Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 1/Level 2 GCSE (9–1)

Time 1 hour 45 minutes

Paper reference **1CH0/1H**

Chemistry

PAPER 1

Higher Tier

You must have:
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.
- There is a periodic table on the back cover of the paper.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

P69485A

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Q:1/1/1/1/1/

P 6 9 4 8 5 A 0 1 3 2

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Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 (a) Chemical cells produce a voltage.

A chemical cell can be made by placing the metals copper and zinc in a beaker of sodium chloride solution.

Figure 1 shows a diagram of this chemical cell.

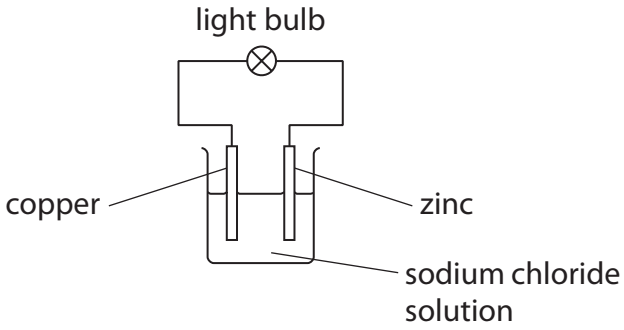

Figure 1

Describe what will happen to the brightness of the light bulb over a long period of time.

(2)

A description to include any two in the correct sequence from
- starts bright
- becomes dimmer

(b) Copper is a transition metal.

Which of the following is most likely to be a property of copper?

(1)

☒ **A** copper forms a white oxide

☒ **B** copper has a high melting point

☒ **C** copper has a low boiling point

☒ **D** copper has a low density

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(c) A copper atom has a diameter of 0.256 nm.

What is the size of this copper atom in metres?

(1)

- ☒ **A** 2.56×10^{-8}
- ☒ **B** 2.56×10^{-9}
- ☒ **C** 2.56×10^{-10}
- ☒ **D** 2.56×10^{-11}

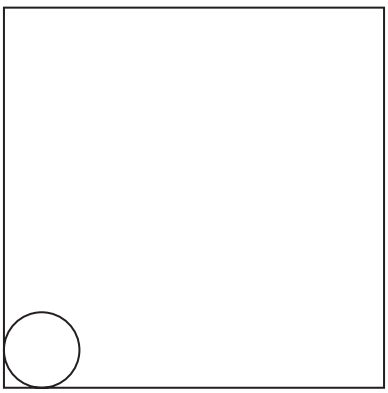
(d) Brass is an alloy of copper and zinc.
One type of brass contains 70% copper.

Zinc atoms are slightly larger than copper atoms.

Draw a labelled diagram in the box to show the arrangement of copper and zinc atoms in this alloy.

Use the circle in the box as a guide to the size of a copper atom.

(2)



(Total for Question 1 = 6 marks)

arrangement of labelled copper and zinc atoms to show disruption
• copper : zinc in (approximate) ratio 7 : 3

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2 Barium hydroxide reacts with dilute hydrochloric acid to form barium chloride and water.

(a) The equation for the reaction is

$$Ba(OH)_2(s) + 2HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$$

Which row of the table shows the correct state of each of the substances in the equation for the reaction?

(1)

		barium hydroxide	hydrochloric acid	barium chloride	water
☒	**A**	solid	aqueous	aqueous	liquid
☒	**B**	solid	liquid	solid	aqueous
☒	**C**	aqueous	aqueous	solid	liquid
☒	**D**	aqueous	liquid	aqueous	aqueous

(b) A student wanted to investigate how the pH of the mixture changes as barium hydroxide is added to dilute hydrochloric acid.

They followed this method.

step 1 measure out 50.0 cm^3 of dilute hydrochloric acid into a beaker using a measuring cylinder

step 2 use a glass rod to place a drop of the acid onto a piece of universal indicator paper and record the pH

step 3 add 0.2 g of barium hydroxide to the acid in the beaker and stir

step 4 use the glass rod to place a drop of the mixture onto a new piece of universal indicator paper and record the pH again

step 5 repeat steps 3–4 until there is no further change in the pH.

(i) Name a piece of equipment which could be used to measure out 50.0 cm^3 of dilute hydrochloric acid more accurately than the measuring cylinder.

(1)

Burette

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(ii) Describe how the pH of the mixture is determined when a drop of it is placed on the universal indicator paper.

(2)

observe / look at) colour produced on (universal indicator) paper
• compare to pH {chart / scale}

(iii) In the method, universal indicator paper is used to determine the pH.

