SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME							
CLASS	4			REGISTER NUMBER			
CENTRE NUMBER					INDEX NUMBER			

Chemistry

6092/01

Paper 1 Theory

Tuesday **1 September 2020** **1 hour**

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number on the Question Paper and Answer Sheet in the spaces provided.

There are **forty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A, B, C, D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

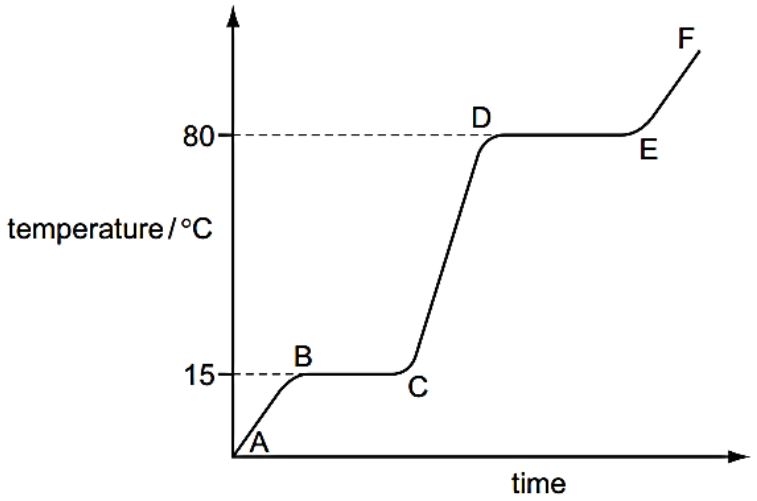
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 17.
The use of an approved scientific calculator is expected, where appropriate.

1 Which row represents the particles of a gas colliding most frequently?

	pressure	temperature
A	low	low
B	high	low
C	low	high
D	high	high

2 The graph shows the change in temperature with time when substance X is heated.



Which stage does X undergo the smallest change in its volume?

A A to B **B** B to C

C D to E **D** E to F

3 Which statement about the Periodic Table is correct?

A Most metallic elements are on the left.

B Elements in the same period have the same number of outer electrons.

C Elements on the left are usually gases.

D The reactivity of Group VII elements increases as the atomic radius increases.

4 Particles with the same electron arrangement are said to be isoelectronic.

Which of the following compounds contains ions which are isoelectronic?

A $MgCl_2$

B KBr

C $CaCl_2$

D Na_2S

5 Which statement about an atom is correct?

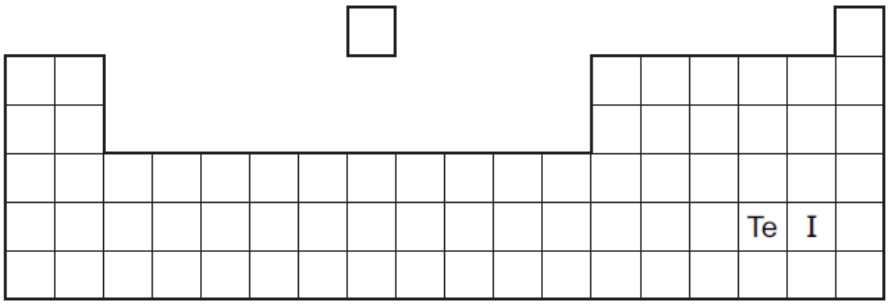
A The number of protons and neutrons will always be equal.

B The number of electrons and neutrons will always be equal.

C The nucleon number can be equal to the proton number.

D The nucleon number can be less than the number of electrons.

6 Iodine, I, has a lower relative atomic mass than tellurium, Te, but is placed after it in the Periodic Table.



Which statement explains why iodine is placed after tellurium in the Periodic Table?

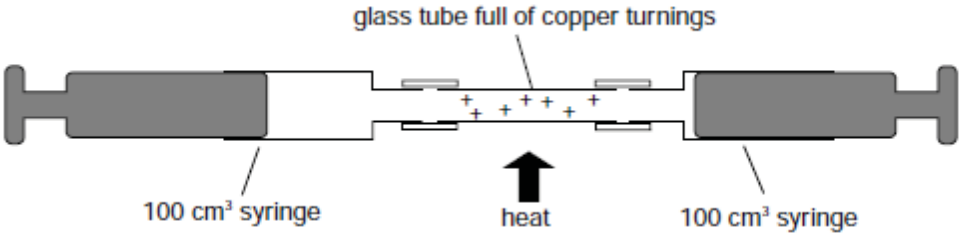
A Iodine has fewer neutrons than tellurium.

