Please check the examination details below before entering your candidate information

Candidate surname	Other names

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

Centre Number | Candidate Number

Thursday 16 May 2019

Morning (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 ▶

1/1/1/1/1/1/1/
P 5 6 4 2 1 A 0 1 3 2

Pearson

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 In a hydrogen-oxygen fuel cell, hydrogen and oxygen react at the electrodes.

(a) The overall reaction occurring in this fuel cell is a reaction of hydrogen with oxygen.

Write the balanced equation for this reaction.

(2)

$2H_2 + O_2 \rightarrow 2H_2O$

fully correct balanced equation
If not (2), then H_2O as product in an equation

(b) The electrodes of a fuel cell are in contact with water and air.
The electrodes are made of platinum rather than iron.

(i) State why iron is not a suitable metal for the electrodes of the cell.

(1)

iron rusts/ corrodes/ reacts {with oxygen/ water} /
iron oxidises / forms iron oxide

(ii) Platinum acts as a catalyst.

State, in terms of its position in the periodic table, why you would expect platinum to act as a catalyst.

(1)

platinum is a transition {metal/ element}

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(c) Some metal objects are electroplated.

State **two** reasons for electroplating a metal object.

(2)

1 improves the appearance/ shiny

2 improves resistance to corrosion/ does not corrode/ prevents reaction with

(Total for Question 1 = 6 marks)

2 In Figure 1, the letters **A**, **E**, **G**, **J**, **X** and **Z** show the positions of six elements in the periodic table.

These letters are not the symbols of the atoms of these elements.

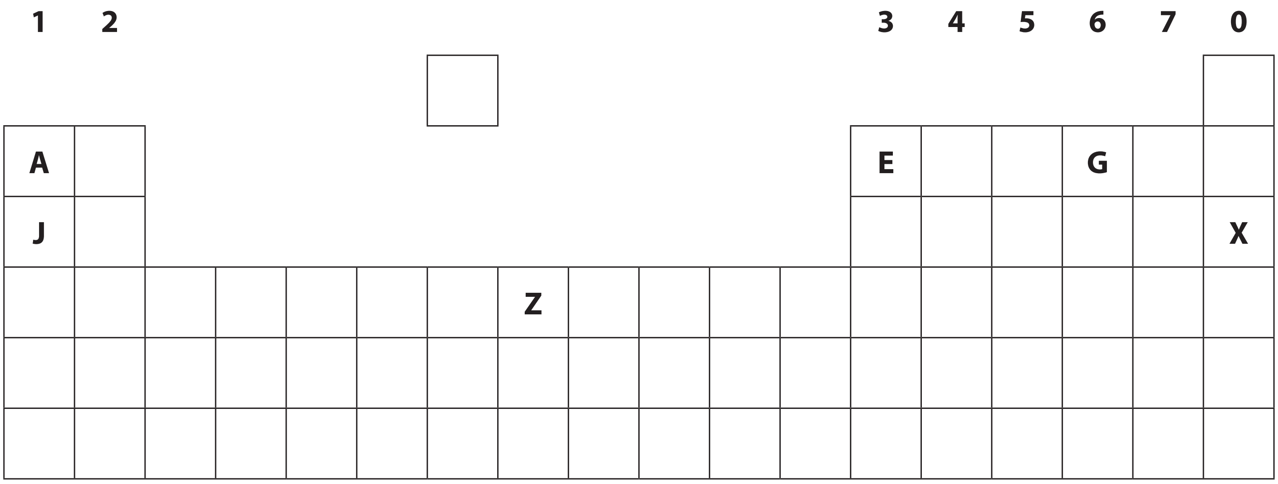

Figure 1

(a) Using the letters **A**, **E**, **G**, **J**, **X** and **Z**

(i) give the letters of the **two** elements that are non-metals

(1)

E, G

(ii) give the letters of **two** elements in period 2

(1)

A, G

(iii) give the letter of an element that normally forms an ion with a charge of +1.