Explain why litmus paper would not be a suitable indicator to use in this experiment.

(2)

litmus paper only shows if the solution is {acidic / alkaline}
• does not show how acidic or alkaline the solution is

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(iv) Figure 2 shows the student's results.

mass of barium hydroxide in g	pH of mixture
0.0	1
0.2	1
0.4	1
0.6	1
0.8	2
1.0	7
1.2	12
1.4	13
1.6	13

Figure 2

On the grid opposite:

- Add suitable scales to the vertical and horizontal axes.
- Plot a graph of the pH of the mixture against the mass of barium hydroxide.

(3)

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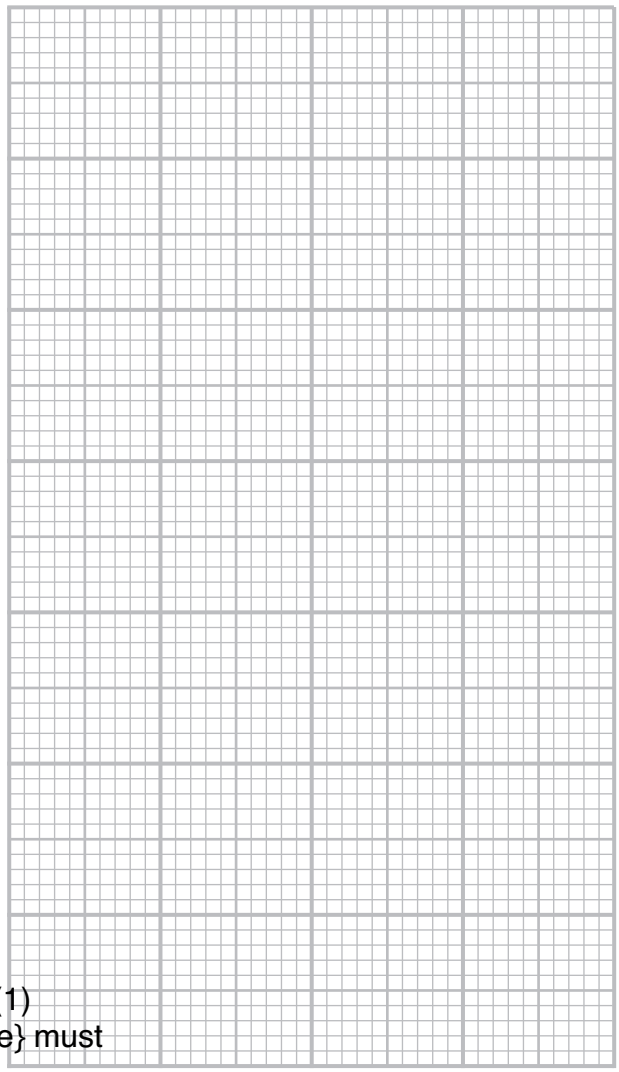
pH of
the mixture



mass of barium hydroxide in g

linear scales on both axes (1)
• {plotted points / best fit line} must cover at least half
graph paper in both directions (1)
• 7 or more points plotted correctly
(? half a square)

(Total for Question 2 = 9 marks)

3 Magnesium carbonate has the formula $MgCO_3$.

(a) Magnesium carbonate contains Mg^{2+} and CO_3^{2-} ions.

(i) The atomic number of magnesium is 12.

What is the electronic configuration of the Mg^{2+} ion?

(1)

☒ **A** 2

☒ **B** 2.8

☒ **C** 2.8.2

☒ **D** 2.8.4

(ii) Explain why solid magnesium carbonate cannot conduct electricity but solid magnesium can.

(3)

• ions (in magnesium carbonate) {cannot move / in a fixed position / held in a lattice / held together by strong electrostatic forces}
• magnesium contains {delocalised/free} electrons
• electrons (in magnesium) can {flow / move} / are

(b) Calculate the percentage by mass of magnesium in magnesium carbonate, $MgCO_3$.

(relative atomic masses: C = 12.0, O = 16.0, Mg = 24.0)

(3)

MP1 – relative formula mass MgCO3
24.0 + 12.0 + 3x16.0 (1) (= 84.0)
MP2 – division
24(.0) (1) (= 0.28571429)
84(.0)
MP3 – conversion to percentage
(0.28571429) x 100

percentage by mass of magnesium = ...

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(c) Magnesium carbonate reacts with dilute hydrochloric acid.
Water and carbon dioxide are two of the products of the reaction.