B Iodine has fewer protons than tellurium.

C Iodine has more neutrons than tellurium.

D Iodine has more protons than tellurium.

7 The percentage of oxygen in the air is found using the apparatus shown in the diagram below. In an investigation, 100 cm^3 of air was passed over heated copper turnings until there was no further decrease in volume.



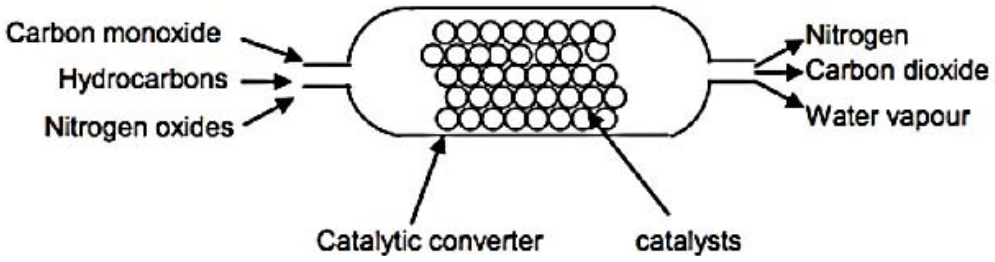
The volume of the gas after the reaction should be about 80 cm^3, but was instead measured to be 90 cm^3. Which could be (a) possible reason(s) for this result?

1 There was insufficient copper to react with all the oxygen in the syringe.
2 There was leakage of air out of the syringes.
3 The volume of gas was measured while it was still hot.

A 1 only **B** 1 and 3

C 2 and 3 **D** 1, 2 and 3

8 The diagram below shows the cross section of a catalytic converter in the exhaust system of a car.



Which process(es) take(s) place in the converter?

1 Hydrocarbons oxidise to form carbon dioxide and water vapour.
2 Carbon monoxide reacts with nitrogen oxides to form carbon dioxide and nitrogen.
3 Nitrogen oxides react with hydrocarbons to form water vapour and nitrogen.

A 1 only

B 2 only

C 1 and 2

D 1 and 3

9 Two of the reactions used in the manufacture of nitric acid, HNO_3, are shown.

$$2NO + O_2 \rightarrow 2NO_2$$
$$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$$

What is the maximum number of moles of nitric acid which could be formed from one mole of nitrogen monoxide, NO?

A 0.5 **B** 1.0 **C** 2.0 **D** 4.0

10 4 g of hydrogen is mixed with 16 g of oxygen and the mixture is ignited to form water.

What are the masses of the substances remaining at the end of the reaction?

	hydrogen/ g	oxygen/ g	water/ g
A	0	0	20
B	2	0	18
C	0	4	16
D	2	0	9

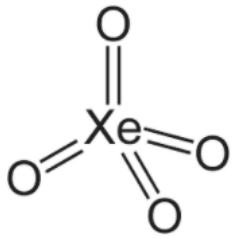
11 All ammonium salts produce ammonia gas on heating with sodium hydroxide.

Which ammonium salt produces the greatest mass of ammonia when heated with sodium hydroxide?

A 0.2 mol NH_4Cl **B** 0.3 mol $(NH_4)_3PO_4$

C 0.4 mol $(NH_4)_2SO_4$ **D** 0.8 mol NH_4NO_3

12 The noble gas elements, though being generally unreactive, are known to be able to react with a few elements to form compounds. One such compound is xenon tetraoxide as shown below.



What is the total number of electrons shared in this compound?

A 8 **B** 12 **C** 14 **D** 16

13 Aerials in portable radios are made of a mixture of the oxides of calcium and iron known as 'ferrite'. It contains 18.5% calcium and 51.9% iron by mass.

Which is the empirical formula of 'ferrite'?