(1)

A, J

(b) Element **E** has an atomic number of 5.
In a sample of **E** there are two isotopes. One isotope has a mass number of 10 and the other isotope has a mass number of 11.

(i) Explain, in terms of subatomic particles, what is meant by the term **isotopes**.

(2)

atoms with) same
(number of) protons
• (atoms with) different
(number of) neutrons

(ii) All atoms of element **E** in this sample contain **(1)**

☒ **A** 5 protons

☐ **B** 5 neutrons

☐ **C** 6 protons

☐ **D** 6 neutrons

(c) Element **X** has an atomic number of 18.

State the electronic configuration of an atom of element **X**. **(1)**

2,8,8

(d) In an experiment, 3.5 g of element **A** reacted with 4.0 g of element **G** to form a compound.

Calculate the empirical formula of this compound.
(relative atomic masses: **A** = 7, **G** = 16)

You must show your working. **(3)**

A : G
3.5 : 4.0
7 16
MP2 for deriving ratio from MP1
0.5 : 0.25

empirical formula of this compound = A2G

(Total for Question 2 = 10 marks)

3 (a) Water, acidified with sulfuric acid, is decomposed by electrolysis. The water is decomposed to produce hydrogen and oxygen.

(i) A sample of hydrogen is mixed with air and ignited.

State what would happen.

(1)

squeaky) pop / gas burns /
water forms

(ii) Throughout the experiment the volume of hydrogen and the volume of oxygen are measured at two-minute intervals.

The results are shown in Figure 2.

time in minutes	volume of hydrogen in cm^3	volume of oxygen in cm^3
0	0	0
2	4	2
4	8	4
6	12	6
8	16	8

Figure 2

Describe, using the data in Figure 2, what the results show about the volumes of hydrogen and of oxygen produced in this experiment.

(2)

. volumes going up:
(oxygen/ hydrogen/ gas)
increase
(with time) / volume
(directly)
proportional to time
• quantitative comparing
hydrogen and
oxygen:
(volume of) hydrogen
double
(volume of) oxygen /
ORA / 2:1 Ratio

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(b) Molten lead bromide is electrolysed.

The products of this electrolysis are

(1)

☐ **A** hydrogen and bromine

☐ **B** hydrogen and oxygen

☒ **C** lead and bromine

☐ **D** lead and oxygen

(c) Calcium nitrate and calcium carbonate are both ionic compounds.

Calcium nitrate mixed with water behaves as an electrolyte.
Calcium carbonate mixed with water does not behave as an electrolyte.

Explain, in terms of solubility and movement of ions, this difference in behaviour.

(2)

• (calcium) nitrate {is soluble/ dissolves}/ (calcium) carbonate {is insoluble/ does not dissolve}
• so ions {free to move in solution / not free in

(d) When molten zinc chloride is electrolysed, zinc ions, Zn^{2+}, form zinc atoms.

Write the half equation for this reaction.

(2)

Zn2+ + 2e(-) → Zn (2)

(Total for Question 3 = 8 marks)

4 Calcium carbonate decomposes on heating to form calcium oxide and carbon dioxide.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

(a) 8.000 g of $CaCO_3$ was heated strongly for about 10 minutes. 6.213 g of solid remained. Calculate the mass of carbon dioxide gas given off.

(1)

8.000- 6.213 = (1.787) (g)

mass of carbon dioxide = ... g

(b) A second sample of calcium carbonate is strongly heated in a crucible until there is no further loss in mass.
The mass of calcium oxide remaining in the crucible is 5.450 g.

(i) The theoretical yield of calcium oxide in this experiment is 5.600 g.

Calculate the percentage yield of calcium oxide.

(2)

5.450 x 100
5.600
= 97.3214….

percentage yield = ...

(ii) The mass of solid left in the crucible is less than the theoretical mass of calcium oxide that should be obtained.