Complete the balanced equation for this reaction.

(1)

$MgCO_3 + 2HCl \rightarrow$ MgCl2 $+ H_2O + CO_2$

(Total for Question 3 = 8 marks)

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4 Sucrose is a carbohydrate.

When a solution of sucrose is fermented using yeast, ethanol is formed.

$$\text{sucrose} + \text{water} \rightarrow \text{ethanol} + \text{carbon dioxide}$$

(a) In one experiment, 100.00 g of sucrose was dissolved in water.

Yeast was added and the mixture allowed to ferment until no more bubbles of carbon dioxide were seen to be formed.

The ethanol was obtained from the mixture and its mass determined.

The results are shown in Figure 3.

	mass in g
mass of sucrose	100.00
mass of ethanol obtained from the reaction	8.07
theoretical mass of ethanol formed	53.80

Figure 3

The percentage yield is calculated using

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

(i) State the meanings of the terms **actual yield** and **theoretical yield**.

(2)

actual yield

Actual yield – {mass/amount/yield} (of product) formed in the {reaction / experiment} (1)

theoretical yield

Theoretical yield – calculated {mass/amount/yield} of product formed (using the balanced equation) / {mass/amount/yield} of product formed if all reactant used to form product only with no losses

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(ii) Use the information in Figure 3 to calculate the percentage yield of ethanol in this experiment.

(2)

8.07 (1) (= 0.15)
53.80
0.15 x 100 (1) (= 15)

percentage yield = ...

(iii) State **two** reasons why the actual yield of a reaction is usually less than the theoretical yield.

(2)

1 • Some reactant remained unreacted

• Some product is lost during {the reaction /processes/extraction/purification}

2 .....

(b) The balanced equation for the fermentation of sucrose is

$$C_{12}H_{22}O_{11} + H_2O \rightarrow 4C_2H_5OH + 4CO_2$$

(i) Calculate the atom economy of this reaction to produce ethanol.

Give your answer to two significant figures.

(relative formula masses: $C_{12}H_{22}O_{11} = 342$, $H_2O = 18$, $C_2H_5OH = 46$, $CO_2 = 44$)

(3)

342 + 18 = 360 / 4x46 + 4x44 = 360

atom economy = ... %

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(ii) Explain the effect on the atom economy of this reaction if the carbon dioxide produced was used to make fizzy drinks.

(2)

• carbon dioxide becomes {useful/a desired product /no longer a waste product}
• so atom economy increases (to 100%)

(Total for Question 4 = 11 marks)

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5 When copper sulfate solution is electrolysed using copper electrodes, the mass of each electrode changes.

(a) Draw a labelled diagram to show the apparatus that can be used to electrolyse copper sulfate solution using copper electrodes.

(2)

two (copper) electrodes in {beaker / suitable container}
of {copper sulfate / solution / electrolyte}
• connected to {power supply / battery / cell}

(b) Before the electrolysis is carried out, the mass of each electrode is determined.

Explain what should be done to the copper electrodes before their masses are determined.

(2)

• (electrodes) cleaned (using emery paper) (or similar)
• to remove {surface oxide / grease / impurities}

(c) Figure 4 shows the results obtained from an electrolysis experiment when copper sulfate solution was electrolysed for 10 minutes.

	electrodes	
	anode	**cathode**
mass of electrode before electrolysis in g	6.43	6.17
mass of electrode after electrolysis in g	5.62	6.95
change in mass in g	– 0.81	+ 0.78

Figure 4

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(i) Explain, in terms of ions, the changes in mass of the two electrodes shown in the results in Figure 4.

(3)

at anode copper / atoms {lose electrons / oxidised} / (copper) ions leave anode (– cause mass loss)
• (copper) ions (in solution) move to cathode
• At cathode (copper) ions {gain electrons / reduced} (- cause mass increase)

(ii) The electrolysis was repeated using another pair of copper electrodes of the same masses.

Explain a change that could be made to the electrolysis experiment to cause the mass of the cathode to increase by 2.34 g in 10 minutes.

(2)

mass of copper increased by {3x / calculated 2.34/0.78} (=3)
• (so) need (3x) / more {current / voltage} passing through solution

(Total for Question 5 = 9 marks)

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6 The method used to extract a metal from its ore depends on the position of the metal in the reactivity series.

(a) Aluminium is extracted from its ore by electrolysis.

Explain why this method is used to extract aluminium from its ore.