A $CaFe_2O$

B $CaFe_2O_4$

C Ca_2FeO_2

D Ca_4Fe_2O

14 A 14 g sample of nitrogen gas contains the same number of atoms as 23 g of element X which is monoatomic.

What is the relative atomic mass, A_r of X?

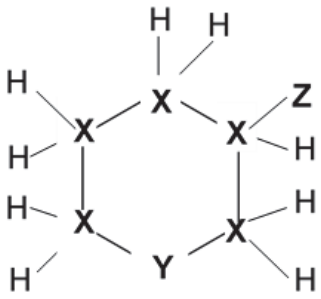
A 3.5

B 14

C 23

D 46

15 The compound below is made up of hydrogen and the elements **X**, **Y** and **Z**.



Which statement is **incorrect**?

A Element **Z** is most likely from Group I.

B Element **X** is most likely from Group IV.

C The compound has a simple molecular structure.

D The compound has the molecular formula $\mathbf{X}_5\mathbf{Y}H_9\mathbf{Z}$.

16 A large piece of calcium is added to a test tube of water.

What is likely to be observed during this reaction?

1 The piece of calcium sinks in the water.
2 Bubbles of a colourless and odourless gas are given off.
3 A white precipitate is observed after a while in a colourless solution.

A 1 only **B** 2 only **C** 1 and 2 only **D** 1, 2 and 3

17 Magnesium oxide is produced by heating magnesium carbonate.

$MgCO_3 \rightarrow MgO + CO_2$

When 84 g of an impure sample of magnesium carbonate is heated, 28 g of magnesium oxide is produced.

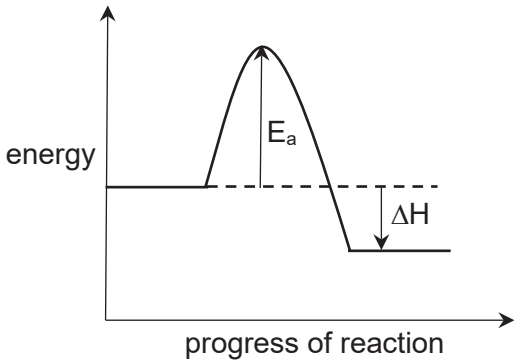
What is the mass (in g) of pure magnesium carbonate in the sample?

[M_r: $MgCO_3$, 84; MgO, 40]

A $\frac{28}{40} \times 84$ **B** $\frac{28}{84} \times 40$

C $\frac{40}{28} \times 100$ **D** $\frac{84}{28} \times 40$

18 The energy profile diagram for a particular reaction is shown below.



Which statement is true about this reaction?

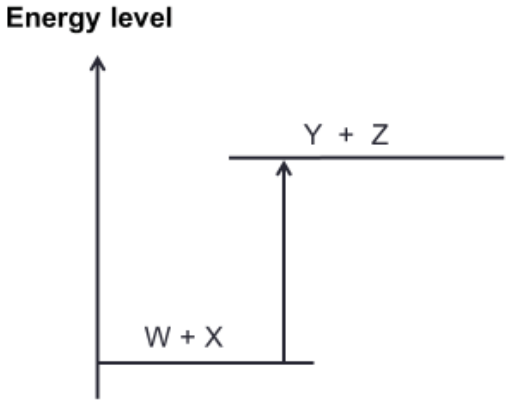
A E_a is the energy released by breaking bonds in the reactants.

B ΔH is the energy released by forming bonds in the products.

C More energy is absorbed in bond-breaking than that released in bond-forming.

D More energy is released in bond-forming than that absorbed in bond-breaking.

19 The energy level diagram for a reaction is as shown.



The initial temperature measured was 28.0 °C. As the reaction progressed, the reaction temperature changed by 5.5 °C.

What would be the final temperature recorded?

