3 ☐

400 nm^3 ☐

8000 nm^3 ☐

(1)

(Total 11 marks)

Q2.

The halogens are elements in Group 7.

(a) Bromine is in Group 7.

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Give the number of electrons in the outer shell of a bromine atom.

_____

(1)

(b) Bromine reacts with hydrogen. The gas hydrogen bromide is produced.

What is the structure of hydrogen bromide?

Tick **one** box.

Giant covalent ☐

Ionic lattice ☐

Metallic structure ☐

Small molecule ☐

(1)

(c) What is the formula for fluorine gas?

Tick **one** box.

F ☐

F_2 ☐

F^2 ☐

2F ☐

(1)

A student mixes solutions of halogens with solutions of their salts.

The table below shows the student's observations.

	Potassium chloride (colourless)	**Potassium bromide (colourless)**	**Potassium iodide (colourless)**
Chlorine (colourless)		Solution turns orange	Solution turns brown
Bromine (orange)	No change		Solution turns brown

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Iodine (brown)	No change	No change	

(d) Explain how the reactivity of the halogens changes going down Group 7.

Use the results in the table above.

_____

_____

_____

_____

_____

_____

(3)

A company uses chlorine to produce titanium chloride from titanium dioxide.

(e) What is the relative formula mass (M_r) of titanium dioxide, TiO_2?

Relative atomic masses (A_r): O = 16 Ti = 48

Tick **one** box.

64 ☐

80 ☐

128 ☐

768 ☐

(1)

(f) The company calculates that 500 g of titanium dioxide should produce 1.2 kg of titanium chloride.

However, the company finds that 500 g of titanium dioxide only produces 900 g of titanium chloride.

Calculate the percentage yield.

_____

_____

_____

_____

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Percentage yield = _____ %

(2)

(Total 9 marks)

Q3.

This question is about the structure of the atom.

(a) Complete the sentences.

Choose answers from the box.

Each word may be used once, more than once, or not at all.

electron	**ion**	**neutron**
nucleus	**proton**	

The centre of the atom is the _____ .

The two types of particle in the centre of the atom are the proton

and the _____ .

James Chadwick proved the existence of the _____ .

Niels Bohr suggested particles orbit the centre of the atom. This type of particle

is the _____ .

The two types of particle with the same mass are the neutron

and the _____ .

(5)

The table below shows information about two isotopes of element **X**.

	Mass number	**Percentage (%) abundance**
Isotope 1	63	70
Isotope 2	65	30

(b) Calculate the relative atomic mass (A_r) of element **X** using the equation:

$$A_r = \frac{\text{(mass number} \times \text{percentage) of isotope 1 + (mass number} \times \text{percentage) of isotope 2}}{100}$$

Use the table above.

Give your answer to 1 decimal place.

_____

_____

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_____

_____

A_r = _____

(2)

(c) Suggest the identity of element **X**.

Use the periodic table.

Element **X** is _____

(1)

(d) The radius of an atom of element **X** is 1.2×10^{-10} m

The radius of the centre of the atom is $\frac{1}{10000}$ the radius of the atom.

Calculate the radius of the centre of an atom of element **X**.

Give your answer in standard form.

_____

_____

_____

_____

Radius = _____ m

(2)

(Total 10 marks)

Q4.

This question is about elements in Group 1.

A teacher burns sodium in oxygen.

(a) Complete the word equation for the reaction.

sodium + oxygen ⟶ _____

(1)

(b) What is the name of this type of reaction?

Tick **one** box.

Decomposition ☐

Electrolysis ☐

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Oxidation ☐

Precipitation ☐

(1)

(c) The teacher dissolves the product of the reaction in water and adds universal indicator.

The universal indicator turns purple.

What is the pH value of the solution?

Tick **one** box.

1 ☐	4 ☐	7 ☐	13 ☐

(1)

(d) The solution contains a substance with the formula NaOH

Give the name of the substance.

_____

(1)

(e) All alkalis contain the same ion.

What is the formula of this ion?

Tick **one** box.

H^+ ☐

Na^+ ☐

OH^- ☐

O^{2-} ☐

(1)

(f) A solution of NaOH had a concentration of 40 g/dm^3

What mass of NaOH would there be in 250 cm^3 of the solution?

_____

_____

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_____

_____

Mass = _____ g

(2)

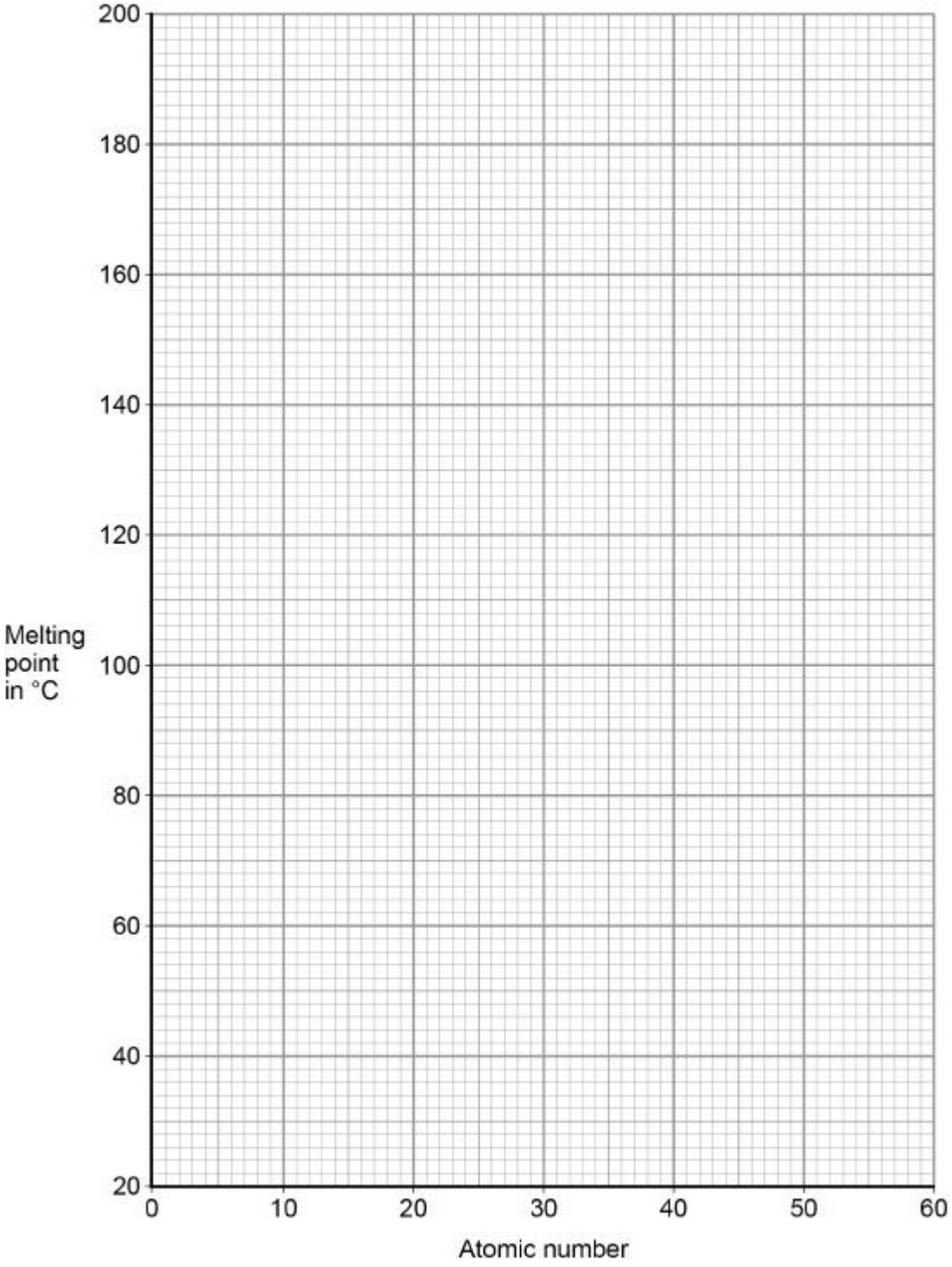
(g) The melting points of the elements in Group 1 show a trend.

The table below shows the atomic numbers and melting points of the Group 1 elements.

Element	**Atomic number**	**Melting point in °C**
Lithium	3	181
Sodium	11	98
Potassium	19	63
Rubidium	37	**X**
Caesium	55	29

Plot the data from the table on the graph below.

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(2)

(h) Predict the melting point, **X**, of rubidium, atomic number 37

Use the graph above.

Melting point = _____ °C

(1)

(Total 10 marks)

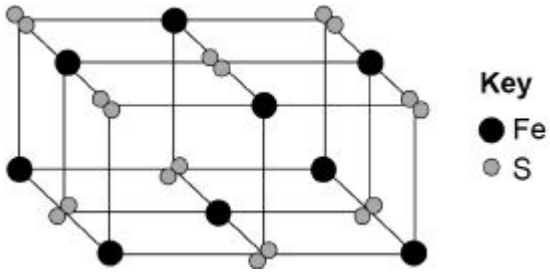
Q5.

This question is about metals and metal compounds.

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(a) Iron pyrites is an ionic compound.

The diagram below shows a structure for iron pyrites.



Determine the formula of iron pyrites.

Use the diagram above.