(2)

aluminium is (very) high in the reactivity series / very reactive
• needs a lot of energy (to remove oxygen from the oxide)

(b) (i) One step in the extraction of titanium metal involves the displacement reaction between titanium chloride, $TiCl_4$, and magnesium.

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

This equation can be simplified as

$$Ti^{4+} + 2Mg \rightarrow Ti + 2Mg^{2+}$$

Explain why this displacement reaction can be described as a redox reaction.

(3)

redox involves both) reduction and oxidation
• magnesium (atoms) loses electrons (and are oxidised)
• titanium ions accept electrons (and are reduced)

(ii) The formula of the sulfate ion is SO_4^{2-}.

Which of the following is the formula of titanium sulfate containing the Ti^{4+} ion?

(1)

☒ **A** $TiSO_4$

☒ **B** Ti_2SO_4

☒ **C** $Ti(SO_4)_2$

☒ **D** $Ti_2S_2O_8$

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(c) Phytoextraction is an alternative biological method that can be used to extract metals from very low-grade ores.

Give **one** disadvantage of phytoextraction as a method of extraction of metals.

(1)

slow process / large area of land required / only extracts metal from the ground surface / metals need further extraction

(d) Copper is low down in the reactivity series and can be obtained from copper oxide.

Devise a simple method to obtain a sample of copper from copper oxide in the laboratory.

(2)

mix copper oxide with {carbon / powdered charcoal} (in a suitable container)
• heat (with carbon) (strongly until no further change)

(Total for Question 6 = 9 marks)

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7 The volume of dilute sulfuric acid required to neutralise 25.0 cm^3 of ammonia solution can be found by titration.

In the titration, a few drops of methyl orange indicator were added to the ammonia solution in a conical flask before adding the dilute sulfuric acid.

(a) State the change in colour of the methyl orange at the end point when the ammonia solution has just been neutralised.

(2)

from Yellow to Orange

(b) When the ammonia solution was neutralised by the dilute sulfuric acid, a solution of ammonium sulfate was formed.

Complete the balanced equation for the reaction between ammonia solution and sulfuric acid.

(2)

2 $NH_3 + H_2SO_4 \rightarrow$ (NH4)2SO4

(c) The titration was repeated to obtain a mean volume of dilute sulfuric acid required to neutralise the 25.0 cm^3 of ammonia solution.
The volumes of the two solutions were measured accurately.

Explain **two** other practical steps that should be used in the titration to ensure that an accurate titre volume is obtained.

(4)

1 use of white tile
- easier to see precisely when indicator changes colour
- (near to end point) {add (acid) slowly / in small quantities each time}
- easier to stop excess acid being added (when indicator changes colour)

2

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(d) The mean volume of dilute sulfuric acid required to neutralise the ammonia solution was determined from the results of the titration.

This volume of dilute sulfuric acid was added to 25.0 cm^3 of ammonia solution in a conical flask.

Devise a plan to produce a sample of dry ammonium sulfate from the contents of the conical flask.

(3)

heat solution (in an evaporating basin) (to concentrate)
• (cool and) crystallise
• dry ammonium sulfate crystals (between filter papers)

(Total for Question 7 = 11 marks)

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8 (a) Bromine is a liquid at room temperature and vaporises readily.
Bromine has a simple molecular structure.

Which row of the table shows the most likely melting and boiling points of bromine?

(1)

	melting point in °C	boiling point in °C
☒ **A**	–70	–6.3
☒ **B**	–17	6.3
☒ **C**	–7	63
☒ **D**	17	630

(b) Part of the structure of graphene is shown in Figure 5.

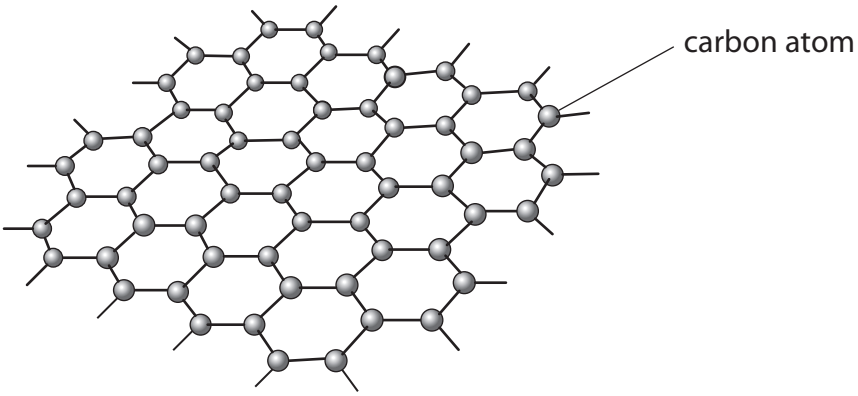

Figure 5

Explain why graphene will be a good conductor of an electric current.