A 22.5 °C **B** 28.0 °C

C 33.5 °C **D** 39.0 °C

20 How does a catalyst affect the activation energy and enthalpy of a reaction?

	activation energy	enthalpy
A	increases	decreases
B	decreases	decreases
C	decreases	stays the same
D	increases	stays the same

21 Which is the overall equation for the reactions that take place in a hydrogen fuel cell?

A $2H_2 + O_2 \rightarrow 2H_2O$

B $2H_2O \rightarrow 2H_2 + O_2$

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

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

22 Which is **not** a redox reaction?

A $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

B $Cu^{2+} + Zn \rightarrow Cu + Zn^{2+}$

C $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

D $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

23 Hydrogen peroxide (H_2O_2) acts as an oxidising agent in some reactions, but in others, as a reducing agent.

reaction 1: $H_2O_2 + 2KI + H_2SO_4 \rightarrow I_2 + K_2SO_4 + 2H_2O$

reaction 2: $5H_2O_2 + 2KMnO_4 + 3H_2SO_4 + \rightarrow 2MnSO_4 + K_2SO_4 + 5O_2 + 8H_2O$

reaction 3: $H_2O_2 + Ag_2O \rightarrow 2Ag + O_2 + 2H_2O$

Which row identifies correctly the role of hydrogen peroxide in each reaction?

	reaction 1	reaction 2	reaction 3
A	oxidising agent	reducing agent	oxidising agent
B	oxidising agent	reducing agent	reducing agent
C	reducing agent	oxidising agent	reducing agent
D	reducing agent	oxidising agent	oxidising agent

24 Element X is extracted by the electrolysis of a molten compound made up of elements X and Y. The electrode reactions are as shown:

Cathode: X^{2+} (l) + $2e^-$ $\rightarrow$ X (*l*)

Anode: $2Y^{2-}$ (*l*) $\rightarrow$ Y_2 (g) + $4e^-$

Which of the following could be the compound?

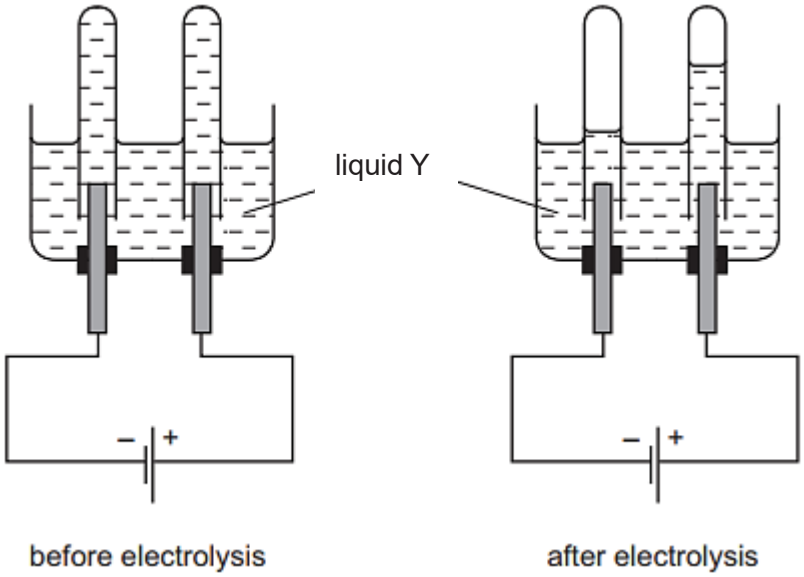
A aluminium oxide

B calcium chloride

C magnesium oxide

D potassium chloride

25 The diagrams show an electrolysis set-up using inert electrodes.



Which could be liquid Y?

1 aqueous sodium nitrate
2 aqueous copper(II) sulfate
3 concentrated aqueous sodium chloride
4 dilute sulfuric acid

A 4 only **B** 1 and 4 only

C 2 and 4 only **D** 1, 3 and 4 only

26 The table below shows details of four experiments (**A**, **B**, **C** and **D**) in which the same mass of the catalyst manganese(IV) oxide was added to 10 cm^3 samples of aqueous hydrogen peroxide, H_2O_2.

Different conditions were used to study the effect of each on the rate of reaction, measured by the volume of oxygen produced in 10 s.

In one of the experiments, the catalyst was more finely powdered compared to the others.

Which experiment is this likely to be?

