PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



EXAM QUESTION PACK

SECTION 1: PRINCIPLES OF CHEMISTRY (PACK 1)

SCORE	PERCENTAGE
/279	%

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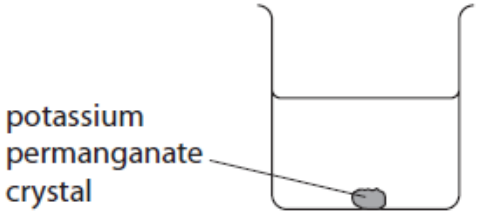
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Q1.

A potassium permanganate crystal is placed in a beaker of water.



After several days a coloured solution forms.

(a) Give the names of the two processes that cause the coloured solution to form.

(2)

1 .....

2 .....

(b) The formula of potassium permanganate is $KMnO_4$

(i) How many different types of atom are in $KMnO_4$?

(1)

☒ **A** 3

☒ **B** 4

☒ **C** 6

☒ **D** 7

(ii) Calculate the relative formula mass (M_r) of $KMnO_4$

(1)

M_r = ...

(c) Potassium permanganate can be used as an oxidising agent.

State what is meant by the term **oxidising agent**.

(1)

.....

.....

(Total for question = 5 marks)

Q2.

This question is about alcohols, carboxylic acids and esters.

(a) Ethanol can be manufactured by the fermentation of a solution of glucose.

(i) Write a word equation for this reaction.

(1)

.....

(ii) State the substance that needs to be added for the reaction to occur.

(1)

.....

(iii) State two conditions needed for this reaction.

(2)

.....

.....

(b) In the presence of an acid catalyst, ethanoic acid is heated with butanol to form an ester.

(i) Which of these is the formula of the ester?

(1)

☒ **A** $CH_3COOC_3H_7$

☒ **B** $CH_3COOC_4H_9$

☒ **C** $C_2H_5COOC_4H_9$

☒ **D** $C_3H_7COOC_2H_5$

(ii) State how you would know that an ester has formed.

(1)

.....

.....

(iii) Give one use of an ester.

(1)

.....

.....

(c) Aspirin is a compound used to reduce pain.

Aspirin contains a carboxylic acid functional group and an ester functional group.

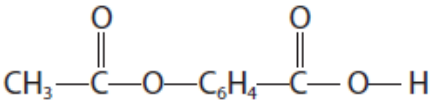
(i) State what is meant by the term **functional group**.

(1)

.....

.....

(ii) This is the structural formula of aspirin.



Draw a circle around the carboxylic acid functional group.

(1)

(iii) Aspirin has this percentage composition by mass.

C = 60.00% H = 4.44% O = 35.56 %

Show by calculation that the empirical formula of aspirin is $C_9H_8O_4$

(3)

(Total for question = 12 marks)

Q3.

This question is about alcohols, carboxylic acids and esters.

(a) Ethanol can be manufactured by reacting ethene with steam in the presence of a phosphoric acid catalyst.

Which row gives the correct conditions of temperature and pressure for this reaction?

(1)

	Temperature in °C	Pressure in atmospheres
☒ **A**	35	300
☒ **B**	65	300
☒ **C**	300	65
☒ **D**	300	35

(b) Give the displayed formula of butanol.

(1)

(c) Ethanoic acid (CH_3COOH) is a carboxylic acid present in vinegar.

(i) The concentration of CH_3COOH in vinegar can be found by titration with aqueous potassium hydroxide (KOH).

The equation for the reaction is

$$CH_3COOH + KOH \rightarrow CH_3COOK + H_2O$$

In a titration, a 25.0 cm^3 sample of vinegar is neutralised by 45.00 cm^3 of KOH solution of concentration 0.400 mol/dm^3.

Calculate the concentration, in mol/dm^3, of CH3COOH in this sample of vinegar.

(2)

concentration = ... mol/dm^3

(ii) A sample of vinegar containing 0.0030 mol of CH_3COOH is poured into a flask.

Calculate the maximum volume, in cm^3, of carbon dioxide gas formed at rtp when excess sodium carbonate is added to the flask.

The equation for the reaction is

$$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$$

[Assume that the molar volume of carbon dioxide at rtp is 24 000 cm^3]

(2)

volume = ... cm^3

(d) Alcohols react with carboxylic acids to form esters.

Which alcohol could react to form the ester ethyl propanoate?

(1)

☒ **A** CH_3OH

☒ **B** C_2H_5OH

☒ **C** C_3H_7OH

☒ **D** C_4H_9OH

(e) Polyesters are formed in condensation polymerisation reactions between dicarboxylic acids and diols.

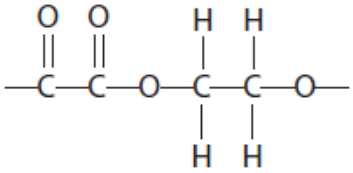
(i) State one difference between condensation polymerisation and addition polymerisation.

(1)

.....

.....

(ii) The repeat unit of a polyester is



Give the displayed formula of each of the two monomers needed to form this polyester.

(2)

(iii) Give one advantage of biopolyesters.

(1)

.....

.....

(Total for question = 11 marks)

Q4.

This question is about alcohols, carboxylic acids and esters.

(a) The table gives information about some alcohols.

Alcohol	Structural formula	Relative formula mass
methanol	CH_3OH	32
ethanol	C_2H_5OH	
	C_4H_9OH	74

Complete the table by giving the missing information.

(2)

(b) Ethanol can be oxidised to ethanoic acid by heating with potassium dichromate(VI) and another reagent.

(i) Name the other reagent.

(1)

.....

(ii) State the colour change that occurs during this reaction.

(1)

from ..... to .....

(c) Alcohols react with carboxylic acids to form esters.

(i) Name the ester that forms when ethanol reacts with ethanoic acid.

(1)

.....

(ii) Complete the equation for the reaction between methanol and ethanoic acid.

(2)

CH_3OH + ... → .....+ H_2O

(Total for question = 7 marks)

Q5.

This question is about some of the alkali metals and their compounds.

(a) When a teacher drops a small piece of sodium into a trough of cold water, she observes bubbles of gas.

Give two other observations that would be made when sodium reacts with cold water.

(2)

1 .....

.....

2 .....

.....

(b) Lithium reacts with fluorine to form the compound lithium fluoride.

(i) Give a chemical equation for this reaction.

(1)

.....

(ii) Give a test to show that lithium fluoride contains lithium ions.

(2)

.....

.....

.....

.....

(iii) Draw diagrams to show the arrangement of the electrons in a lithium ion and in a fluoride ion.

Include the charge on each ion.

(3)

lithium ion	fluoride ion

(c) The table shows the electronic configurations of sodium and potassium.

Element	Electronic configuration
sodium	2.8.1
potassium	2.8.8.1

Explain, in terms of their electronic configurations, why potassium is more reactive than sodium.

(3)

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.....

(Total for question = 11 marks)

Q6.

This question is about alkanes.

(a) (i) Which of these is the **molecular** formula of an alkane?

(1)

☒ **A** C_2H_5

☒ **B** C_4H_{10}

☒ **C** CH_2CH_2

☒ **D** $CH_3CH_2CH_3$

(ii) Which of these has the same empirical formula and molecular formula?

(1)

☒ **A** CH_2

☒ **B** C_2H_6

☒ **C** C_3H_8

☒ **D** C_4H_{10}

(b) In the presence of ultraviolet radiation, methane reacts with bromine to form bromomethane and hydrogen bromide.

(i) State the name of this type of reaction.

(1)

.....

(ii) Give a chemical equation for this reaction.

(1)

.....

(c) One mole of an alkane burns completely in oxygen.

The equation represents the reaction.

$$\text{alkane} + x\text{O}_2 \rightarrow y\text{CO}_2 + z\text{H}_2\text{O}$$

The numbers x, y and z are used to balance the equation.

(i) The complete combustion of one mole of the alkane produces 220 g of carbon dioxide and 108 g of water.