A possible reason for this is that

(1)

☐ **A** some solid was lost from the crucible

☒ **B** the solid remaining absorbed some water from the air

☐ **C** some carbon dioxide remained in the crucible

☐ **D** the decomposition was incomplete

(c) Another sample of calcium carbonate is heated and the mass of solid remaining is measured each minute.

The results are shown in Figure 3.

time in minutes	0	1	2	3	4	5	6	7
mass of solid remaining in g	9.0	8.1	7.2	6.4	6.0	5.6	5.3	5.2

Figure 3

(i) Explain the trend shown by the data in Figure 3.

(2)

rate/ mass loss} is slowing down
• as amount of reactant falls

(ii) It is impossible to be sure from this data that the reaction is complete.

State why.

(1)

mass may decrease further / not heated to constant mass
/ last two mass figures not the same

(d) (i) Calculate the relative formula mass of calcium carbonate, $CaCO_3$.
(relative atomic masses: C = 12, O = 16, Ca = 40)

(2)

40 + 12 + 3 x 16
=100

relative formula mass = ...

(ii) Calculate the atom economy for the formation of calcium oxide in this reaction.

$$CaCO_3 \rightarrow CaO + CO_2$$

You must show your working.
(relative atomic masses: C = 12, O = 16, Ca = 40;
relative formula mass: calcium oxide = 56)

(2)

$\frac{56}{100}$

atom economy = 56 %

(Total for Question 4 = 11 marks)

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5 (a) One way to extract metals from land contaminated with metal compounds is phytoextraction.
When plants grow they absorb metal ions through their roots.
The plants are harvested, dried and burned forming an ash.
The ash contains metal compounds.

Plants were grown in a piece of ground contaminated with nickel compounds.

(i) 1 kg of the ash from these plants contained 142.0 g of nickel compounds.

Calculate the percentage by mass of nickel compounds in the ash.

(3)

1kg = 1000g

~~142~~
1000

percentage by mass = ...

(ii) Nickel is extracted from nickel compounds.

State an advantage of extracting nickel by phytoextraction rather than from its ore.

(1)

- decontaminates ground / conserves {nickel / nickel ores / ores} / allows use of low-grade ore /
- specified environmental reason: e.g. less noise due to mining / carbon

(b) Some nickel ores contain nickel sulfide.

(i) In the first stage of extracting nickel from nickel sulfide, the nickel sulfide, NiS, is heated in air to form nickel oxide, NiO, and sulfur dioxide.

Write the balanced equation for this reaction.

(2)

2NiS + 3O2 → 2NiO + 2SO2 (2)
all four formulae

(ii) In the final stage of the extraction process, a nickel compound is electrolysed to produce pure nickel.

An advantage of producing a metal by electrolysis is that

(1)

☐ **A** electrolysis uses a large amount of electricity

☒ **B** the metal produced by electrolysis is very pure

☐ **C** electrolysis is a very cheap method of extraction

☐ **D** electrolysis is the only method of extracting unreactive metals

(c) In a different method of obtaining nickel, the process produces a mixture of the liquids nickel tetracarbonyl and iron pentacarbonyl.

The boiling point of nickel tetracarbonyl is 43 °C.
The boiling point of iron pentacarbonyl is 103 °C.
These two liquids mix together completely.

Describe the process used to separate these two liquids.

(3)

fractional) distillation
• heat/ boil
• nickel tetracarbonyl {{boils/evaporates}
off first / is obtained from top of
column/ vapour is condensed by

(Total for Question 5 = 10 marks)

6 (a) Hydrated copper sulfate, $CuSO_4.5H_2O$, is a blue solid.
Anhydrous copper sulfate, $CuSO_4$, is a white solid.

Heat energy is needed to convert hydrated copper sulfate to anhydrous copper sulfate.
This is a reversible reaction.

$$CuSO_4.5H_2O \rightleftharpoons CuSO_4 + 5H_2O$$

Devise an experiment to show that this is a reversible reaction.