(3)

carbon has 4 outer shell electrons

• 3 electrons used in bond with other carbon atoms / each carbon forms 3 bonds

• (one) electron free to move / delocalised

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(c) Part of the structure of potassium chloride is shown in Figure 6.

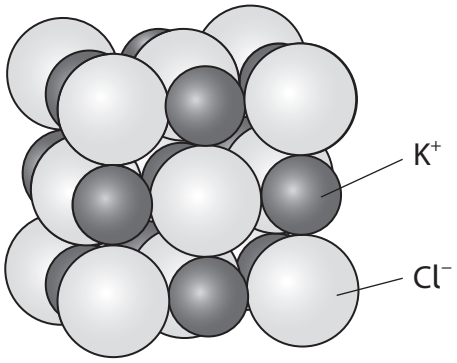

Figure 6

Potassium chloride has a melting point of 770 °C.

Explain why potassium chloride has a high melting point.

(2)

• {ionic / giant / lattice} structure

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*(d) A molecule of methane can be represented in several different ways as shown in Figure 7.
These representations have been labelled **A**–**E** to assist you in your answer.

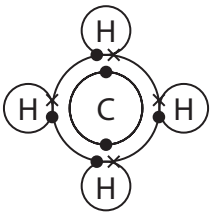
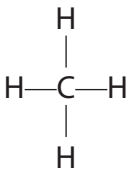
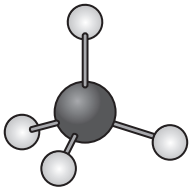
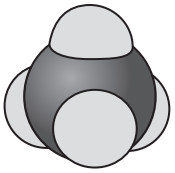
A	B	C	D	E
CH_4				

Figure 7

Describe what information can be obtained from each representation including the limitations of these representations of methane.

(6)

they show methane contains carbon and hydrogen
- structure A only shows the ratio of C:H (as 1:4)
- structure A gives no information about bonding in molecule
- structure A gives no information about shape of molecule
- dot & cross diagram, B, shows the covalent bonding between the C and H atoms
- single bonds, show in structures B, C and D
- inner shell not involved in bonding
- structure B does not show the 3-D positions of atoms
- single lines used to show single covalent bonds in structure C
- only a 2-D representation and not positions in space
- ball & stick model, D, shows position in space / 3-D arrangement
- atoms not actually connected by the sticks
- space-filling, structure E, model shows 3-D arrangement of atoms
- E shows approximate relative sizes occupied by separate atoms
- no information about type of bond between atoms in structure

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(Total for Question 8 = 12 marks)

9 (a) A student carried out an investigation to determine the order of reactivity of four metals, **W**, **X**, **Y** and **Z**.
A piece of metal **W** was added to a test tube containing excess dilute hydrochloric acid.
This was repeated with the other three metals, **X**, **Y** and **Z**.
In each case, the size of each piece of metal was the same.
The student recorded observations on each reaction for three minutes.

The observations obtained are shown in Figure 8.

metal	observations with dilute hydrochloric acid
W	Bubbles formed quickly with some metal remaining after three minutes.
X	A few bubbles were seen to form. The metal looked unchanged after three minutes.
Y	Bubbles formed quickly. After three minutes all the metal had reacted.
Z	Bubbles formed very quickly with no metal remaining after three minutes.

Figure 8

(i) Use the information in Figure 8 to place the metals in order of reactivity from the least reactive to the most reactive.

(2)

least reactive ⟶ most reactive

X	W	Y	Z

(ii) The experiment was repeated using an excess of dilute sulfuric acid in place of the dilute hydrochloric acid.

metal + sulfuric acid → metal sulfate + hydrogen

When metal **Y** reacts with dilute sulfuric acid, bubbles form quickly at first and then the reaction stops.
Most of the solid metal remains.

Explain why the reaction between metal **Y** and excess dilute sulfuric acid stopped even though there was solid metal **Y** left.

(2)

• metal sulfate {insoluble / coats the metal / forms a barrier}
• prevents further reaction of metal with acid

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(iii) The reactions between metals and dilute ethanoic acid are slower than reactions between metals and dilute hydrochloric acid.
This is because ethanoic acid is a weak acid.

Explain the meaning of the term **weak acid**.