Calculate the values of y and z.

[M_r of CO_2 = 44 M_r of H_2O = 18]

(2)

y = ...

z = ...

(ii) Determine the molecular formula of the alkane and the value of *x*.

(2)

molecular formula = ...

x = ...

(d) When an alkane burns in a limited supply of air, incomplete combustion occurs.

Explain why incomplete combustion of an alkane could be harmful to humans.

(2)

.....

.....

.....

.....

(Total for question = 10 marks)

Q7.

This question is about the metal aluminium.

(a) (i) Draw a labelled diagram to represent the structure and bonding in a metal.

(2)

(ii) Explain why a metal conducts electricity.

(2)

.....

.....

.....

.....

(b) Aluminium is used to make cans for drinks.



Give two properties of aluminium that make it suitable for this use.

(2)

1 .....

.....

2 .....

.....

(c) Aluminium is extracted from aluminium oxide (Al_2O_3) by electrolysis.

The electrolyte is aluminium oxide dissolved in molten cryolite.

(i) State why aluminium cannot be extracted by heating aluminium oxide with carbon.

(1)

.....

.....

(ii) Aluminium is produced at the negative electrode.

The ionic half-equation for the reaction is

$$Al^{3+} + 3e^- \rightarrow Al$$

State why this is a reduction reaction.

(1)

.....

.....

(iii) Complete the ionic half-equation for the reaction at the positive electrode.

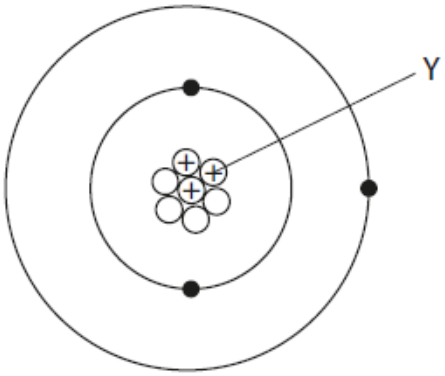
(2)

..... O^{2-} → ..... + ...

(Total for question = 10 marks)

Q8.

The diagram shows an atom of an element.



(a) (i) What is the name of the particle labelled Y?

(1)

☒ **A** electron

☒ **B** ion

☒ **C** neutron

☒ **D** proton

(ii) Give the mass number of this atom.

(1)

.....

(iii) Name this element.

Use the Periodic Table on page 2 to help you.

(1)

.....

(b) There are two isotopes of this element.

Give one way, in terms of sub-atomic particles, that these isotopes are the same and one way that they are different.

(2)

same

.....

.....

different

.....

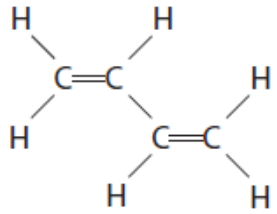
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(Total for question = 5 marks)

Q9.

The organic compound butadiene is a colourless gas used in the manufacture of synthetic rubber for tyres.

The displayed formula of butadiene is



(a) Explain why butadiene is described as an unsaturated hydrocarbon.

(3)

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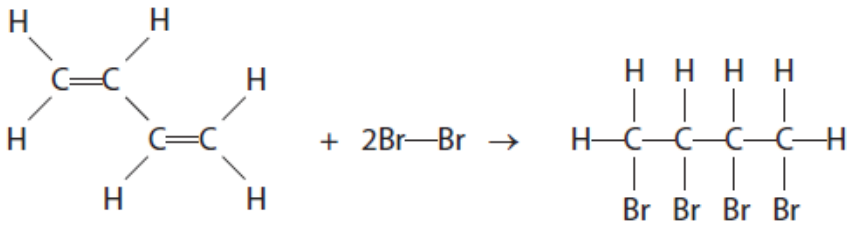
(b) (i) Butadiene reacts with bromine water.

State the colour change that occurs during this reaction.

(1)

from ..... to
.....

(ii) The equation for the reaction between butadiene and bromine can be shown using displayed formulae.



The table gives some bond energies.

Bond	C—H	C=C	Br—Br	C—C	C—Br
Bond energy in kJ/mol	412	612	193	348	276

Use this information to calculate the enthalpy change, Δ*H*, for the reaction.

Include a sign in your answer.

(4)

Δ*H* = ... kJ/mol

(c) A scientist does an investigation to find out if butadiene would be a good fuel.

He burns a sample of butadiene gas and observes that carbon forms as black soot.

(i) Complete the equation to explain the scientist's observation.

(1)

$$2C_4H_6 + 7O_2 \rightarrow .....C + 4CO + 2CO_2 + ...H_2O$$

(ii) Explain how one of the products, other than carbon, may cause a problem.

(2)

.....

.....

.....

.....

(iii) The equation for the combustion of butadiene in excess oxygen is

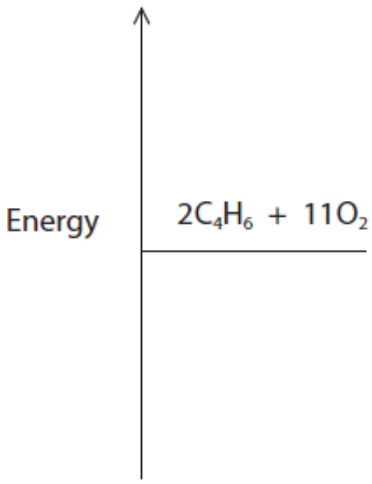
$$2C_4H_6 + 11O_2 \rightarrow 8CO_2 + 6H_2O$$

The enthalpy change for this reaction, ΔH, is – 3446 kJ/mol.

Complete the energy profile diagram for the reaction.

Label the enthalpy change for this reaction, ΔH, and the activation energy.

(4)



(Total for question = 15 marks)

Q10.

The mineral nesquehonite is a form of hydrated magnesium carbonate.

The formula, $MgCO_3.xH_2O$, shows that nesquehonite contains water of crystallisation.

When a sample of nesquohonite is heated gently, the water of crystallisation is given off and anhydrous magnesium carbonate is left.

Six students are each given a sample of nesquehonite of mass 6.1 g. The students heat their samples for different times. The samples are then allowed to cool before being reweighed.