_____

(1)

(b) An atom of iron is represented as $^{56}_{26}Fe$

Give the number of protons, neutrons and electrons in this atom of iron.

Number of protons _____

Number of neutrons _____

Number of electrons _____

(3)

(c) Iron is a transition metal.

Sodium is a Group 1 metal.

Give **two** differences between the properties of iron and sodium.

1. _____

_____

2. _____

_____

(2)

Nickel is extracted from nickel oxide by reduction with carbon.

(d) Explain why carbon can be used to extract nickel from nickel oxide.

_____

_____

_____

_____

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(2)

(e) An equation for the reaction is:

$$NiO + C \longrightarrow Ni + CO$$

Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses (A_r): C = 12 Ni = 59

Relative formula mass (M_r): NiO = 75

Give your answer to 3 significant figures.

_____

_____

_____

_____

_____

_____

Percentage atom economy = _____ %

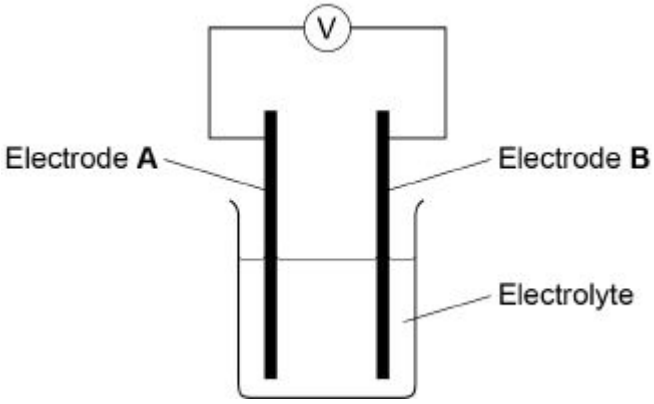
(3)

(Total 11 marks)

Q6.

Chemical reactions can produce electricity.

(a) The diagram below shows a simple cell.



Which of these combinations would not give a zero reading on the voltmeter in the diagram above?

Tick **one** box.

Electrode A	**Electrode B**	**Electrolyte**	☐

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Copper	Copper	Sodium chloride solution	☐
Zinc	Zinc	Water	☐
Copper	Zinc	Sodium chloride solution	☐
Copper	Zinc	Water	☐

(1)

Alkaline batteries are non-rechargeable.

(b) Why do alkaline batteries eventually stop working?

_____

_____

(1)

(c) Why can alkaline batteries **not** be recharged?

_____

_____

(1)

Hydrogen fuel cells and rechargeable lithium-ion batteries can be used to power electric cars.

(d) Complete the balanced equation for the overall reaction in a hydrogen fuel cell.

$$_____\ H_2 + _____ \longrightarrow _____\ H_2O$$

(2)

(e) The table below shows data about different ways to power electric cars.

	Hydrogen fuel cell	**Rechargeable lithium-ion battery**
Time taken to refuel or recharge in minutes	5	30
Distance travelled before refuelling or recharging in miles	Up to 415	Up to 240
Distance travelled per unit of energy in km	22	66
Cost of refuelling or recharging in £	50	3

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Minimum cost of car in £	60 000	18 000

Evaluate the use of hydrogen fuel cells compared with rechargeable lithium-ion batteries to power electric cars.

Use the table above and your own knowledge.

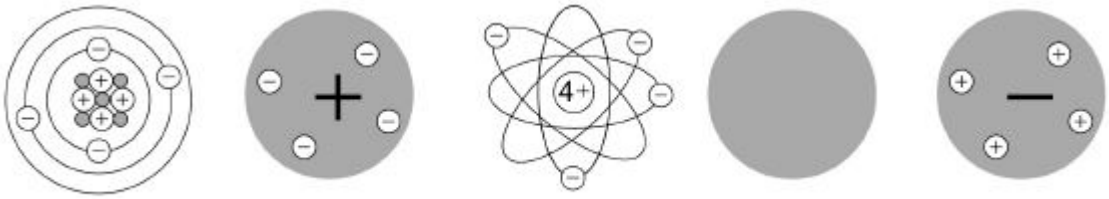
(6)

(Total 11 marks)

Q7.

The diagram below represents different models of the atom.

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A B C D E

(a) Which diagram shows the plum pudding model of the atom?

Tick **one** box.

A		B		C		D		E	

(1)

(b) Which diagram shows the model of the atom developed from the alpha particle scattering experiment?

Tick **one** box.

A		B		C		D		E	

(1)

(c) Which diagram shows the model of the atom resulting from Bohr's work?

Tick **one** box.

A		B		C		D		E	

(1)

(d) Define the mass number of an atom.

_____

_____

(1)

(e) Element **X** has two isotopes. Their mass numbers are 69 and 71

The percentage abundance of each isotope is:

- 60% of ^{69}**X**
- 40% of ^{71}**X**

Estimate the relative atomic mass of element **X**.

Tick **one** box.

< 69.5 ☐

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Between 69.5 and 70.0 ☐

Between 69.5 and 70.0 ☐

Between 70.0 and 70.5 ☐

> 70.5 ☐

(1)

(f) Chadwick's experimental work on the atom led to a better understanding of isotopes.

Explain how his work led to this understanding.

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q8.

This question is about copper sulfate.

Blue copper sulfate turns white when it is heated.

The word equation for the reaction is:

hydrated copper sulfate ⇌ anhydrous copper sulfate + water

blue white

(a) What name is given to hydrated copper sulfate in this reaction?

Tick **one** box.

Catalyst ☐

Element ☐

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Product ☐

Reactant ☐

(1)

(b) What does the symbol ⇌ mean?

Tick **one** box.

Endothermic ☐

Exothermic ☐

Reversible ☐

Polymerisation ☐

(1)

(c) Complete the sentence.

The colour change when the water is added to anhydrous copper sulfate

is white to _____ .

(1)

A student heats 2.5 g of hydrate copper sulfate in a test tube.

0.9 g of water is given off.

The remaining solid is anhydrous copper sulfate.

(d) Calculate the mass of anhydrous copper sulfate produced.

_____

_____

Mass of anhydrous copper sulfate = _____ g

(2)

(e) Calculate the percentage of water contained in 2.5 g of hydrated copper sulfate.

_____

_____

_____

Percentage of water = _____ %

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(2)

(f) Draw **one** line from each compound to the formula for the compound.

Compound	Formula for the compound
	CuO
Copper sulfate	CuS
	$CuSO_4$
Water	H_2O
	H_2SO_4

(2)

(Total 8 marks)

Q9.

Older cars are tested each year to measure the amount of pollutants contained in exhaust fumes.

The table below shows the maximum allowed percentages of exhaust pollutants for petrol cars.

Age of car in years	Maximum allowed percentage (%) of exhaust pollutant	
	Carbon monoxide	Unburned hydrocarbons
16−24	0.30	0.02
3−16	0.20	0.02

(a) Explain how carbon monoxide is produced when petrol is burned in car engines.

_____

_____

_____

_____

(2)

(b) Suggest **two** reasons why the maximum allowed percentage of carbon monoxide has been decreased for newer cars.

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1. _____

_____

2. _____

_____

(2)

(c) Give **one** reason for having a maximum allowed percentage of unburned hydrocarbons in exhaust fumes.

_____

_____

(1)

Oxides of nitrogen are also pollutants contained in exhaust fumes.

(d) Describe how oxides of nitrogen are produced when petrol is burned in car engines.

_____

_____

_____

_____

(2)

Catalytic converters are fitted to car exhausts to reduce the amount of pollutants released into the atmosphere.

(e) Nitrogen dioxide is an oxide of nitrogen.

Nitrogen dioxide reacts to produce nitrogen and oxygen in catalytic converters.

Complete the equation for this reaction.

The equation should be balanced.

$$___\ NO_2\,(g) \longrightarrow _____ + ___\ O_2\,(g)$$

(2)

(f) Give **two** effects of atmospheric pollution which are reduced by using catalytic converters.

1. _____

_____

2. _____

_____

(2)

(g) The catalyst in catalytic converters is a mixture of three elements.

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Where in the periodic table are these elements most likely to be found?

Tick **one** box.

Alkali metals ☐

Halogens ☐

Noble gases ☐

Transition metals ☐

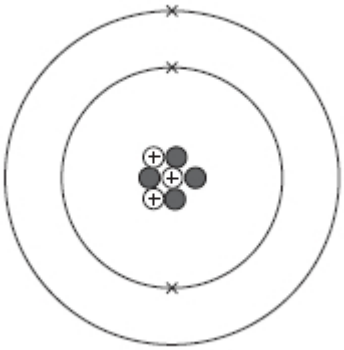
(1)

(Total 12 marks)

Q10.

This question is about atomic structure.

The figure below represents the structure of a lithium atom.



(a) Name the particle in the atom that has a positive charge.

_____

(1)

(b) Name the particle in the atom that has the smallest mass.

_____

(1)

(c) Complete the sentences.

Choose the answers from the box.

3	**4**	**7**	**10**

The mass number of the lithium atom is _____.

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The number of neutrons in the lithium atom is _____.

(2)

(d) What are lithium atoms with different numbers of neutrons called?

Tick (✔) **one** box.

Compounds ☐

Ions ☐

Isotopes ☐

Molecules ☐

(1)

(e) Name the particle in the atom discovered by James Chadwick.

_____ .

(1)

(f) An element has two isotopes.

The table shows information about the isotopes.