(4)

DECOMPOSITION
• heat the (hydrated) {crystals / solid}
• (solid) goes white/ steam is observed / water produced

REVERSE REACTION
• add water / water rejoins / water reacts with anhydrous solid
• (solid) goes blue (again) / heat is released

(b) Hydrogen reacts with iodine to form hydrogen iodide.
Iodine gas is purple and hydrogen iodide gas is colourless.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

Hydrogen and iodine are placed in a sealed container.
The container is left until equilibrium is reached.

The conditions are changed favouring the forward reaction.

Explain what you would **see**.

(2)

• less purple / lighter/ paler / fades
• because less iodine

(c) Calculate the number of atoms combined in one mole of copper iodide, CuI_2.
(Avogadro constant = 6.02×10^{23})

(2)

- 3 x 6.02 x 1023
- = 1.8 x 1024

number of atoms = ...

(Total for Question 6 = 8 marks)

7 Many metals corrode.

(a) When a metal corrodes

(1)

- ☒ **A** the metal reacts with nitrogen
- ☒ **B** the metal reacts with another metal
- ☒ **C** the metal element decomposes
- ☒ **D** the metal is oxidised ✓

(b) An experiment is carried out to see if magnesium ribbon wrapped around a piece of iron rod has an effect on the rate at which the iron rod rusts.

The apparatus is shown in Figure 4.

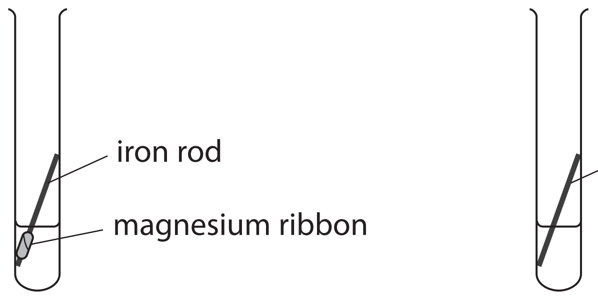

Figure 4

The method used is

- an iron rod, with magnesium ribbon wrapped around it, is placed in a boiling tube labelled **A**
- 10 cm^3 water from a measuring cylinder is poured into this boiling tube
- an identical rod but with no magnesium ribbon wrapped around it is placed in a second boiling tube labelled **B**
- 10 cm^3 water from a measuring cylinder is poured into this boiling tube.

Both boiling tubes are left for a few days.

(i) Explain why iron rod rather than stainless steel rod is used in this experiment.

(2)

stainless steel resistant to {corrosion/ rusting/ oxidation} / corrosion rate slower / does not react with {air/oxygen} and water
• neither rod would rust/ react (in a few days) / there would be no {rusting / reaction}/ no change would occur / it would take a long time

(ii) State why it is not necessary to use a pipette to measure out 10 cm^3 water in this experiment.

(1)

measuring cylinder accurate enough / accuracy of pipette not needed / no need to be (more) accurate / the volume of water is not critical

(iii) After a few days the two boiling tubes were examined.

The results are shown in Figure 5.

boiling tube A	the appearance of the iron rod is unchanged the magnesium has started to disappear
boiling tube B	a small amount of brown deposit has formed around the rod

Figure 5

Explain the results of this experiment.

(2)

A) the magnesium has {corroded/ reacted/ oxidised} /
(B) {rusting / corrosion / oxidation} has occurred (1)
• because magnesium is more reactive than iron /

(c) Hydrazine, N_2H_4, reacts with oxygen.

$$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$$

A metal in water corrodes faster than an identical piece of metal in the same volume of water containing dissolved hydrazine.

Use the information to explain how hydrazine slows corrosion.

(2)

• {less oxygen / no oxygen / oxygen is removed} by the hydrazine
• oxygen is needed for {rusting / reaction} /

(d) Ammonia is used to make hydrazine.