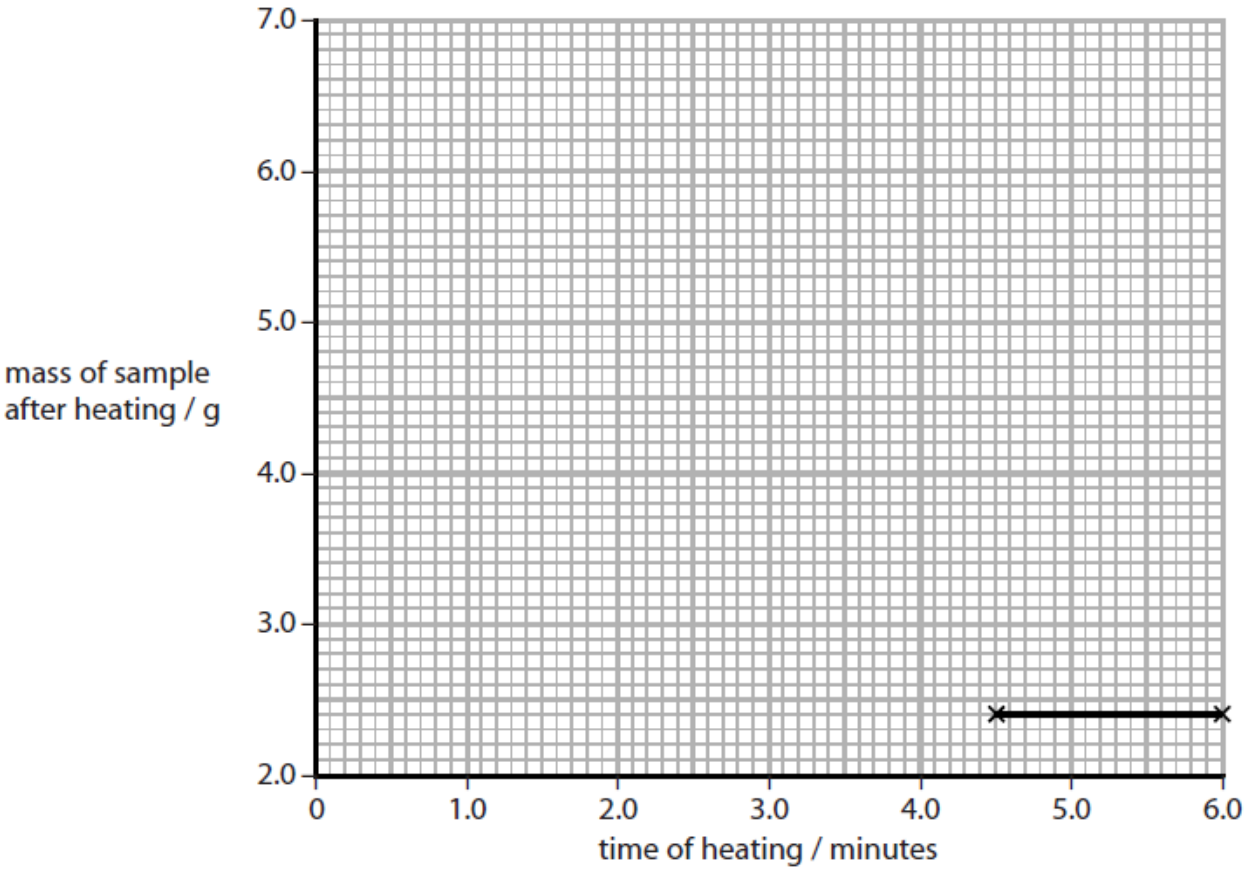
The table shows their results.

time of heating / minutes	0	1.0	2.0	3.0	4.0	4.5	6.0
mass of sample after heating / g	6.1	5.3	4.5	3.7	2.8	2.4	2.4

(a) Plot these results on the grid provided. The last two points have been plotted for you.

Draw a straight line of best fit for the points you have plotted.

(2)



(b) Predict the mass of sample remaining after heating for 2.5 minutes.

Show on the graph how you obtain your answer.

(2)

mass after 2.5 minutes = ... g

(c) State why the last two masses in the table are exactly the same.

(1)

.....

.....

(d) A sample of nesquehonite contains 1.68 g of $MgCO_3$ and 1.08 g of H_2O.

Calculate the value of x in the formula $MgCO_3.xH_2O$

[M_r of $MgCO_3$ = 84; M_r of H_2O = 18]

(3)

x = ...

(e) When anhydrous magnesium carbonate is heated strongly, it decomposes.

The equation for the reaction is:

$$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$$

Calculate the volume of carbon dioxide formed in cm^3, at rtp, when 4.2 g of anhydrous magnesium carbonate are completely decomposed.

[M_r of $MgCO_3$ = 84]

[Assume that the molar volume at rtp of carbon dioxide is 24 dm^3]

(3)

volume = ... cm^3

(Total for question = 11 marks)

Q11.

The concentration of NaClO(aq) in a solution of bleach is found by reacting it with hydrochloric acid.

The equation for the reaction is

$$NaClO(aq) + 2HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + Cl_2(g)$$

An excess of dilute hydrochloric acid is added to 4.00 cm^3 of bleach solution.

60.0 cm^3 of chlorine gas is produced.

(a) Explain a safety precaution that should be taken when doing this experiment.

(2)

.....

.....

.....

.....

(b) (i) Calculate the amount, in moles, of chlorine gas produced. Assume one mole of chlorine gas occupies 24 000 cm^3.

(2)

amount of chlorine = ... mol

(ii) Determine the amount, in moles, of NaClO in 4.00 cm^3 of bleach.

(1)

amount of NaClO = ... mol

(iii) Calculate the concentration, in mol/dm^3, of the bleach solution.

(2)

concentration = ... mol/dm^3

(Total for question = 7 marks)

Q12.

Substances can exist as solids, liquids or gases.

(a) (i) Give the change of state that occurs when a substance melts.

(1)

.....

(ii) Complete the word equation for the sublimation of iodine.

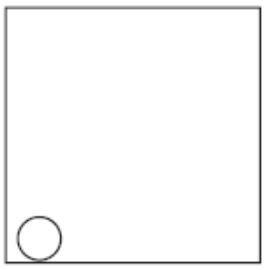
iodine (s) → iodine (.....)

(1)

(b) The circle in the diagram represents a particle.

Complete the diagram to show the arrangement of particles in a gas.

(1)



(c) The table lists some statements about particles.

Place ticks (✓) in boxes to show which two statements are correct for water particles.

(2)

Statement	Tick
the particles only vibrate	
the particles do not move	
the particles have no gaps between them	
the particles move randomly	
the particles have more energy than in ice	
the particles have a regular arrangement	

(Total for question = 5 marks)

Q13.

The table gives some information about the halogens, chlorine, bromine and iodine.

Halogen	Physical state at room temperature	Colour
chlorine	gas	pale green
bromine		red-brown
iodine	solid	

(a) Complete the table.

(2)

(b) Chlorine has two isotopes of mass numbers 35 and 37

The relative percentage of each isotope in a sample of chlorine is

chlorine-35 77.78% chlorine-37 22.22%

Calculate the relative atomic mass of this sample of chlorine.

Give your answer to one decimal place.

(3)

relative atomic mass = ...

(c) A student is given an aqueous solution of chlorine and an aqueous solution of potassium bromide.

Explain how he can use these two solutions to compare the reactivity of chlorine with the reactivity of bromine.

(4)

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(Total for question = 9 marks)

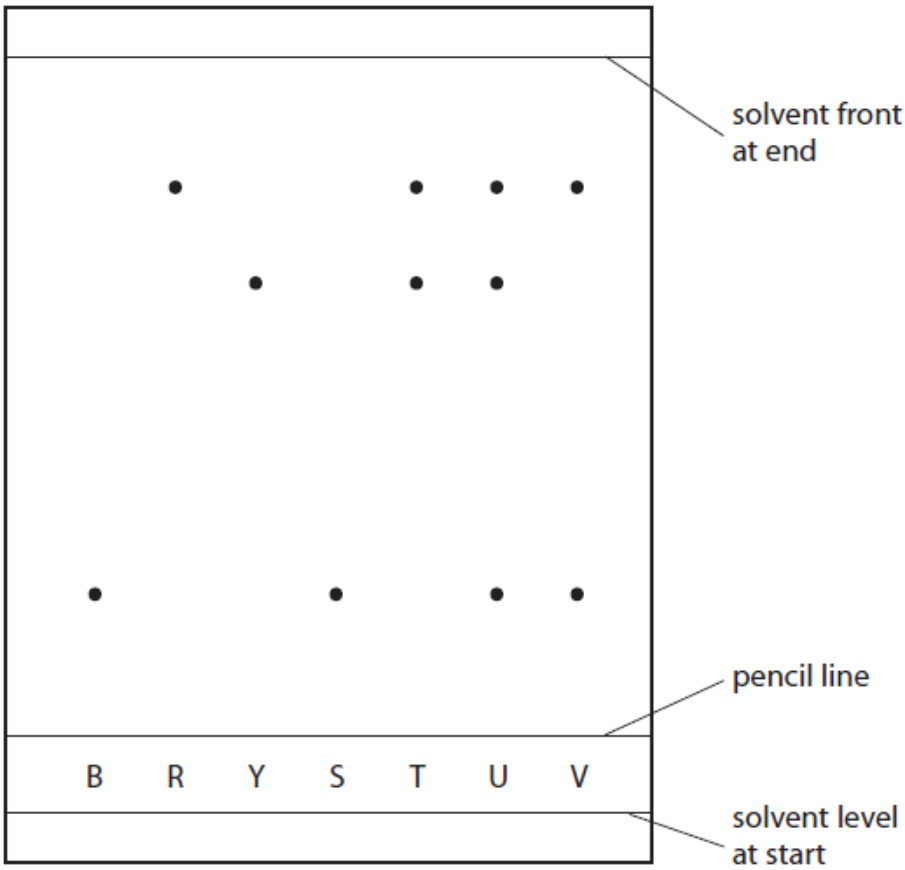
Q14.