(2)

partially {dissociated / ionised}
• {concentration of H+ ions lower / fewer H+ ions}
than expected

(b) The formula of aluminium sulfate is $Al_2(SO_4)_3$.

Calculate the total number of atoms that combine to form 5.13 g of aluminium sulfate.

(relative atomic masses: O = 16.0, Al = 27.0, S = 32.0
Avogadro number = 6.02×10^{23})

(4)

formula mass Al2(SO4)3
= 2x27 + 3x(32 + 16x4) (1) (= 342)
moles of Al2(SO4)3
= 5.13 (1) (= 0.015)
342
no of atoms in formula Al2(SO4)3 = 17
no of atoms in 0.015 moles = 17 x 0.015 x 6.02 x 1023 (1)
= 1.5351 x 1023

number of atoms = ...

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(c) Iron is more reactive than lead.
Iron reacts with lead nitrate solution to form solid lead.
Two possible balanced equations for the reaction are

Equation **1** $Fe + Pb(NO_3)_2 \rightarrow Fe(NO_3)_2 + Pb$

Equation **2** $2Fe + 3Pb(NO_3)_2 \rightarrow 2Fe(NO_3)_3 + 3Pb$

In one experiment, it was found that 4.48 g of iron reacted with excess lead nitrate solution to form 24.84 g of lead.

Carry out a calculation, using the information above, to show which equation represents the reaction taking place.

(relative atomic masses: Fe = 56.0, Pb = 207)

(3)

moles Fe = 4.48 (1) (= 0.08)
56.0
moles Pb = 24.84 (1) (= 0.12)
207
ratio moles Fe : moles Pb = 2 : 3
or 1 : 1.5
so equation 2

(Total for Question 9 = 13 marks)

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10 When hydrogen is removed from an alkane, an alkene is formed.

This is an example of a dehydrogenation reaction.

(a) Under certain conditions the dehydrogenation of propane forms propene and a dynamic equilibrium is reached.

(i) State what is meant by dynamic in this context.

(1)

both forward and back(ward) reactions take place at same time

*(ii) The equation for this equilibrium reaction is

$$\underset{\text{propane}}{C_3H_8(g)} \rightleftharpoons \underset{\text{propene}}{C_3H_6(g)} + H_2(g)$$

The forward reaction takes in heat energy and is endothermic.
A manufacturer produces large quantities of propene using this equilibrium reaction.

Suggest, with explanations, suitable conditions that the manufacturer could use to maximise the yield and rate of production of propene from propane.

(6)

• use of suitable catalyst (any suitable metal eg Pt)
• helps increase rate of forward reaction
• and helps increase rate of back reaction
• so increases rate of attainment of equilibrium
• but has no effect on equilibrium yield
• increase temperature would increase rate of reaction
• shifts equilibrium to right hand side
• so increases equilibrium yield
• so use a high temperature (range 200–600 oC – anything would be reasonable)
• use of very high temperatures increases energy use
• so makes product more expensive
• as fewer molecules on left hand side than right
• so use low pressures
• moves equilibrium to right hand side
• so increases equilibrium yield
• high pressure increases rate but decreases yield OR low pressure increases yield but decreases rate
• pressure used is a compromise between rate and yield

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(b)

$$C_3H_8(g) \rightleftharpoons C_3H_6(g) + H_2(g)$$
propane propene

State the maximum volume of propene, in dm^3, formed by the dehydrogenation of 300 dm^3 of propane.

(assume all volumes of gases are measured under the same conditions of temperature and pressure)

(1)

maximum volume of propene = 300 dm^3

(c) 900 dm^3 of propane, measured at room temperature and pressure, were dehydrogenated to form propene.

$$C_3H_8(g) \rightleftharpoons C_3H_6(g) + H_2(g)$$
propane propene

Calculate the maximum mass, in kg, of hydrogen formed in this reaction.

(relative atomic mass: H = 1.0;
1 mol of any gas at room temperature and pressure occupies 24 dm^3)

(4)

1 mol C3H8 produces 1 mol H2 (1)
no moles propane = 900 (1) (= 37.5)
24
= no moles H2
mass of H2 = 37.5 x 2 g (1) (= 75.0 (g))
= 7.50 x 10-2 (kg) (1) (= 0.075)

mass of hydrogen = ... kg

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS

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The periodic table of the elements

1	2											3	4	5	6	7	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	63.5 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

* The elements with atomic numbers from 58 to 71 are omitted from this part of the periodic table.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

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