In the industrial process to manufacture ammonia, nitrogen and hydrogen are combined in the presence of an iron catalyst.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(i) State the name of the industrial process to manufacture ammonia.

(1)

Haber process

(ii) Predict the effect that adding the catalyst has on the rate of attainment of equilibrium.

(1)

rate increased / speeded up / quicker / faster

(iii) Predict the effect that adding the catalyst has on the equilibrium yield of ammonia.

(1)

yield unchanged/ stays same / none

(Total for Question 7 = 11 marks)

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8 Pieces of zinc react with copper sulfate solution.
Zinc sulfate solution is colourless.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

(a) Describe what you would **see** when an excess of zinc is added to copper sulfate solution and the mixture left until the reaction is complete.

(2)

• {(red-)brown / orange / pink} solid formed
• (some) {grey/silver} solid remains

(b) This reaction is described as a redox reaction.

Explain, in terms of electrons, which particles have been oxidised and which particles have been reduced in this reaction.

(4)

zinc oxidised
• because (zinc) lose electrons/ half equation
• copper (ions) reduced
• because copper (ions) gained

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(c) The copper sulfate solution used has a concentration of $15.95\ g\ dm^{-3}$.

Calculate the number of moles of copper sulfate, $CuSO_4$, in $50.00\ cm^3$ of this solution.
(relative atomic masses: O = 16, S = 32, Cu = 63.5)

(3)

0.005/ 5 x 10-3 mol with or without working
scores 3
Mr = 63.5 + 32 + 4 x 16 (1) (=159.5)
AND EITHER
mass of copper sulfate =
50/1000 x 15.95 (1) (= 0.7975 g)
moles = 0.7975/159.5 (1) (= 0.005 mol)

number of moles of copper sulfate = ... mol

(d) In another experiment, 0.043 mol of copper sulfate, $CuSO_4$, is used.

Calculate, to one decimal place, the minimum mass of zinc that must be added to react with all the copper sulfate.
(relative atomic mass: Zn = 65)

(2)

0.043 x 65 2.795)
= 2.8 g

mass = ... g

(Total for Question 8 = 11 marks)

9 (a) **X** and **Y** are solutions of two different acids.
The concentration of acid in each solution, in mol dm^{-3}, is the same.
Solution **X** has a pH of 3.40 and solution **Y** has a pH of 4.40.

(i) State what could be used to measure these pH values of 3.40 and 4.40.

(1)

use pH meter/ pH probe

(ii) What is the concentration of hydrogen ions in solution **X** compared with that in solution **Y**?

(1)

☐ **A** ten times lower

☐ **B** lower by a factor of 3.30/4.40

☐ **C** higher by a factor of 4.40/3.30

☒ **D** ten times higher

(b) An experiment is planned to record the change in pH as a powdered base is added to 50 cm^3 dilute hydrochloric acid.

The method suggested is

step 1 add dilute hydrochloric acid up to the 50 cm^3 mark on a beaker

step 2 add one spatula of the base and stir

step 3 measure the pH of the mixture

step 4 repeat steps 2 and 3 until the pH stops changing.

(i) State how you could change the method so that the amounts of dilute hydrochloric acid and of the base can be measured more accurately.

(2)

dilute hydrochloric acid use measuring cylinder / pipette / burette

base

(ii) During the experiment the pH changes from 2 to 10.
If phenolphthalein indicator is added at the beginning of the experiment, a colour change occurs as the base is added.

State the colour change that occurs.

(1)

colour at start Colorless

colour at end Pink / Magneta

(iii) Explain, in terms of the particles present, why the pH increases during the experiment.

(2)

• {hydrogen ions/ H+} {reacted / neutralised}
• {concentration falls/ fewer} H+ / {concentration rises/ more} OH-

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*(c) Some properties of four solids, **A**, **B**, **C** and **D**, are shown in Figure 6.

The solids, in no particular order, are copper carbonate, copper oxide, magnesium metal and sodium hydroxide.