In a chromatography experiment a student uses samples of three pure food dyes, blue (B), red (R) and yellow (Y).

He also uses samples of four unknown substances, S, T, U and V.

The student puts a small drop of each substance on the pencil line.

The diagram shows the student's chromatogram at the end of the experiment.



(a) Which of the unknown substances contains only one food dye?

(1)

☒ **A** substance S

☒ **B** substance T

☒ **C** substance U

☒ **D** substance V

(b) Explain which pure food dyes are in substance V.

(2)

.....

.....

.....

.....

(c) (i) Calculate the R_f value of the yellow food dye Y.

(3)

R_f = ...

(ii) State how the chromatogram suggests that the yellow food dye Y is less soluble in the solvent than

the red food dye R.

(1)

.....

.....

(Total for question = 7 marks)

Q15.

A student investigates the reaction between sodium hydroxide solution and dilute sulfuric acid.

He does a titration to find the concentration of the sulfuric acid.

This is his plan for the titration. There are some mistakes and omissions in his plan.

- rinse a conical flask with the sodium hydroxide solution
- use a measuring cylinder to measure out 25 cm^3 of the sodium hydroxide solution and add it to the conical flask
- add a few drops of methyl orange indicator to the conical flask
- rinse a burette with water and then fill it with the sulfuric acid
- add the acid from the burette to the conical flask until the indicator changes colour at the end-point of the titration
- record the final burette reading

(a) Give the colour change of the methyl orange indicator at the end-point.

(2)

from ..... to .....

(b) Describe four changes that the student could make to improve his plan.

(4)

1 .....

.....

.....

2 .....

.....

.....

3 .....

.....

.....

4 .....

.....

.....

(c) The student then does the titration correctly.

He finds that 16.70 cm^3 of the dilute sulfuric acid neutralises 25.0 cm^3 of sodium hydroxide solution of concentration 0.200 mol/dm^3

The equation for the reaction is

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration, in mol/dm^3, of the sulfuric acid.

(3)

concentration of sulfuric acid = ... mol/dm^3

(Total for question = 9 marks)

Q16.

(a) Explain why metals conduct electricity but covalent compounds do not conduct electricity.

(4)

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(b) Hydrogen chloride, HCl, is a covalent substance.

When hydrogen chloride is added to water, a solution of dilute hydrochloric acid is formed.

This solution does conduct electricity.

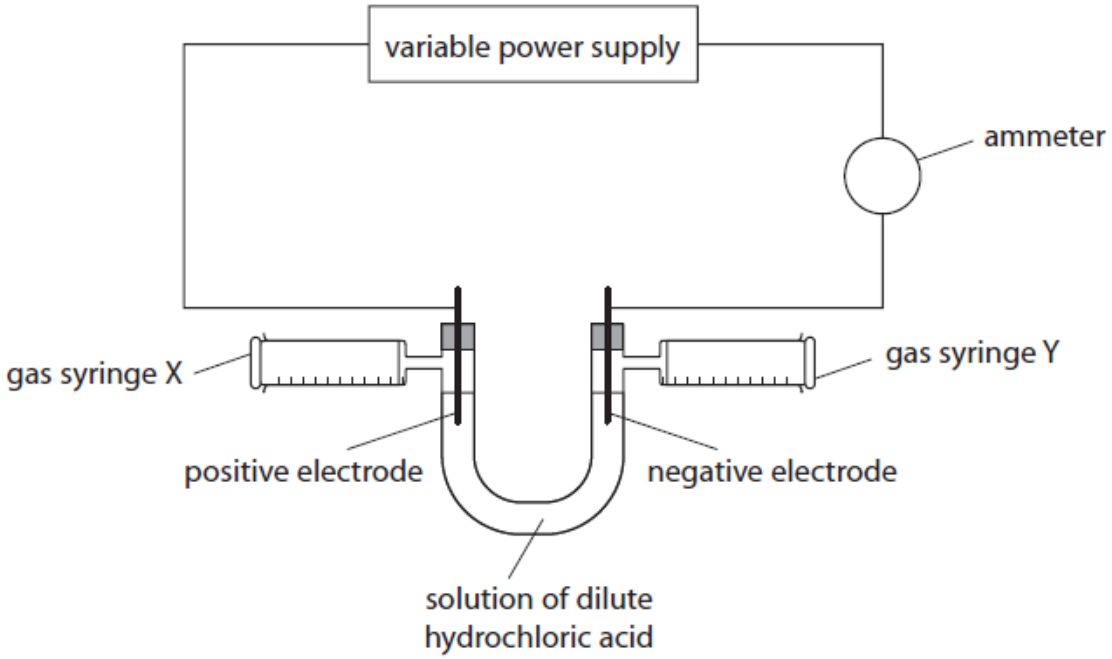
Name the type of particle in the solution of the dilute hydrochloric acid that allows it to conduct electricity.

(1)

.....

(c) The teacher uses this apparatus to investigate the electrolysis of a solution of dilute hydrochloric acid.

The ammeter measures the current.



The teacher wants to find out if there is a relationship between current and volume of gas collected at each electrode.

She adjusts the power supply until the current is 0.1 amp.

After 5 minutes she records the volume of gas collected in syringe X and syringe Y.

The teacher repeats the experiment several times, using a different current each time.

The table gives the teacher's results for syringe Y.

Current in amp	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
Volume of gas in cm^3	8	15	22	25	37	44	52	60

(i) Plot the results for syringe Y.

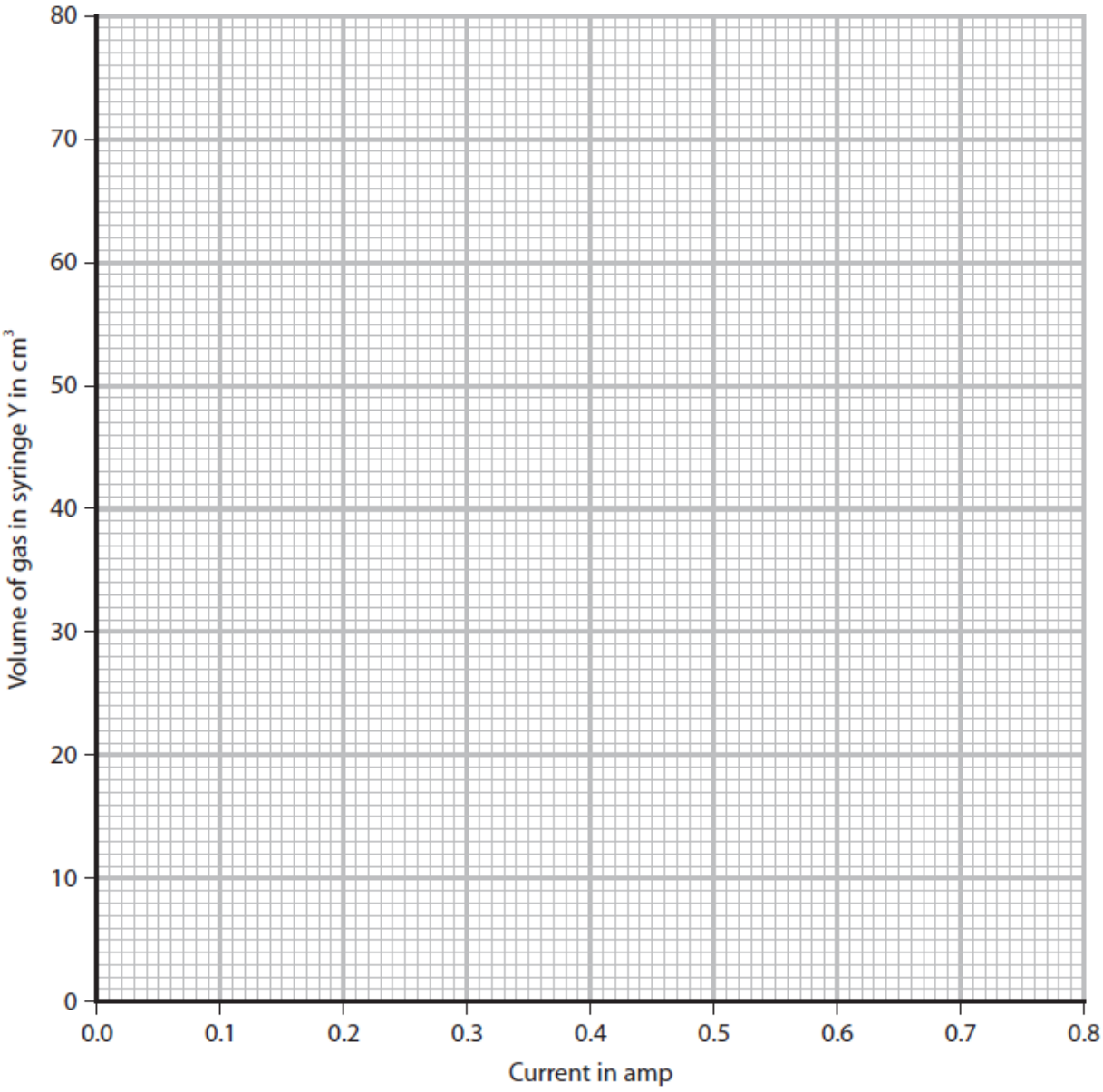
(1)