	Mass number	**Percentage (%) abundance**
Isotope 1	10	20
Isotope 2	11	80

Calculate the relative atomic mass (A_r) of the element.

Use the equation:

$$A_r = \frac{(\text{mass number} \times \text{percentage}) \text{ of isotope 1} + (\text{mass number} \times \text{percentage}) \text{ of isotope 2}}{100}$$

Give your answer to 1 decimal place.

_____

_____

_____

_____

Relative atomic mass (A_r) = _____

(2)

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(g) The radius of an atom is 0.2 nm

The radius of the nucleus is $\frac{1}{10000}$ the radius of the atom.

Calculate the radius of the nucleus.
Give your answer in standard form.

_____

_____

_____

_____

Radius = _____ nm

(2)

(Total 10 marks)

Q11.

This question is about metal oxides.

When sodium is heated in oxygen, sodium oxide is produced.

(a) Balance the equation for the reaction.

_____ Na + O_2 ⟶ 2 Na_2O

(1)

(b) Why is this an oxidation reaction?

_____

_____

(1)

(c) Sodium oxide is added to water and shaken.
Universal indicator is added.
The pH of the solution is 14

What is the colour of the universal indicator?

Tick (✔) **one** box.

Green ☐

Purple ☐

Red ☐

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Yellow ☐

(1)

(d) Aluminium oxide reacts with hydrochloric acid to produce a salt.

What is the name of the salt produced?

Tick (✔) **one** box.

Aluminium chloride ☐

Aluminium nitrate ☐

Aluminium sulfate ☐

Aluminium sulfide ☐

(1)

A student investigates the solubility of four metal oxides and four non-metal oxides in water.

The student tests the pH of the solutions formed.

The table shows the student's results.

Type of oxide	Oxide	Solubility in water	pH of solution
Metal oxides	Sodium oxide	Soluble	14
	Calcium oxide	Soluble	10
	Magnesium oxide	Slightly soluble	9
	Zinc oxide	Insoluble	No solution formed
Non-metal oxides	Carbon dioxide	Soluble	5
	Sulfur dioxide	Soluble	2
	Phosphorus oxide	Soluble	1
	Silicon dioxide	Insoluble	No solution formed

The student makes two conclusions.

Conclusion 1: 'All metal oxides produce alkaline solutions.'

Conclusion 2: 'All non-metal oxides produce acidic solutions.'

(e) Explain why the student's conclusions are only partly correct.

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Use information from the table above.

(4)

(f) Give an improved conclusion for metal oxides.

Use the table above.

(2)

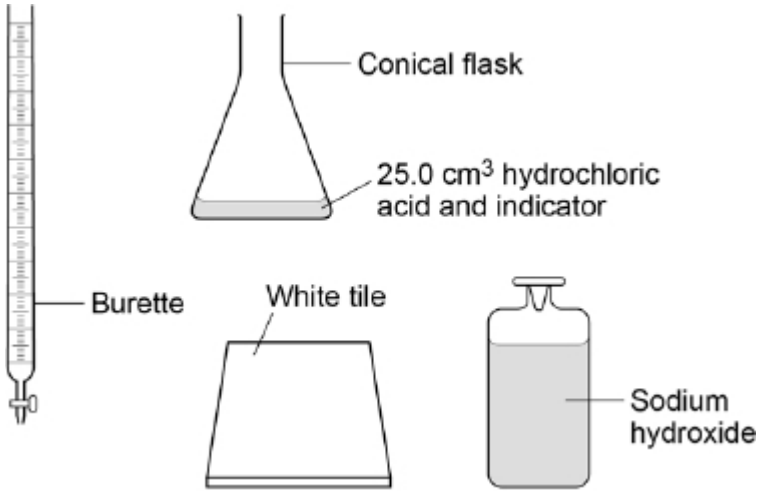
(Total 9 marks)

Q12.

Sodium hydroxide reacts with hydrochloric acid.

The diagram shows apparatus that can be used to find the volume of sodium hydroxide reacting with 25.0 cm^3 hydrochloric acid.

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(a) Describe a method to find the exact volume of sodium hydroxide that reacts with 25.0 cm^3 of hydrochloric acid.

(6)

The reaction produces a solution of sodium chloride.

A student wants to obtain sodium chloride crystals from the sodium chloride solution.

This is the method used.

1. Add solid charcoal to the sodium chloride solution to remove the indicator colour.
2. Remove the solid charcoal.
3. Evaporate the solution to dryness over a Bunsen burner.

(b) Charcoal is not soluble in water.

Suggest a method the student could use to remove the solid charcoal in **Step 2**.

_____

_____

(1)

(c) The student obtains a powdery white solid.

Suggest how the student could improve **Step 3** of the method to obtain larger crystals instead of powder.

_____

_____

(1)

(Total 8 marks)

Q13.

A student investigated the law of conservation of mass.

The law of conservation of mass states that the mass of the products is equal to the mass of the reactants.

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This is the method used.

1. Pour lead nitrate solution into a beaker labelled **A**.
2. Pour potassium chromate solution into a beaker labelled **B**.
3. Measure the mass of both beakers and contents.
4. Pour the solution from beaker **B** into beaker **A**.
5. Measure the mass of both beakers and contents again.

When lead nitrate solution and potassium chromate solution are mixed, a reaction takes place.

This is the equation for the reaction:

$$Pb(NO_3)_2(aq) + K_2CrO_4(aq) \longrightarrow PbCrO_4(s) + 2KNO_3(aq)$$

(a) What would the student see when the reaction takes place?

_____

_____

(1)

(b) The table shows the student's results.

	Mass in g
Beaker **A** and contents before mixing	128.71
Beaker **B** and contents before mixing	128.97
Beaker **A** and contents after mixing	154.10
Beaker **B** after mixing	103.58

Show that the law of conservation of mass is true.

Use the data from the table above.

_____

_____

_____

_____

(2)

(c) What is the resolution of the balance used to obtain the results in the table?

Tick (✔) **one** box.

0.01 g ☐ 0.1 g ☐ 1 g ☐ 100 g ☐

(1)

(d) Calculate the relative formula mass (M_r) of lead nitrate $Pb(NO_3)_2$

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Relative atomic masses (A_r): N = 14 O = 16 Pb = 207

Relative formula mass = _____

(2)

(e) The formula of potassium chromate is K_2CrO_4

The charge on the potassium ion is +1

What is the formula of the chromate ion?

Tick (✔) **one** box.

CrO_4^+ ☐

CrO_4^{2+} ☐

CrO_4^- ☐

CrO_4^{2-} ☐

(1)

(f) Another student also tests the law of conservation of mass using the same method.

The student uses a different reaction.

This is the equation for the reaction.

$$Na_2CO_3(aq) + 2HCl(aq) \longrightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

Explain why this student's results would **not** appear to support the law of conservation of mass.

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(3)
(Total 10 marks)

Q14.

This question is about atoms.

(a) What does the number 19 represent in $^{19}_{9}F$?

_____

(1)

(b) How many atoms are present in one mole of fluorine atoms?

Tick (✔) **one** box.

2.03×10^{26} ☐

2.06×10^{23} ☐

6.02×10^{23} ☐

6.02×10^{26} ☐

(1)

(c) The plum pudding model of the atom was replaced by the nuclear model.

The nuclear model was developed after the alpha particle scattering experiment.

Compare the plum pudding model with the nuclear model of the atom.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(d) An element has three isotopes.

The table shows the mass numbers and percentage of each isotope.

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	Isotope 1	Isotope 2	Isotope 3
Mass number	24	25	26
Percentage (%)	78.6	10.1	11.3

Calculate the relative atomic mass (A_r) of the element.

Give your answer to 3 significant figures.

Relative atomic mass = _____

(2)

(Total 8 marks)

Q15.

A scientist produces zinc iodide (ZnI_2).

This is the method used.

1. Weigh 0.500 g of iodine.
2. Dissolve the iodine in ethanol.
3. Add an excess of zinc.
4. Stir the mixture until there is no further change.
5. Filter off the excess zinc.
6. Evaporate off the ethanol.

(a) Ethanol is flammable.

Suggest how the scientist could carry out **Step 6** safely.

(1)

(b) Explain why the scientist adds excess zinc rather than excess iodine.

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_____

(3)

(c) Calculate the minimum mass of zinc that needs to be added to 0.500 g of iodine so that the iodine fully reacts.

The equation for the reaction is:

$$Zn + I_2 \longrightarrow ZnI_2$$

Relative atomic masses (M_r): Zn = 65 I = 127

_____

_____

_____

_____

_____

_____

Minimum mass of zinc = _____ g

(3)

A different scientist makes zinc iodide by the same method.

The scientist obtains 12.5 g of zinc iodide.

The percentage yield in this reaction is 92.0%.

(d) What is the maximum theoretical mass of zinc iodide produced in this reaction?

_____

_____

_____

_____

_____

_____

Maximum theoretical mass = _____ g

(3)

(e) Suggest **one** reason why the percentage yield in this reaction is **not** 100%.

_____

_____

(1)

(f) The scientist makes a solution of zinc iodide with a concentration of 0.100 mol / dm^3

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Calculate the mass of zinc iodide (ZnI_2) required to make 250 cm^3 of this solution.

Relative atomic masses (A_r): Zn = 65 I = 127

_____

_____

_____

_____

_____

_____

Mass = _____ g

(3)

(Total 14 marks)

Q16.

Cells contain chemicals which react to produce electricity.