	A	B	C	D
colour of solid	black	silver	white	green
observation when solid is added to water	black solid remains	a few bubbles appear on surface of solid	solid dissolves and forms colourless solution	green solid remains
pH of mixture of solid added to water	7	8	13	7
observation when solid is added to dilute sulfuric acid	on warming, solid disappears to form blue solution	effervescence solid disappears to form colourless solution	solid disappears to form colourless solution	effervescence solid disappears to form blue solution

Figure 6

Identify the solids **A**, **B**, **C** and **D**, explaining how the information in Figure 6 supports the identification of each solid.

(6)

• A is copper oxide
• copper oxide is black
• copper oxide reacts with sulfuric acid to make {copper sulfate / blue solution} but no gas
• B is magnesium
• magnesium is silver coloured
• magnesium reacts/ bubbles with water
• magnesium reacts with sulfuric acid to give hydrogen / equation
• C is sodium hydroxide
• sodium hydroxide is white
• sodium hydroxide solution is colourless
• sodium hydroxide reacts with sulfuric acid to form a colourless solution / equation
• sodium hydroxide solution is alkaline
• sodium hydroxide has hydroxide ions
• D is copper carbonate
• copper carbonate is green
• carbonates are insoluble
(6)
• copper carbonate reacts with sulfuric acid to form copper sulfate and {gas / carbon dioxide}
• copper carbonate reacts with sulfuric acid to form carbon dioxide / equation
• copper sulfate (solution) is blue

(Total for Question 9 = 13 marks)

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10 (a) Nitric acid can be titrated with a solution of ammonia.

(i) State the type of reaction occurring when nitric acid reacts with ammonia.

(1)

Neutralisation

(ii) What salt is formed in this reaction?

(1)

☐ **A** ammonia nitric

☐ **B** ammonia nitrate

☐ **C** ammonium nitric

☒ **D** ammonium nitrate

(b) In one stage of the production of nitric acid, nitrogen oxide, NO, is reacted with oxygen to make nitrogen dioxide, NO_2.

$$2NO + O_2 \rightarrow 2NO_2$$

Calculate the minimum volume of air, measured at room temperature and pressure, required to react with 1000 g nitrogen oxide to form nitrogen dioxide.

Assume that the air contains 20% oxygen by volume.
(relative atomic masses: N = 14, O = 16
1 mol of gas occupies 24 dm^3 at room temperature and pressure)

(4)

moles NO = 1000/30 (= 33.3…)
moles O2 = moles NO /2 (= 16.666…)
volume O2 = moles x 24 = 16.666… x 24 =400 dm3

volume of air = ... dm^3

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*(c) In another stage in the production of nitric acid, ammonia is reacted with oxygen to form nitrogen oxide and water.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

Heat energy is given out when ammonia reacts with oxygen.

The conditions chosen for the reaction are
- excess air, rather than just the right amount
- a pressure of 10 atm, rather than atmospheric pressure
- a temperature of 900 °C, rather than room temperature.

Explain the effect of the conditions chosen on the equilibrium yield of nitrogen oxide and on the rate of attainment of equilibrium.

(6)

EXCESS AIR
- increases oxygen concentration
- so excess air favours right hand side
- and gives higher yield
- excess air increases concentration of oxygen
- equilibrium reached faster

PRESSURE
- 9 molecules on left and 10 on right
- so higher pressure favours left hand side
- and gives lower yield
- higher pressure increases concentration of gases
- more frequent collisions
- equilibrium reached faster

TEMPERATURE
- heat energy given out in forward reaction
- higher temperature favours reaction that takes in heat energy
- so higher temperature favours left hand side
- hence lower yield
- molecules move faster at higher temperature
- more frequent collisions
- therefore more reactions in given time
- equilibrium reached faster

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(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS

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The Periodic Table of the Elements

Key

relative atomic mass **atomic symbol** name atomic (proton) number

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
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

***** *The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.*

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