(ii) Draw a circle around the anomalous result.

(1)

(iii) Draw a line of best fit.

(1)



(iv) Explain a possible cause of the anomalous result, other than misreading the apparatus.

(2)

.....

.....

.....

.....

(v) Deduce the relationship between current and volume of gas collected in syringe Y.

(1)

.....

.....

(d) The ionic half-equation for the reaction that produces the gas in syringe X is

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

The ionic half-equation for the reaction that produces the gas in syringe Y is

$$2H^+ + 2e^- \rightarrow H_2$$

(i) Suggest how these ionic half-equations show that the volume of chlorine collected in syringe X should be the same
as the volume of hydrogen collected in syringe Y.

(1)

.....

.....

.....

(ii) Suggest why the volume of chlorine collected in syringe X is always less than the volume of hydrogen collected
in syringe Y.

(1)

.....

.....

.....

(Total for question = 13 marks)

Q17.

Crude oil is a mixture of hydrocarbons.

(a) This passage is about the industrial separation of crude oil.

Complete the passage by adding the missing words.

(3)

Crude oil is ..... to form vapour.

The vapour is passed through a ..... column.

The refinery gases are collected at the top of the column because they have low

....

(b) Bitumen is collected at the bottom of the column.

Give one use of bitumen.

(1)

.....

(c) One of the hydrocarbons in crude oil is an alkane with this structural formula.

$CH_3CH_2CH_2CH_2CH_3$

(i) Give the name of this alkane.

(1)

.....

(ii) Calculate the relative molecular mass (M_r) of this alkane.

(1)

M_r = ...

(d) Catalytic cracking is used to convert long-chain alkanes into shorter-chain alkanes.

Give the name of the catalyst and the temperature used in catalytic cracking.

(2)

catalyst
.....

temperature
.....

(e) Catalytic cracking also produces alkenes.

Decane ($C_{10}H_{22}$) can undergo cracking to give C_4H_{10} and two different alkenes.

Complete the equation for this cracking process.

(2)

$C_{10}H_{22} \rightarrow C_4H_{10}$ + ... +
.....

Q18.

Dinitrogen tetraoxide, N_2O_4, is a colourless gas.

Nitrogen dioxide, NO_2, is a brown gas.

The two gases can exist together in dynamic equilibrium according to the equation

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

(a) Explain what is meant by the term **dynamic equilibrium**.

(2)

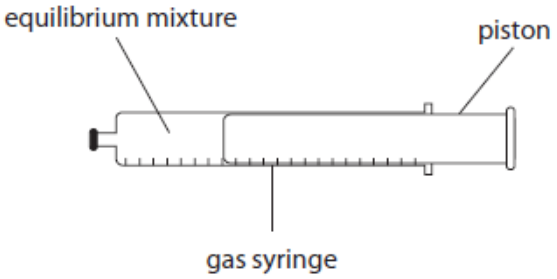
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(b) Some N_2O_4 and some NO_2 are put into a sealed gas syringe and allowed to form an equilibrium mixture.



This equilibrium mixture is brown.

(i) The pressure of the gas in the syringe is increased by pushing in the piston. The mixture is then allowed to reach a new equilibrium at the same temperature as before.

Explain why the new equilibrium mixture contains less NO_2 than the original equilibrium mixture.

(2)

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(ii) A student suggests that the new equilibrium mixture would be lighter in colour than the original equilibrium mixture, as there is now less NO_2 present.

Suggest why the new equilibrium mixture is actually darker than the original.

(1)

.....

.....

.....

(c) Carbon monoxide, CO, and oxides of nitrogen are produced in a car engine when petrol is burned.

These oxides can be partly removed by using a catalytic converter fitted to the car's exhaust system.

(i) State how oxides of nitrogen are produced in the car engine.

(1)

.....

.....

(ii) Give a disadvantage of allowing oxides of nitrogen to escape into the atmosphere.

(1)

.....

.....

(iii) Write a chemical equation for the reaction between nitrogen monoxide, NO, and carbon monoxide to form carbon dioxide and nitrogen.

(1)

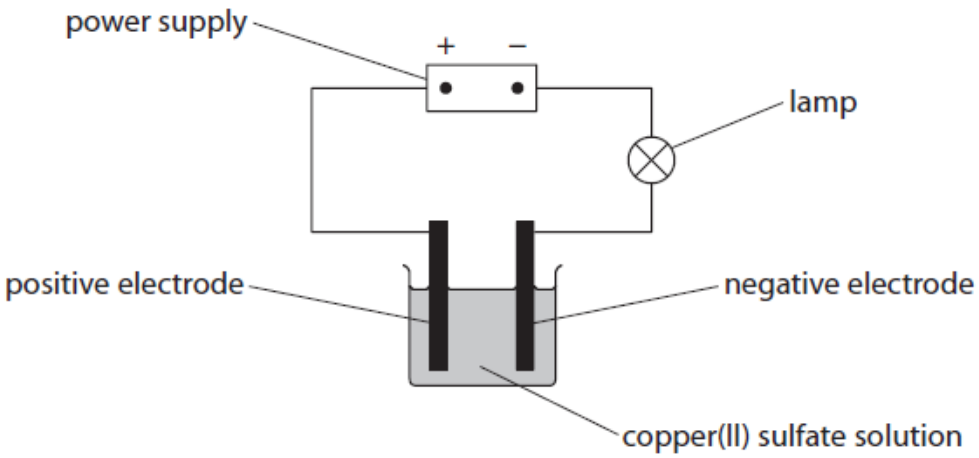
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(Total for question = 8 marks)

Q19.

This question is about the electrolysis of copper(II) sulfate solution.

(a) The diagram shows the apparatus used for the electrolysis.



A student records the total increase in mass of the negative electrode every minute for 8 minutes.

The table shows the results.