(a) Why can a rechargeable cell be recharged?

_____

_____

(1)

(b) Give **two** factors that affect the voltage produced by a cell.

1. _____

2. _____

(2)

(c) Balance the half-equation for the reaction occurring at an electrode in one type of hydrogen fuel cell.

$$H_2 \quad + \quad OH^- \quad \longrightarrow \quad H_2O \quad + \quad e^-$$

(1)

(d) Why is the fuel cell in Question (c) described as an alkaline fuel cell?

_____

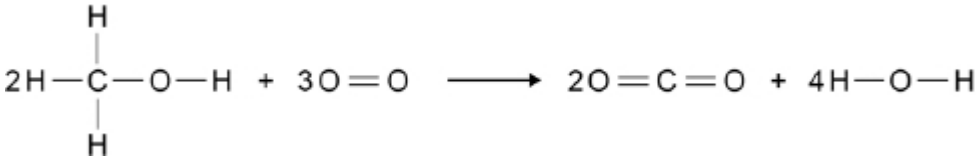
_____

(1)

(e) Another type of fuel cell uses methanol instead of hydrogen.

The diagram represents the reaction in this fuel cell.

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The table shows the bond energies for the reaction.

	C–H	C–O	O–H	O=O	C=O
Bond energy in kJ / mol	412	360	464	498	805

Calculate the overall energy change for the reaction.

Use the diagram and the table above.

_____

_____

_____

_____

_____

_____

Overall energy change = _____ kJ / mol

(3)

(Total 8 marks)

Q17.

The figure below shows magnesium burning in air.



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© Charles D Winters/Science Photo Library

(a) Look at the figure above.

How can you tell that a chemical reaction is taking place?

_____

_____

(1)

(b) Name the product from the reaction of magnesium in the figure.

_____

(1)

(c) The magnesium needed heating before it would react.

What conclusion can you draw from this?

Tick **one** box.

- The reaction is reversible ☐
- The reaction has a high activation energy ☐
- The reaction is exothermic ☐
- Magnesium has a high melting point ☐

(1)

(d) A sample of the product from the reaction in the figure above was added to water and shaken.

Universal indicator was added.

The universal indicator turned blue.

What is the pH value of the solution?

Tick **one** box.

- 1 ☐
- 4 ☐
- 7 ☐
- 9 ☐

(1)

(e) Why are nanoparticles effective in very small quantities?

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Tick **one** box.

They are elements ☐

They are highly reactive ☐

They have a low melting point ☐

They have a high surface area to volume ratio ☐

(1)

(f) Give **one** advantage of using nanoparticles in sun creams.

_____

_____

(1)

(g) Give **one** disadvantage of using nanoparticles in sun creams.

_____

_____

(1)

(h) A coarse particle has a diameter of 1×10^{-6} m.
A nanoparticle has a diameter of 1.6×10^{-9} m.

Calculate how many times bigger the diameter of the coarse particle is than the diameter of the nanoparticle.

_____

_____

_____

_____

(2)

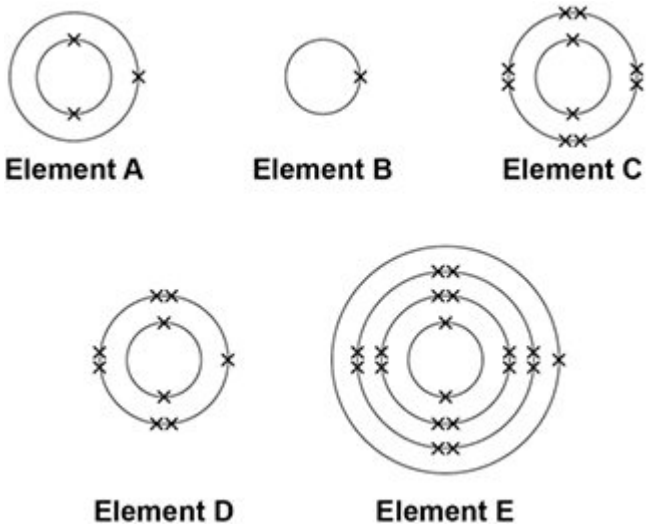
(Total 9 marks)

Q18.

The electronic structure of the atoms of five elements are shown in the figure below.

The letters are **not** the symbols of the elements.

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Choose the element to answer the question. Each element can be used once, more than once or not at all.

Use the periodic table to help you.

(a) Which element is hydrogen?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(b) Which element is a halogen?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(c) Which element is a metal in the same group of the periodic table as element **A**?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(d) Which element exists as single atoms?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(e) There are two isotopes of element **A**. Information about the two isotopes is shown in the table below.

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Mass number of the isotope	6	7
Percentage abundance	92.5	7.5

Use the information in the table above above to calculate the relative atomic mass of element **A**.
Give your answer to 2 decimal places.

_____

_____

_____

_____

_____

_____

_____

Relative atomic mass = _____

(4)

(Total 8 marks)

Q19.

An atom of aluminium has the symbol $^{27}_{13}Al$

(a) Give the number of protons, neutrons and electrons in this atom of aluminium.

Number of protons _____

Number of neutrons _____

Number of electrons _____

(3)

(b) Why is aluminium positioned in Group 3 of the periodic table?

_____

_____

(1)

(c) In the periodic table, the transition elements and Group 1 elements are metals.

Some of the properties of two transition elements and two Group 1 elements are shown in the table below.

	Transition elements		**Group 1 elements**	
	Chromium	Iron	Sodium	Caesium

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Melting point in °C	1857	1535	98	29
Formula of oxides	CrO Cr_2O_3 CrO_2 CrO_3	FeO Fe_2O_3 Fe_3O_4	Na_2O	Cs_2O

Use your own knowledge **and** the data in the table above to compare the chemical and physical properties of transition elements and Group 1 elements.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 10 marks)

Q20.

Rock salt is a mixture of sand and salt.

Salt dissolves in water. Sand does **not** dissolve in water.

Some students separated rock salt.

This is the method used.

1. Place the rock salt in a beaker.
2. Add 100 cm^3 of cold water.
3. Allow the sand to settle to the bottom of the beaker.
4. Carefully pour the salty water into an evaporating dish.
5. Heat the contents of the evaporating dish with a Bunsen burner until salt crystals start to form.

(a) Suggest **one** improvement to step 2 to make sure all the salt is dissolved in the water.

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_____

_____

(1)

(b) The salty water in step 4 still contained very small grains of sand.

Suggest **one** improvement to step 4 to remove all the sand.

_____

_____

(1)

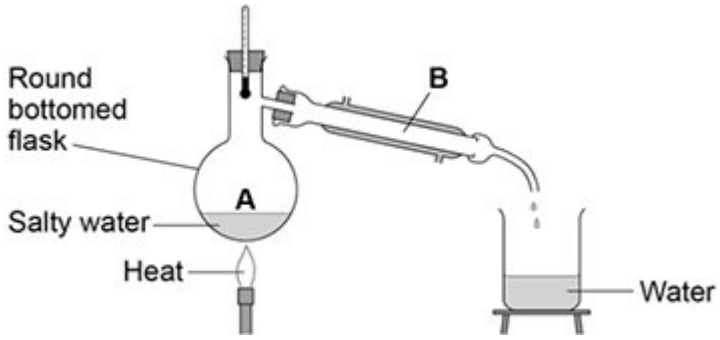
(c) Suggest **one** safety precaution the students should take in step 5.

_____

_____

(1)

(d) Another student removed water from salty water using the apparatus in the figure below.



Describe how this technique works by referring to the processes at **A** and **B**.

_____

_____

_____

_____

(2)

(e) What is the reading on the thermometer during this process?

_____ °C

(1)

(Total 6 marks)

Q21.

This question is about halogens and their compounds.

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The table below shows the boiling points and properties of some of the elements in Group 7 of the periodic table.

Element	Boiling point in °C	Colour in aqueous solution
Fluorine	−188	colourless
Chlorine	−35	pale green
Bromine	X	orange
Iodine	184	brown

(a) Why does iodine have a higher boiling point than chlorine?

Tick **one** box.

Iodine is ionic and chlorine is covalent ☐

Iodine is less reactive than chlorine ☐

The covalent bonds between iodine atoms are stronger ☐

The forces between iodine molecules are stronger ☐

(1)

(b) Predict the boiling point of bromine.

_____

(1)

(c) A redox reaction takes place when aqueous chlorine is added to potassium iodide solution.

The equation for this reaction is:

$$Cl_2(aq) + 2KI(aq) \rightarrow I_2(aq) + 2KCl(aq)$$

Look at table above.

What is the colour of the final solution in this reaction?

Tick **one** box.

Brown ☐

Orange ☐

Pale green ☐

Colourless ☐

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(1)

(d) What is the ionic equation for the reaction of chlorine with potassium iodide?

Tick **one** box.

$Cl_2 + 2K \rightarrow 2KCl$ ☐

$2I^- + Cl_2 \rightarrow I_2 + 2Cl^-$ ☐

$I^- + Cl \rightarrow I + Cl^-$ ☐

$I^- + K^+ \rightarrow KI$ ☐

(1)

(e) Why does potassium iodide solution conduct electricity?

Tick **one** box.

It contains a metal ☐

It contains electrons which can move ☐

It contains ions which can move ☐

It contains water ☐

(1)

(f) What are the products of electrolysing potassium iodide solution?

Tick **one** box.