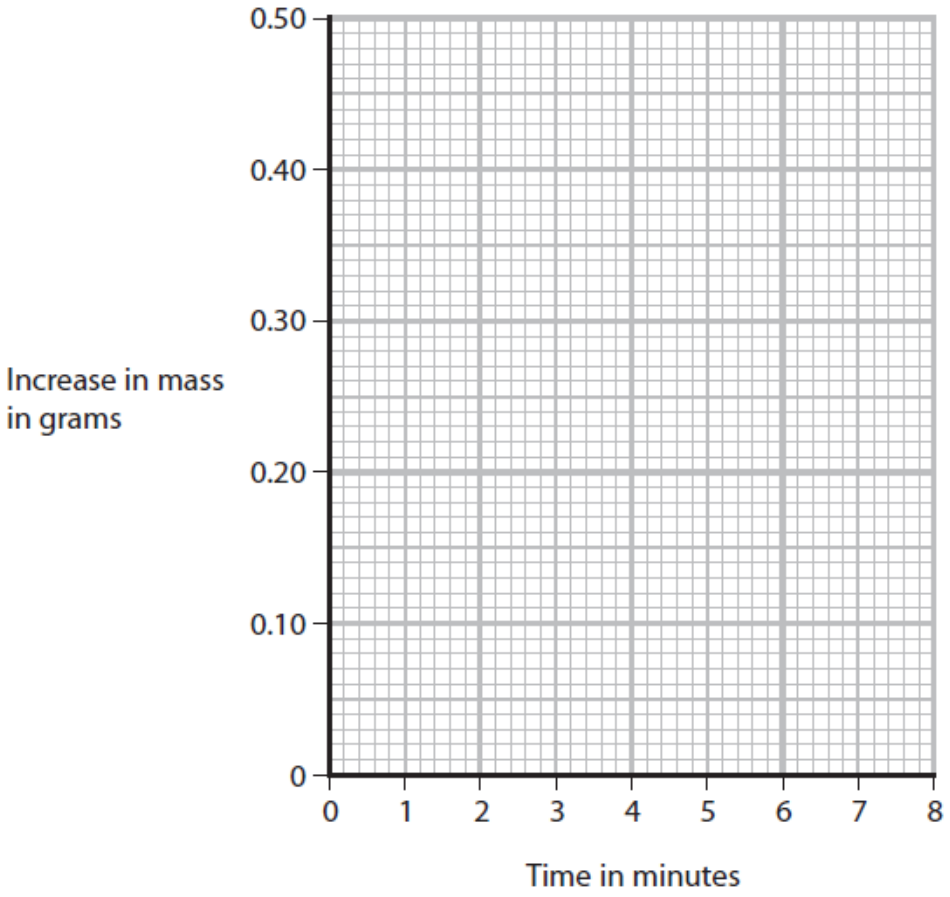
Time in minutes	Total increase in mass of the negative electrode in grams
0	0.00
1	0.15
2	0.27
3	0.34
4	0.39
5	0.41
6	0.42
7	0.42
8	0.42

(i) Plot the student's results.

(1)

(ii) Draw a curve of best fit.

(1)



(iii) Explain the shape of the graph.

(2)

.....

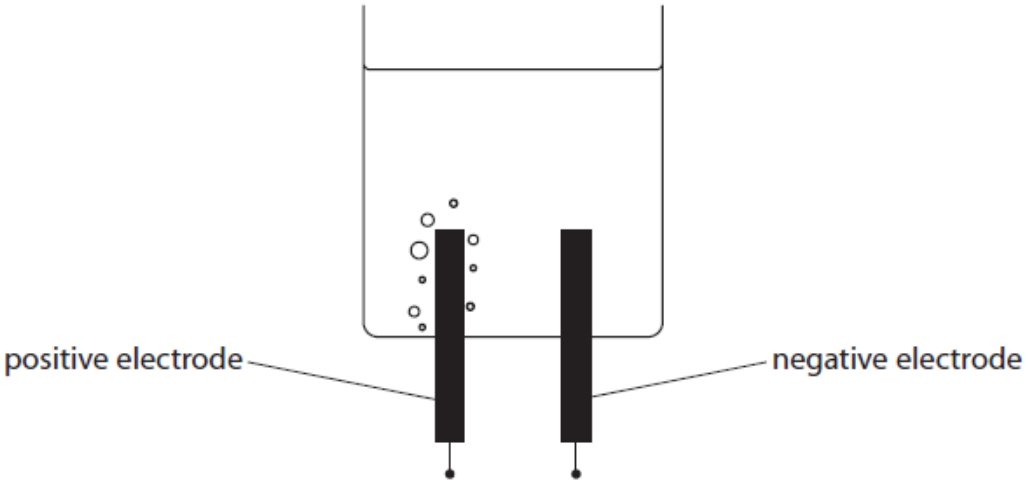
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(b) The product at the positive electrode is oxygen gas.

(i) The student repeats the electrolysis using different apparatus.



Describe how the student should collect a sample of pure oxygen at the positive electrode.

(2)

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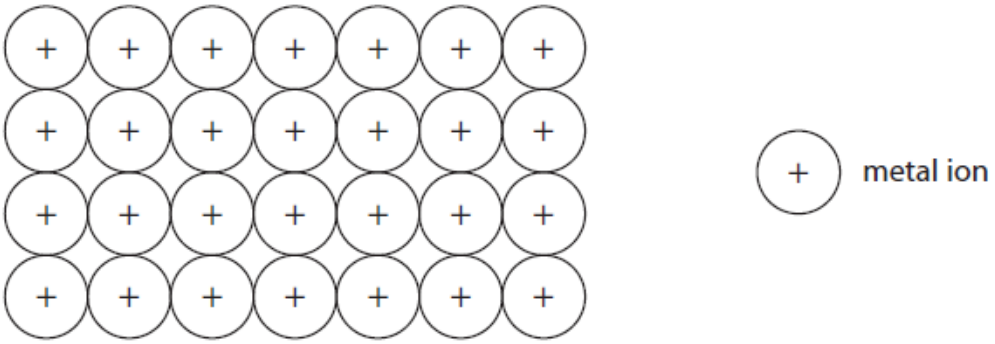
(ii) Give an ionic half-equation for the formation of oxygen.

(2)

.....

(c) The wire used to connect the power supply to the electrodes is made of copper metal.

The diagram shows the arrangement of the ions in a metal.



(i) Metals that are malleable can also be stretched to form long, thin wires.

Suggest why metals can be stretched to form wires.

(2)

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.....

(ii) Explain why metals conduct electricity.

(2)

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.....

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.....

(Total for question = 12 marks)

Q20.

This question is about copper and its compounds.

(a) Copper is a metal used for electrical wiring.

Explain why copper is a good conductor of electricity.

(2)

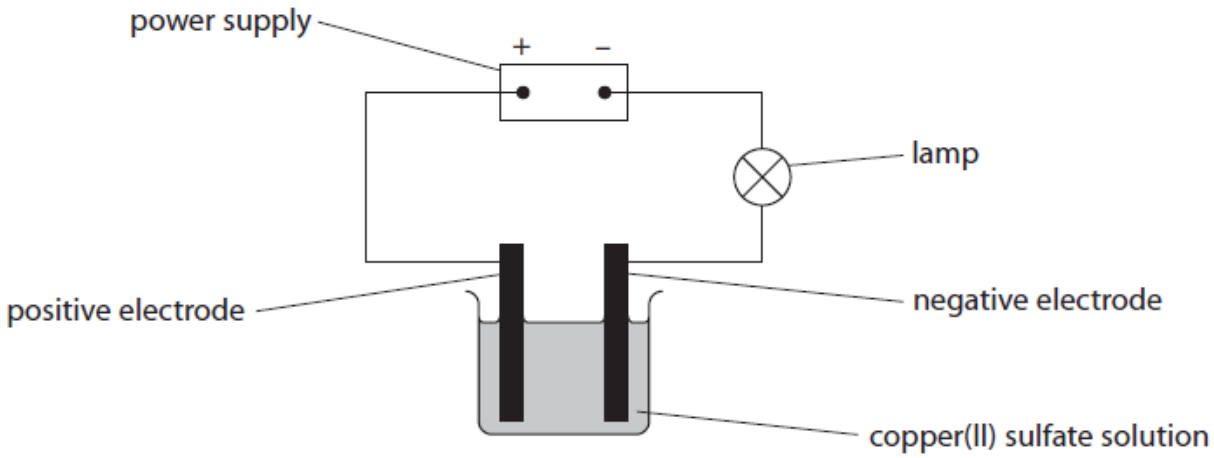
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(b) This apparatus is used to investigate the electrolysis of copper(II) sulfate solution with graphite electrodes.



Copper forms at the negative electrode and oxygen forms at the positive electrode.

(i) State what would be observed at each electrode.

(2)

negative electrode

.....

positive electrode

.....

(ii) The ionic half-equation for the reaction at the negative electrode is

$$Cu^{2+} + 2e^{-} \rightarrow Cu$$

State why this is a reduction reaction.

(1)

.....

.....

(iii) Explain why the copper(II) sulfate solution becomes paler blue during the electrolysis.

(2)

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(c) When hydrated copper(II) sulfate crystals are heated, anhydrous copper(II) sulfate forms.

A mass of 12.5 g of hydrated copper(II) sulfate crystals is heated in a crucible until all the water of crystallisation is removed.

A mass of 8.0 g of anhydrous copper(II) sulfate forms.

Show by calculation that the formula of hydrated copper(II) sulfate is $CuSO_4.5H_2O$

[M_r of $CuSO_4$ = 159.5 M_r of H_2O = 18]

(4)

(Total for question = 11 marks)

Q21.

This question is about elements, compounds and mixtures.

(a) Name the element that burns with a lilac flame.

(1)

.....

(b) Name the technique used to separate the mixture of colours in black ink.

(1)

.....

(c) The box gives the names of some substances.

air	bromine	magnesium	neon	sodium chloride	sulfur

Choose substances from the box to answer these questions.

(i) Identify the compound.

(1)

.....

(ii) Identify the mixture.

(1)

.....

(iii) Identify the non-metal element that is a solid at room temperature.

(1)

.....

(Total for question = 5 marks)

Q22.

Grapes contain glucose that can be fermented to make ethanol.



(a) The grapes are collected and crushed to produce an aqueous solution containing glucose. Yeast is added to the solution and the mixture is left to ferment at a temperature of about 30 °C in the absence of air.

(i) State why yeast is added.

(2)

.....

.....

.....

.....

(ii) Explain why another organic compound may also be formed if fermentation is carried out in the presence of air.

(2)

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(iii) Explain why 30 °C is considered to be an optimum temperature for this reaction.

(2)

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(b) Ethanol can also be manufactured by reacting ethene with steam.

(i) Write the chemical equation for this reaction.

(1)

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(ii) Name the type of reaction that occurs.

(1)

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(iii) State **two** conditions used for this reaction in industry.

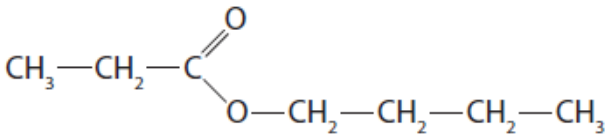
(2)

1 .....

2 .....

(c) Grapes also contain esters.

The formula of an ester is shown.



Deduce the name of the carboxylic acid and the alcohol that can react together to make this ester.

(2)

carboxylic acid .....

alcohol .....

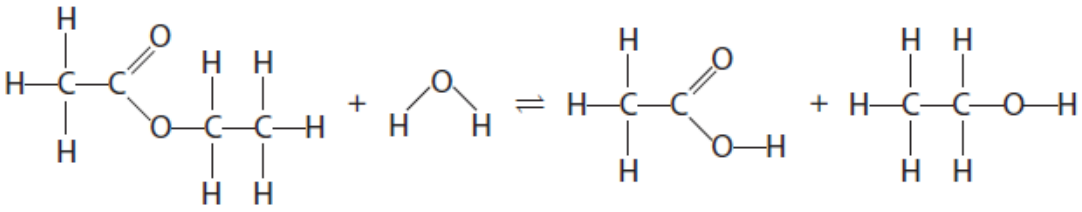
(Total for question = 12 marks)

Q23.

This question is about esters.

Ester A reacts with water to form ethanoic acid and ethanol.

The displayed formulae of the reactants and products are shown in this equation



ester A

The molar enthalpy change (ΔH) for the reaction is 0 kJ/mol.

(a) (i) Draw a ring around the functional group in ester A.

(1)

(ii) Give the name of ester A.

(1)

.....

(iii) Describe a chemical test, other than using an indicator, to show that the reaction mixture contains ethanoic acid.

(2)

.....

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(b) Explain why the molar enthalpy change (ΔH) for the reaction between ester A and water is 0 kJ/mol.

In your answer, refer to the bonds broken and the bonds formed.

(2)

.....

.....

.....

.....

(c) A mixture of ester A and water is left in a sealed container until the reaction mixture reaches dynamic equilibrium.

(i) Describe what is meant by dynamic equilibrium.

(2)

.....

.....

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(ii) Explain why adding a catalyst does not change the position of equilibrium.

(2)

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(d) The ethanoic acid produced in the reaction is completely neutralised by 22.75 cm^3 of 0.150 mol/dm^3 barium hydroxide solution.

The equation for the neutralisation reaction is

$$2CH_3COOH + Ba(OH)_2 \rightarrow Ba(CH_3COO)_2 + 2H_2O$$

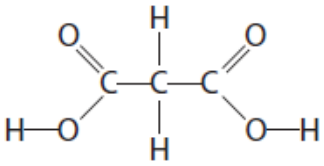
Calculate the amount, in moles, of ethanoic acid neutralised.

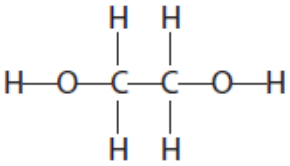
Give your answer to 3 significant figures.

(3)

amount = ... mol

(e) The structures of two organic compounds are shown.





These compounds react together to form a polymer.

Give the repeat unit of the polymer formed.

(2)

(Total for question = 15 marks)

Q24.

Ethanol, C_2H_5OH, is a member of the homologous series of alcohols.

(a) Give two characteristics of a homologous series.

(2)

1 .....

.....

2 .....

.....

(b) When ethanol is heated with potassium dichromate(VI) and one other reagent, the ethanol is oxidised to ethanoic acid,

CH_3COOH

(i) Give the formula of the other reagent.

(1)

.....

(ii) State the colour change that occurs during this oxidation reaction.

(2)

from ..... to
.....

(iii) Draw the displayed formulae for ethanol and ethanoic acid in the boxes.

(2)

ethanol	ethanoic acid

(c) Ethanol can be manufactured by two different methods.
The table gives some information about the two methods.

	Hydration of ethene	Fermentation of glucose
raw material	crude oil	sugar cane
rate of reaction	fast	slow
purity of ethanol	pure	impure
operating temperature	300 °C	30 °C
operating pressure	60 – 70 atmospheres	1 atmosphere
catalyst	phosphoric acid	enzymes in yeast

(i) Discuss the advantages and disadvantages of these two methods, using information from the table.

(6)

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(ii) The word equation for the fermentation process is

glucose → ethanol + carbon dioxide

Complete the chemical equation for this reaction.

(1)

$C_6H_{12}O_6$ → ..... +
.....

(Total for question = 14 marks)

Q25.

Ethanol, C_2H_5OH, can be manufactured from ethene and steam using a phosphoric acid catalyst.

(a) (i) State the temperature and pressure used in this manufacturing process.

(2)

temperature

.....

pressure

.....

(ii) Draw the displayed formula of ethanol.

(1)

(b) Ethanol burns in a plentiful supply of air to form carbon dioxide and water.

(i) Give the chemical equation for this reaction.