Product at cathode	**Product at anode**	
hydrogen	iodine	☐
hydrogen	oxygen	☐
potassium	iodine	☐
potassium	oxygen	☐

(1)

(Total 6 marks)

Q22.

This question is about the reaction of ethene and bromine.

The equation for the reaction is:

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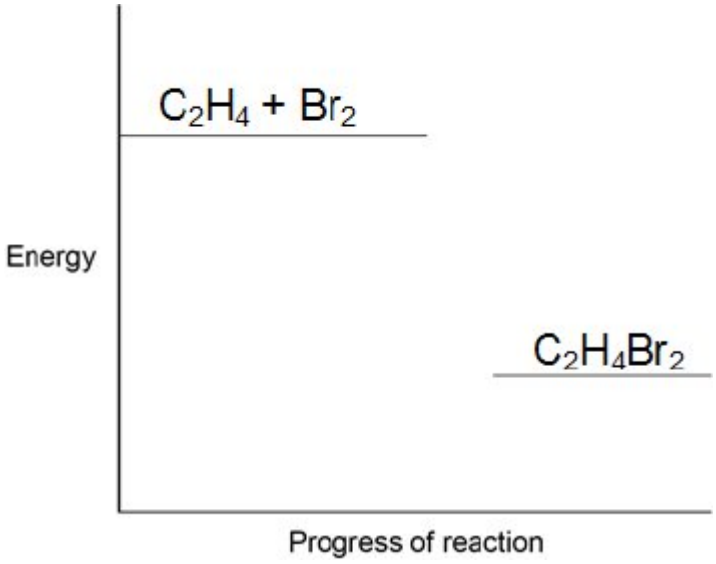
$$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$$

(a) Complete the reaction profile in **Figure 1**.

Draw labelled arrows to show:

- The energy given out (ΔH)
- The activation energy.

Figure 1



(3)

(b) When ethene reacts with bromine, energy is required to break covalent bonds in the molecules.

Explain how a covalent bond holds two atoms together.

_____

_____

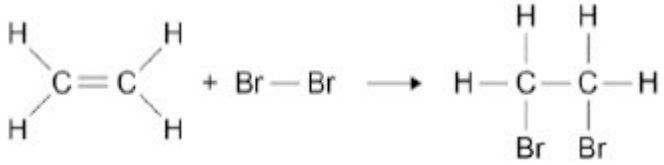
_____

_____

(2)

(c) **Figure 2** shows the displayed formulae for the reaction of ethene with bromine.

Figure 2



The bond enthalpies and the overall energy change are shown in the table below.

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	C=C	C–H	C–C	C–Br	Overall energy change
Energy in kJ / mole	612	412	348	276	−95

Use the information in the table above and **Figure 2** to calculate the bond energy for the Br–Br bond.

_____

_____

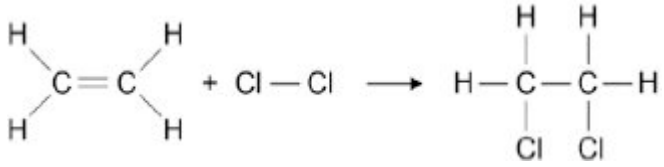
_____

Bond energy _____ kJ / mole

(3)

(d) **Figure 3** shows the reaction between ethene and chlorine and is similar to the reaction between ethene and bromine.

Figure 3



“The more energy levels (shells) of electrons an atom has, the weaker the covalent bonds that it forms.”

Use the above statement to predict and explain how the overall energy change for the reaction of ethene with chlorine will differ from the overall energy change for the reaction of ethene with bromine.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

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(Total 14 marks)

Q23.

This question is about mixtures and analysis.

(a) Which **two** substances are mixtures?

Tick **two** boxes.

Air	☐
Carbon dioxide	☐
Graphite	☐
Sodium Chloride	☐
Steel	☐

(2)

(b) Draw **one** line from each context to the correct meaning.

Context	Meaning
	A substance that has had nothing added to it
Pure substance in chemistry	A single element or a single compound
	A substance containing only atoms which have different numbers of protons
Pure substance in everyday life	A substance that can be separated by filtration
	A useful product made by mixing substances

(2)

(c) What is the test for chlorine gas?

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Tick **one** box.

A glowing splint relights ☐

A lighted splint gives a pop ☐

Damp litmus paper turns white ☐

Limewater turns milky ☐

(1)

(d) A student tested a metal chloride solution with sodium hydroxide solution.

A brown precipitate formed.

What was the metal ion in the metal chloride solution?

Tick **one** box.

Calcium ☐

Copper(II) ☐

Iron(II) ☐

Iron(III) ☐

(1)

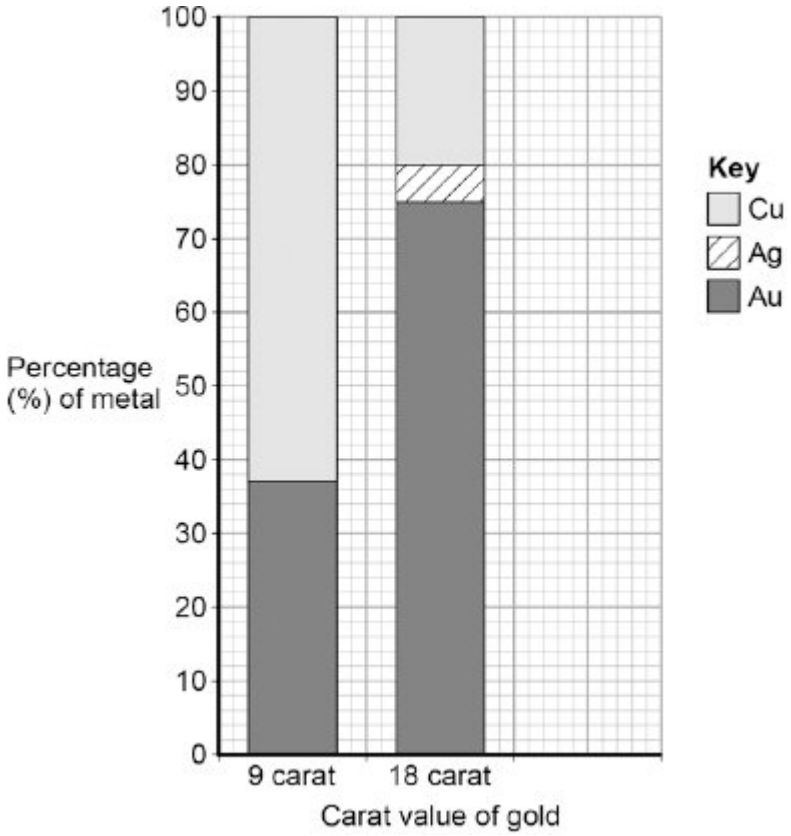
(Total 6 marks)

Q24.

Gold is mixed with other metals to make jewellery.

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

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(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)

Q25.

The table below gives information about four alcohols.

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Alcohol	Formula	Melting point in °C	Boiling point in °C
Methanol	CH_3OH	−94	65
Ethanol	CH_3CH_2OH	−118	78
Propanol	$CH_3CH_2CH_2OH$	−129	97
Butanol	$CH_3CH_2CH_2CH_2OH$	−89	118

(a) Which alcohol in the table is liquid over the greatest temperature range?

_____

(1)

(b) Which statement is correct?

Tick **one** box.

A molecule of ethanol has 5 hydrogen atoms ☐

Butanol has the highest boiling point ☐

Methanol has the largest molecules ☐

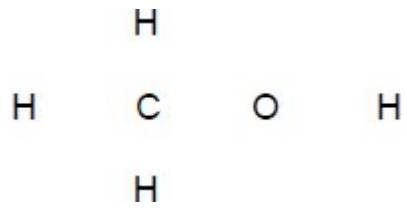
Propanol has the highest melting point ☐

(1)

(c) A molecule of methanol has five single covalent bonds.

Draw the missing bonds in **Figure 1** to complete the displayed formula for methanol.

Figure 1

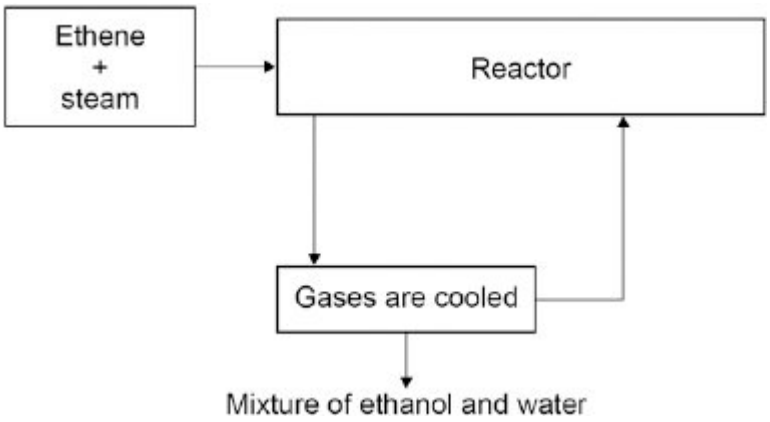


(1)

(d) **Figure 2** shows a flow diagram of the process to produce ethanol.

Figure 2

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Complete the word equation for the reaction to produce ethanol.

_____ + _____ → ethanol

(1)

(e) What happens to the unreacted ethene?