(2)

.....

(ii) When the air supply is limited, incomplete combustion occurs and carbon monoxide forms.

State why carbon monoxide is poisonous to humans.

(1)

.....

.....

(c) When ethanol reacts with ethanoic acid, an ester forms.

Give the name of this ester.

(1)

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(d) Butanedioic acid and ethanediol react together to form a polyester and water.

(i) Give the name of this type of polymerisation.

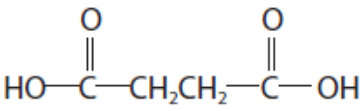
(1)

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(ii) Complete the equation.

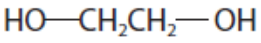
Show only one repeat unit of the polyester.

(3)



.....

+ → +

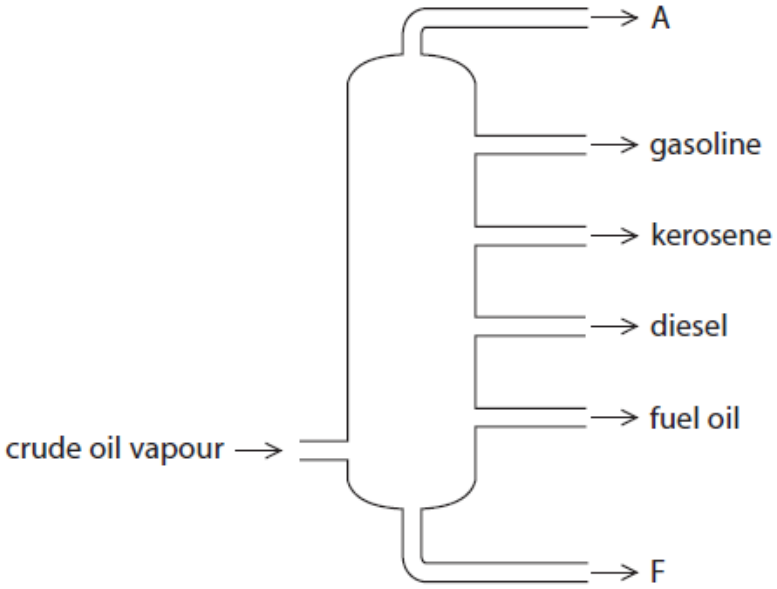


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(Total for question = 11 marks)

Q26.

The diagram shows the industrial equipment used to separate crude oil into fractions.



(a) (i) Give the name of the industrial equipment.

(1)

.....

(ii) Give one use of the fuel oil fraction.

(1)

.....

(iii) Give the names of fraction A and fraction F.

(2)

fraction A

.....

fraction F

.....

(b) One compound in the gasoline fraction is the alkane octane (C_8H_{18}) and one compound in the kerosene fraction is the
alkane dodecane ($C_{12}H_{26}$)

These two alkanes are covalently bonded and have simple molecular structures.

(i) Give the general formula for the alkanes.

(1)

.....

(ii) Explain, in terms of their structures, why $C_{12}H_{26}$ has a higher boiling point than C_8H_{18}

(3)

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(c) Catalytic cracking can be used to convert the alkane $C_{12}H_{26}$ into more useful products.

(i) Give the name of the catalyst used for catalytic cracking.

(1)

.....

(ii) Complete the equation for this cracking reaction.

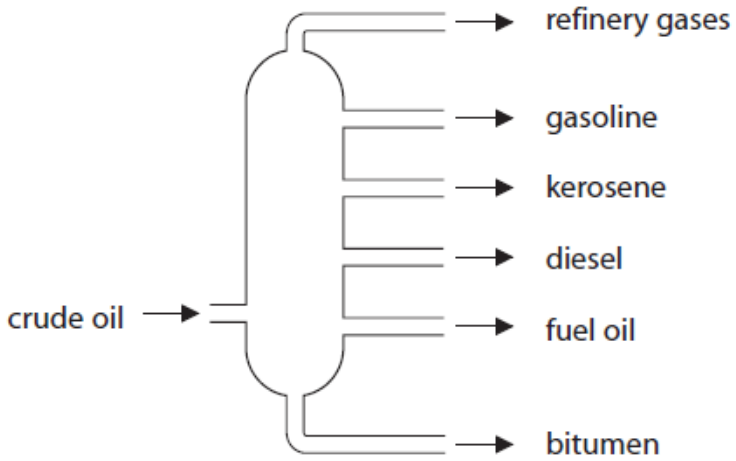
(1)

$$C_{12}H_{26} \rightarrow C_9H_{20} + ...$$

(Total for question = 10 marks)

Q27.

(a) The diagram shows a fractionating column used to separate crude oil into fractions.



(i) Give a use for bitumen and a use for gasoline.

(2)

use for bitumen.....

use for gasoline.....

(ii) Explain why bitumen is collected at the bottom of the fractionating column and gasoline is collected near the top
of the fractionating column.

(2)

.....

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.....

(b) There is a low demand for some of the fractions obtained from crude oil.

Cracking can be used to convert these fractions into more useful substances.

(i) State the conditions needed for cracking.

(2)

.....

.....

(ii) Dodecane ($C_{12}H_{26}$) can be cracked to produce an alkane and two alkenes.

Complete the equation by giving the formulae of the two alkenes.

(2)

$$C_{12}H_{26} \rightarrow C_7H_{16} + \text{.....} + \text{.....}$$

(Total for question = 8 marks)

Q28.

This question is about gases in the atmosphere.

The box gives the names of some gases.

argon	carbon dioxide	hydrogen
nitrogen	oxygen	water vapour

(a) Choose gases from the box to answer these questions.

(i) Identify the least reactive gas in the atmosphere.

(1)

.....

(ii) Identify the most abundant gas in the atmosphere.

(1)

.....

(iii) Identify the gas that is not normally found in the atmosphere.

(1)

.....

(b) State an environmental problem caused by increasing amounts of carbon dioxide in the atmosphere.

(1)

.....

.....

(c) Describe a test for carbon dioxide.

(2)

.....

.....

.....

.....

(Total for question = 6 marks)

Q29.

This question is about gases.

(a) The box gives the names of some gases.

argon	carbon dioxide	hydrogen	nitrogen	oxygen

Use gases from the box to answer these questions.

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

(i) Name the most abundant gas in the Earth's atmosphere.

(1)

.....

(ii) Name the gas that is a compound.

(1)

.....

(iii) Name the least reactive of the gases.

(1)

.....

(iv) Name the gas formed by the complete combustion of hydrocarbons.

(1)

.....

(b) Describe the test for hydrogen gas.

(1)

.....

.....

(Total for question = 5 marks)

Q30.

This question is about some Group 2 elements and their compounds.

(a) Calcium reacts with water to produce calcium hydroxide and hydrogen gas.

(i) Give the word equation for this reaction.

(1)

.....

(ii) State two observations that would be made during this reaction.

(2)

1 .....

2 .....

(b) (i) Describe how a pure, dry sample of the insoluble salt, barium sulfate, could be made from the two solids sodium sulfate and barium chloride.

(5)

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(ii) Give an ionic equation for the reaction that occurs.

Include state symbols in your equation.

(2)

.....

(c) When magnesium nitrate is heated, magnesium oxide, nitrogen dioxide and oxygen form.

The equation for the reaction is

$$2Mg(NO_3)_2(s) \rightarrow 2MgO(s) + 4NO_2(g) + O_2(g)$$

(i) What is the name for this type of reaction?

(1)

☒ **A** addition

☒ **B** combustion

☒ **C** decomposition

☒ **D** neutralisation

(ii) Calculate the **total** volume, in dm^3, of gas produced at rtp when 7.7 g of magnesium nitrate completely reacts.

[Assume that the molar volume of a gas at rtp is 24 dm^3]

[M_r of $Mg(NO_3)_2$ = 148]

Give your answer to two significant figures.

(4)

total volume of gas = ... dm^3

(Total for question = 15 marks)