_____

_____

(1)

(f) Wine contains ethanol.
A bottle of wine was left open in air.
After a few days, the wine tasted of vinegar.
Vinegar is a solution of ethanoic acid in water.

Explain how oxidation causes the wine to taste of vinegar after a few days.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q26.

This question is about hydrocarbons.

(a) The names and formulae of three hydrocarbons in the same homologous series are:

Ethane C_2H_6

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Propane	C_3H_8
Butane	C_4H_{10}

The next member in the series is pentane.

What is the formula of pentane?

_____

(1)

(b) Which homologous series contains ethane, propane and butane?

Tick **one** box.

Alcohols	☐
Alkanes	☐
Alkenes	☐
Carboxylic acids	☐

(1)

(c) Propane (C_3H_8) is used as a fuel.

Complete the equation for the complete combustion of propane.

$C_3H_8 \quad + \quad 5O_2 \quad \rightarrow \quad 3$ _____ + 4 _____

(2)

(d) Octane (C_8H_{18}) is a hydrocarbon found in petrol.

Explain why octane is a hydrocarbon.

_____

_____

(2)

(e) The table below gives information about the pollutants produced by cars using diesel or petrol as a fuel.

Fuel	**Relative amounts of pollutants**		
	Oxides of Nitrogen	**Particulate matter**	**Carbon dioxide**
Diesel	31	100	85
Petrol	23	0	100

Compare the pollutants from cars using diesel with those from cars using petrol.

_____

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_____

_____

_____

_____

_____

(3)

(f) Pollutants cause environmental impacts.

Draw **one** line from each pollutant to the environmental impact caused by the pollutant.

Pollutant	**Environmental impact caused by the pollutant**
	Acid rain
Oxides of nitrogen	Flooding
	Global dimming
Particulate matter	Global warming
	Photosynthesis

(2)

(Total 11 marks)

Q27.

Water from a lake in the UK is used to produce drinking water.

(a) What are the two main steps used to treat water from lakes?

Give a reason for each step.

Step 1 _____

Reason _____

Step 2 _____

Reason _____

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(2)

(b) Explain why it is more difficult to produce drinking water from waste water than from water in lakes.

_____

_____

_____

_____

_____

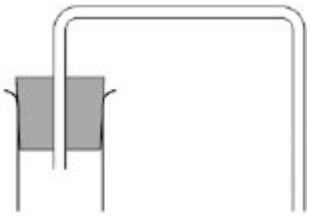
_____

(3)

(c) Some countries make drinking water from sea water.

Complete the figure below to show how you can distil salt solution to produce and collect pure water.

Label the following:
- pure water
- salt solution



(3)

(d) How could the water be tested to show it is pure?

Give the expected result of the test for pure water.

_____

_____

_____

_____

_____

(2)

(e) Why is producing drinking water from sea water expensive?

_____

_____

(1)

(Total 11 marks)

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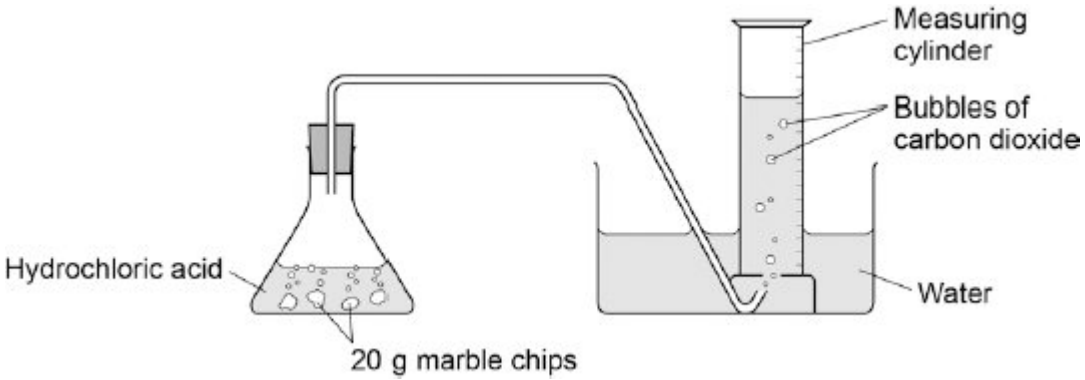
Q28.

Marble chips are mainly calcium carbonate ($CaCO_3$).

A student investigated the rate of reaction between marble chips and hydrochloric acid (HCl).

Figure 1 shows the apparatus the student used.

Figure 1



(a) Complete and balance the equation for the reaction between marble chips and hydrochloric acid.

_____ + _____ → $CaCl_2$ + _____ + _____

(2)

(b) The table below shows the student's results.

Time in s	Volume of gas in dm^3
0	0.000
30	0.030
60	0.046
90	0.052
120	0.065
150	0.070
180	0.076
210	0.079
240	0.080
270	0.080

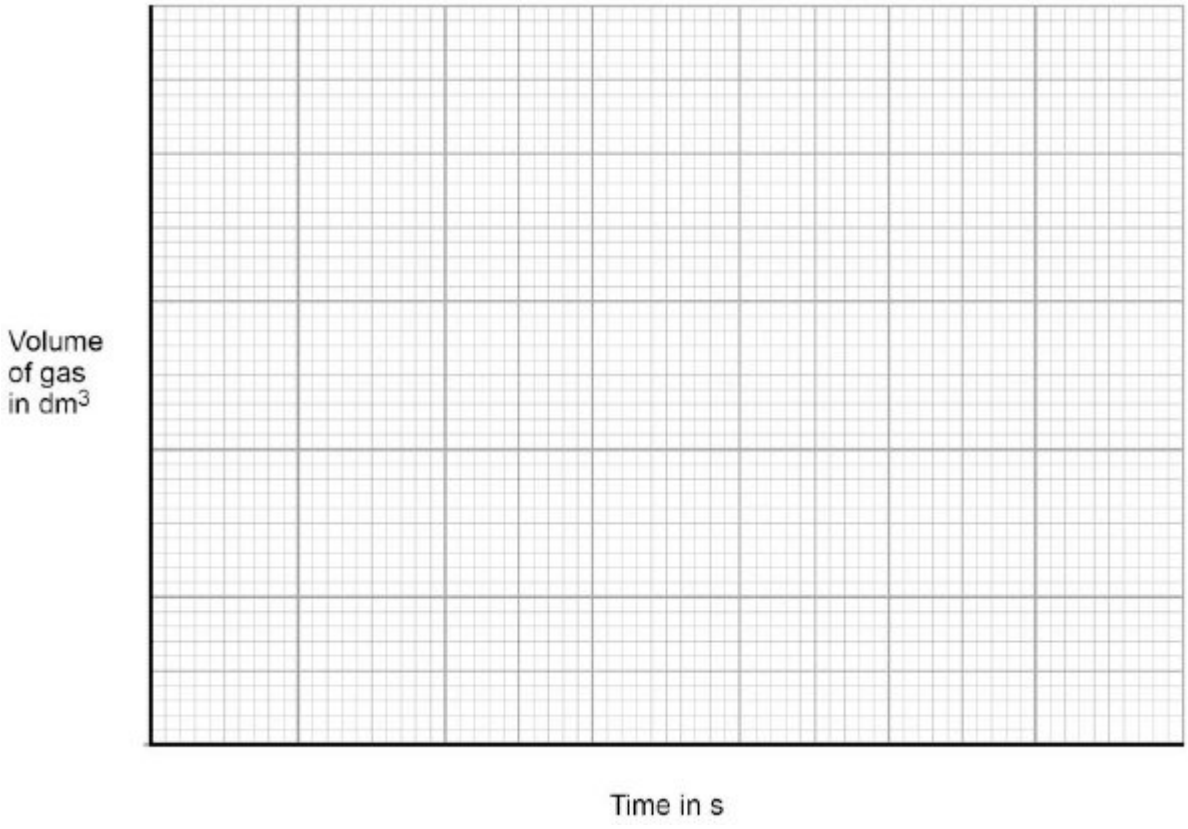
On **Figure 2**:

- Plot these results on the grid.

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- Draw a line of best fit.

Figure 2



(4)

(c) Sketch a line on the grid in **Figure 2** to show the results you would expect if the experiment was repeated using 20 g of smaller marble chips.

Label this line **A**.

(2)

(d) Explain, in terms of particles, how and why the rate of reaction changes during the reaction of calcium carbonate with hydrochloric acid.

_____

_____

_____

_____

_____

_____

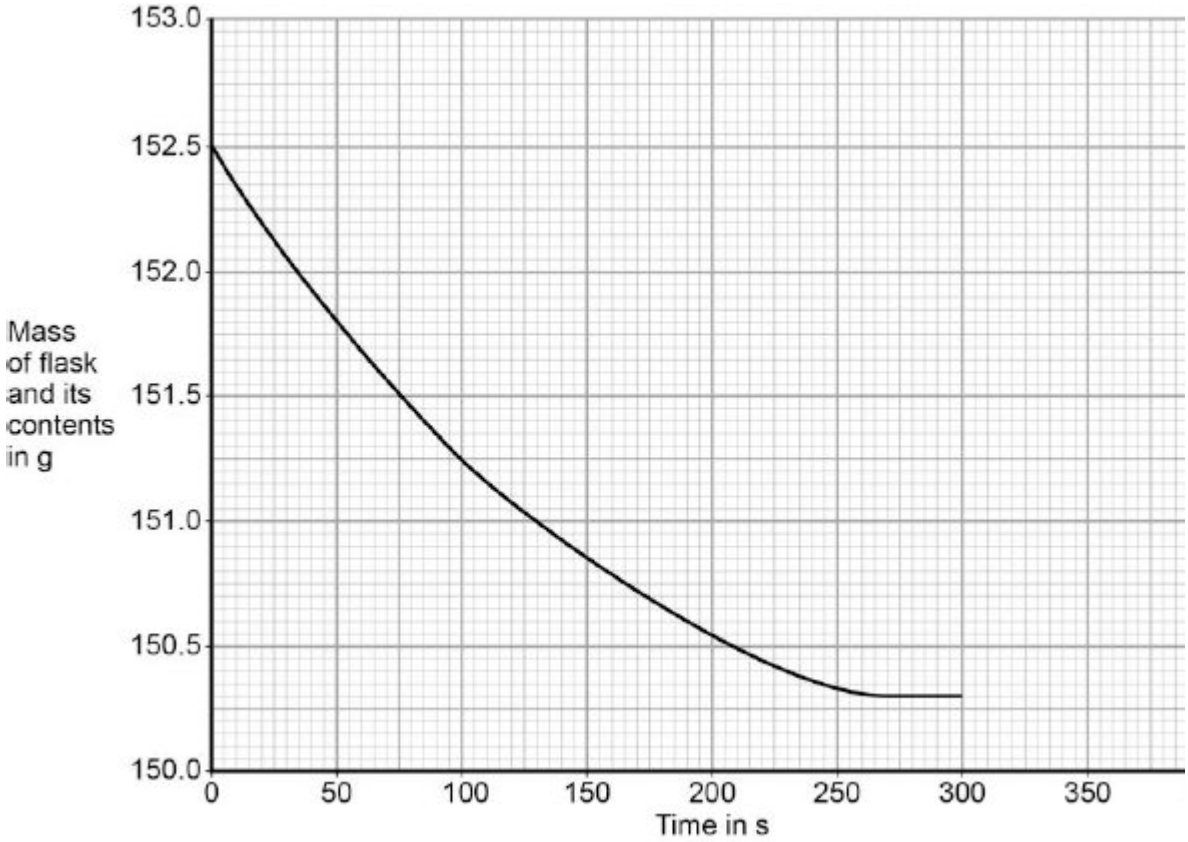
(4)

(e) Another student investigated the rate of reaction by measuring the change in mass.

Figure 3 shows the graph plotted from this student's results.

Figure 3

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Use **Figure 3** to calculate the mean rate of the reaction up to the time the reaction is complete.

Give your answer to three significant figures.

_____

_____

_____

_____

_____

_____

_____

_____

Mean rate of reaction = _____ g / s

(4)

(f) Use **Figure 3** to determine the rate of reaction at 150 seconds.

Show your working on **Figure 3**.

Give your answer in standard form.

_____

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_____

_____

_____

_____

Rate of reaction at 150 s = _____ g / s

(4)

(Total 20 marks)

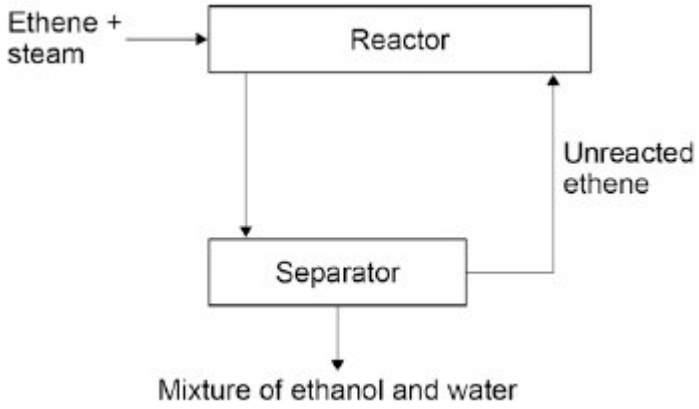
Q29.

In industry ethanol is produced by the reaction of ethene and steam at 300°C and 60 atmospheres pressure using a catalyst.

The equation for the reaction is:

$$C_2H_4\ (g) + H_2O\ (g) \rightleftharpoons C_2H_5OH\ (g)$$

The figure below shows a flow diagram of the process.



(a) Why does the mixture from the separator contain ethanol and water?

_____

_____

(1)

(b) The forward reaction is exothermic.

Use Le Chatelier's Principle to predict the effect of increasing temperature on the amount of ethanol produced at equilibrium.

Give a reason for your prediction.

_____

_____

_____

_____

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(2)

(c) Explain how increasing the pressure of the reactants will affect the amount of ethanol produced at equilibrium.

_____

_____

_____

_____

(2)

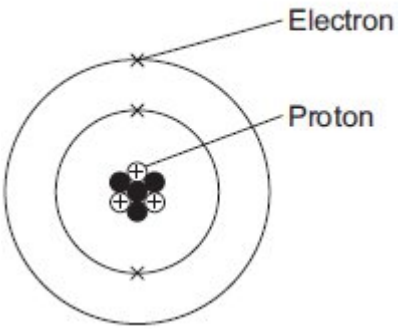
(Total 5 marks)

Q30.

There are eight elements in the second row (lithium to neon) of the periodic table.

(a) **Figure 1** shows a lithium atom.

Figure 1



(i) What is the mass number of the lithium atom in **Figure 1**?

Tick (✔) **one** box.

3 ☐

4 ☐

7 ☐

(1)

(ii) What is the charge of an electron?

Tick (✔) **one** box.

–1 ☐

0 ☐

+1 ☐

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(1)

(iii) Protons are in the nucleus.

Which other sub-atomic particles are in the nucleus?

Tick (✔) **one** box.

ions ☐

molecules ☐

neutrons ☐

(1)

(b) What is **always** different for atoms of different elements?

Tick (✔) **one** box.

number of neutrons ☐

number of protons ☐

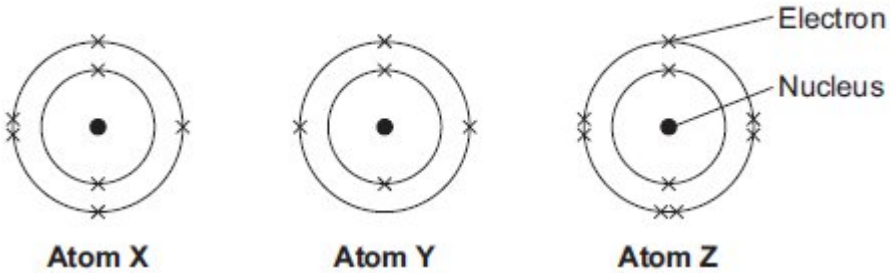
number of shells ☐

(1)

(c) **Figure 2** shows the electron arrangements of three different atoms, **X**, **Y** and **Z**.

These atoms are from elements in the second row (lithium to neon) of the periodic table.

Figure 2



Which atom is from an element in Group 3 of the periodic table?

Tick (✔) **one** box.

Atom X ☐

Atom Y ☐

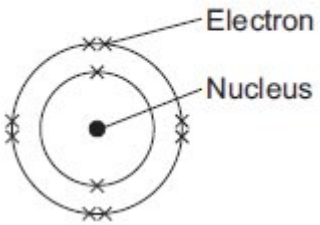
Atom Z ☐

(1)

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(d) **Figure 3** shows the electron arrangement of a different atom from an element in the second row of the periodic table.

Figure 3



(i) Give the chemical symbol of this element.

_____

(1)

(ii) Why is this element unreactive?

_____

_____

(1)

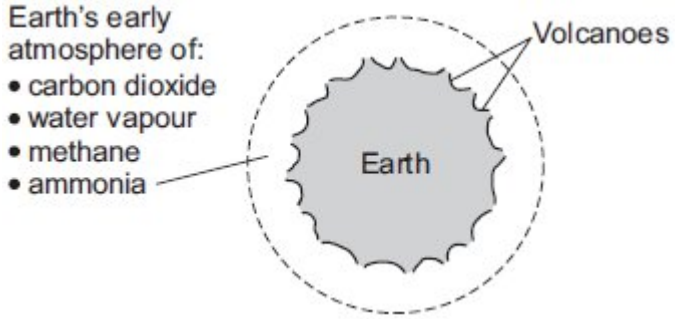
(Total 7 marks)

Q31.

This question is about the Earth and its atmosphere.

(a) **Figure 1** shows the Earth and its atmosphere billions of years ago.

Figure 1



The boiling point of water is 100 °C.

Suggest **one** reason why there was no liquid water on the Earth's surface billions of years ago.

_____

_____

(1)

(b) The Earth's atmosphere today contains nitrogen, oxygen, argon, carbon dioxide and other gases.

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(i) Draw **one** line from each substance to a description of the substance.

Substance	Description of the substance
air	compound
carbon dioxide	element
argon	hydrocarbon
	metal
	mixture

(3)

(ii) Which gas in the Earth's atmosphere is used when hydrocarbons burn?

Tick (✔) **one** box.

- carbon dioxide ☐
- nitrogen ☐
- oxygen ☐

(1)

(iii) What percentage of the Earth's atmosphere is nitrogen?

Tick (✔) **one** box.

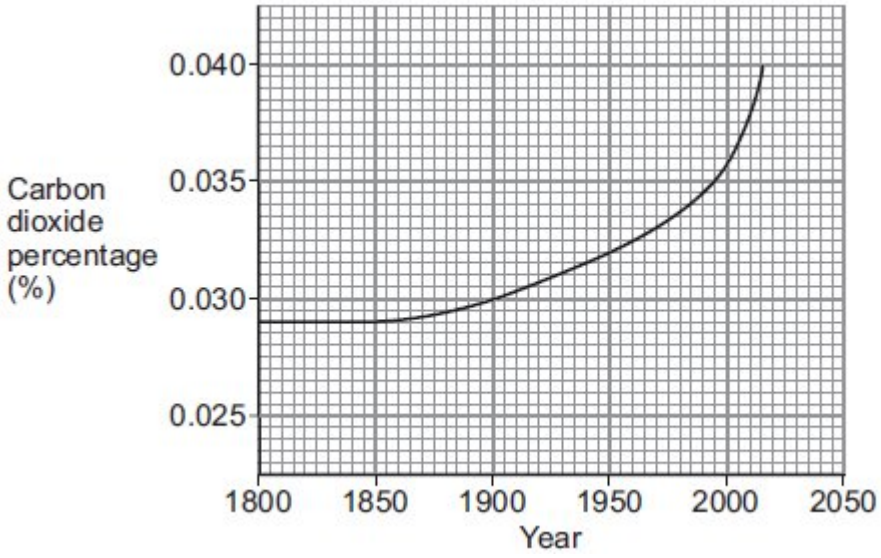
- about 40% ☐
- about 60% ☐
- about 80% ☐

(1)

(c) **Figure 2** shows the carbon dioxide percentage (%) in the Earth's atmosphere since the year 1800.

Figure 2

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(i) What was the carbon dioxide percentage in 1900?

_____ %

(1)

(ii) Describe, in detail, how the carbon dioxide percentage changed from 1900 to 2015.

_____

_____

_____

_____

(2)

(iii) Suggest **two** reasons for the change in the carbon dioxide percentage from 1900 to 2015.

1. _____

_____

2. _____

_____

(2)

(Total 11 marks)

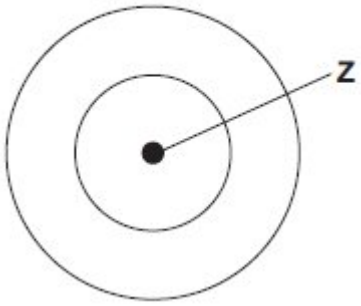
Q32.

There are eight elements in the second row (lithium to neon) of the periodic table.

(a) **Figure 1** shows an atom with two energy levels (shells).

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Figure 1



(i) Complete **Figure 1** to show the electronic structure of a boron atom.

(1)

(ii) What does the central part labelled **Z** represent in **Figure 1**?

_____

(1)

(iii) Name the sub-atomic particles in part **Z** of a boron atom.

Give the relative charges of these sub-atomic particles.

_____

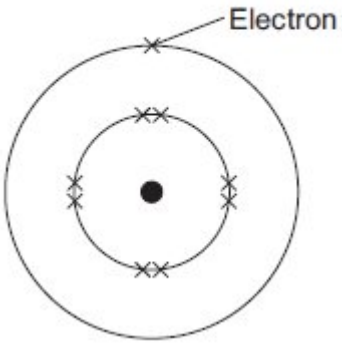
_____

_____

(3)

(b) The electronic structure of a neon atom shown in **Figure 2** is **not** correct.

Figure 2



Explain what is wrong with the electronic structure shown in **Figure 2**.

_____

_____

_____

_____

_____

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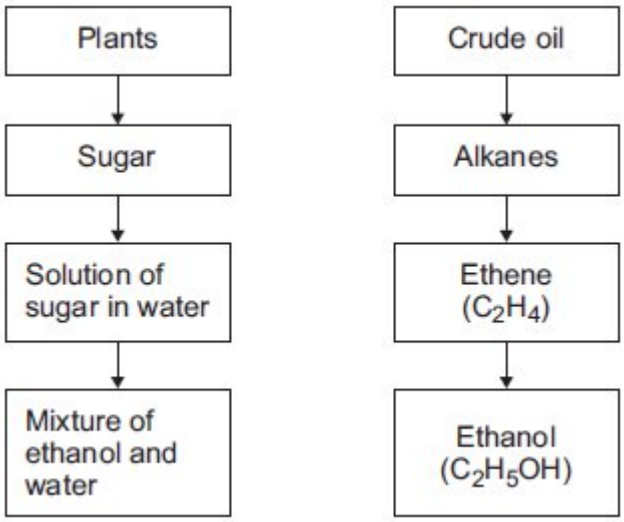
_____

(3)

(Total 8 marks)

Q33.

Ethanol can be made from plants and from crude oil as shown in the diagram below.



(a) Describe how the solution of sugar in water is used to produce the mixture of ethanol and water.

_____

_____

_____

_____

(2)

(b) Ethanol has a boiling point of 78 °C.
Water has a boiling point of 100 °C.

Describe how distillation is used to separate a mixture of ethanol and water.

_____

_____

_____

_____

_____

(3)

(Total 5 marks)

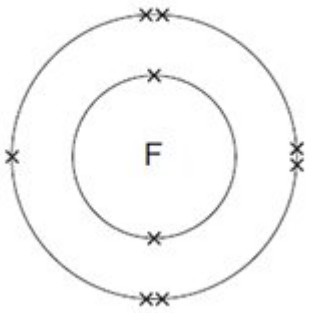
Q34.

This question is about fluorine.

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(a) **Figure 1** shows the arrangement of electrons in a fluorine atom.

Figure 1



(i) In which group of the periodic table is fluorine?

Group _____

(1)

(ii) Complete the table below to show the particles in an atom and their relative masses.

Name of particle	Relative mass
Proton	
Neutron	1
	Very small

(2)

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

alkalis	**alloys**	**isotopes**

Atoms of fluorine with different numbers of neutrons are

called _____ .

(1)

(b) Sodium reacts with fluorine to produce sodium fluoride.

(i) Complete the word equation for this reaction.

sodium + _____ → _____

(1)

(ii) Complete the sentence.

Substances in which atoms of two or more different elements are chemically

combined are called _____ .

(1)

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(iii) The relative formula mass (M_r) of sodium fluoride is 42.

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

ion	mole	molecule

The relative formula mass (M_r), in grams, of sodium fluoride is one

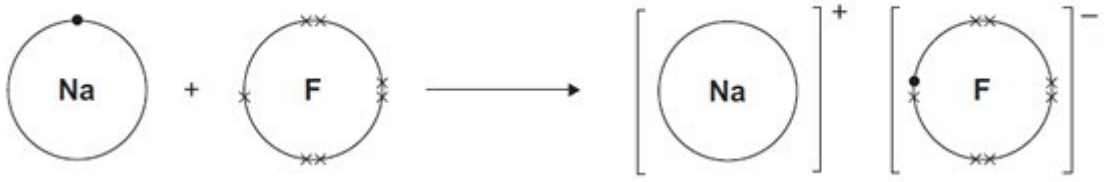
_____ of the substance.

(1)

(iv) **Figure 2** shows what happens to the electrons in the outer shells when a sodium atom reacts with a fluorine atom.

The dots (•) and crosses (×) represent electrons.

Figure 2



Use **Figure 2** to help you answer this question.

Describe, as fully as you can, what happens when sodium reacts with fluorine to produce sodium fluoride.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(v) Sodium fluoride is an ionic substance.

What are **two** properties of ionic substances?

Tick (✔) **two** boxes.

Dissolve in water ☐

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Gas at room temperature	☐
High melting point	☐
Low boiling point	☐

(2)

(Total 13 marks)

Q35.

This question is about atoms, molecules and nanoparticles.

(a) Different atoms have different numbers of sub-atomic particles.

(i) An oxygen atom can be represented as $^{16}_{8}O$

Explain why the mass number of this atom is 16.

You should refer to the numbers of sub-atomic particles in the nucleus of the atom.

_____

_____

_____

_____

_____

_____

(2)

(ii) Explain why $^{12}_{6}C$ and $^{14}_{6}C$ are isotopes of carbon.

You should refer to the numbers of sub-atomic particles in the nucleus of each isotope.

_____

_____

_____

_____

_____

_____

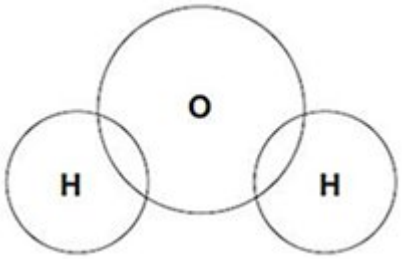
(3)

(b) Hydrogen atoms and oxygen atoms chemically combine to produce water molecules.

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(i) Complete the figure below to show the arrangement of the outer shell electrons of the hydrogen and oxygen atoms in a molecule of water.

Use dots (•) or crosses (×) to represent the electrons.



(2)

(ii) Name the type of bonding in a molecule of water.

_____

(1)

(iii) Why does pure water **not** conduct electricity?

_____

_____

(1)

(c) Nanoparticles of cobalt oxide can be used as catalysts in the production of hydrogen from water.

(i) How does the size of a nanoparticle compare with the size of an atom?

_____

_____

(1)

(ii) Suggest **one** reason why 1 g of cobalt oxide nanoparticles is a better catalyst than 1g of cobalt oxide powder.

_____

_____

(1)

(Total 11 marks)

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