Experiment	concentration of H_2O_2 / $moldm^{-3}$	temperature /°C	volume of oxygen produced in 10 s /cm^3
A	0.05	20	10
B	0.05	20	15
C	0.05	30	20
D	0.10	20	20

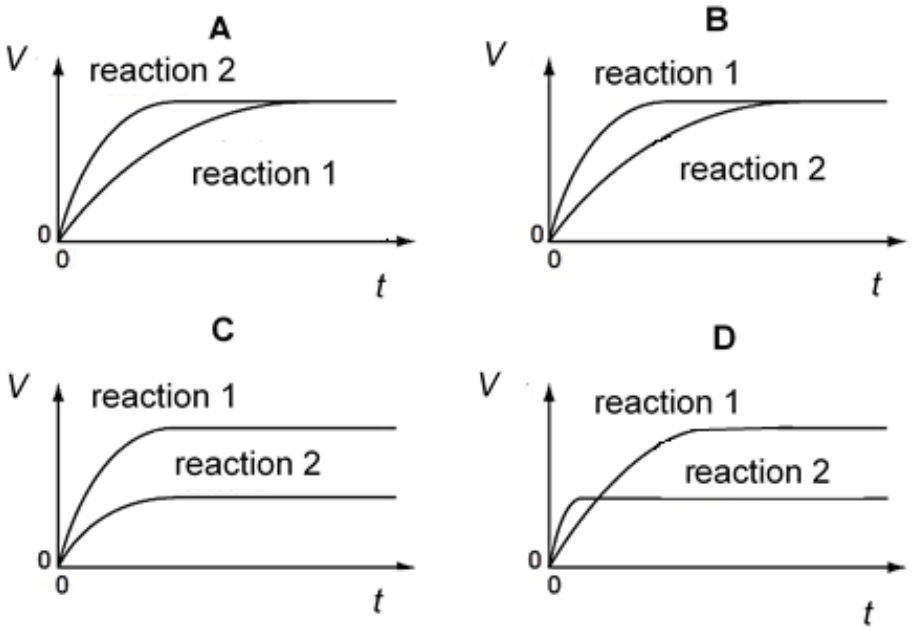
27 A student performs two reactions.

Reaction 1:
Magnesium ribbon (excess) with 50 cm^3 of 1.0 mol/dm^3 dilute hydrochloric acid

Reaction 2:
Magnesium ribbon (excess) with 12.5 cm^3 of 1.0 mol/dm^3 dilute sulfuric acid

In both experiments, the volume of hydrogen produced, V is measured against time, *t*, and the results plotted graphically.

Which set of graphs is correct?



28 An aqueous solution of a chloride is made by the reaction of hydrochloric acid with the hydroxide of metal M:

$M(OH)_2(s) + 2HCl(aq) \rightarrow MCl_2(aq) + 2H_2O(l)$

Which metal **cannot** be M?

A copper

B lead

C magnesium

D iron

29 Element X occurs naturally as the uncombined metal; element Y is obtained by chemical reduction of its oxide with carbon; element Z is obtained by electrolysing its molten chloride.

What is the order of reactivity of X, Y and Z?

	Least reactive	→	**Most reactive**
A	X	Y	Z
B	Y	X	Z
C	Z	X	Y
D	X	Z	Y

30 Which of the statements are true of the Haber process?

1 Ammonia formed is condensed and obtained as a liquid.

2 Hydrogen gas is obtained from cracking of crude oil.

3 Iron catalyst is used to increase the yield of ammonia.

4 Nitrogen gas is oxidised to form ammonia.

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 3 and 4 only

31 The equations for the reactions between iron and chlorine, and iron and hydrochloric acid are shown.

$$2Fe\ (s) + 3Cl_2\ (g) \rightarrow 2FeCl_3\ (s)$$
$$Fe\ (s) + 2HCl\ (aq) \rightarrow FeCl_2\ (aq) + H_2\ (g)$$

Iron and tin are metals that have similar chemical properties. Iron forms ions with charges of 2+ and 3+ while tin forms ions with charges of 2+ and 4+.

Which reaction/s would occur with tin?

1 $Sn\ (s) + 2Cl_2\ (g) \rightarrow SnCl_4\ (s)$
2 $Sn\ (s) + 2HCl\ (aq) \rightarrow SnCl_2\ (aq) + H_2\ (g)$
3 $Sn\ (s) + Cl_2\ (g) \rightarrow SnCl_2\ (g)$

A 1, 2 and 3

B 1 and 2 only

C 2 and 3 only

D 2 only

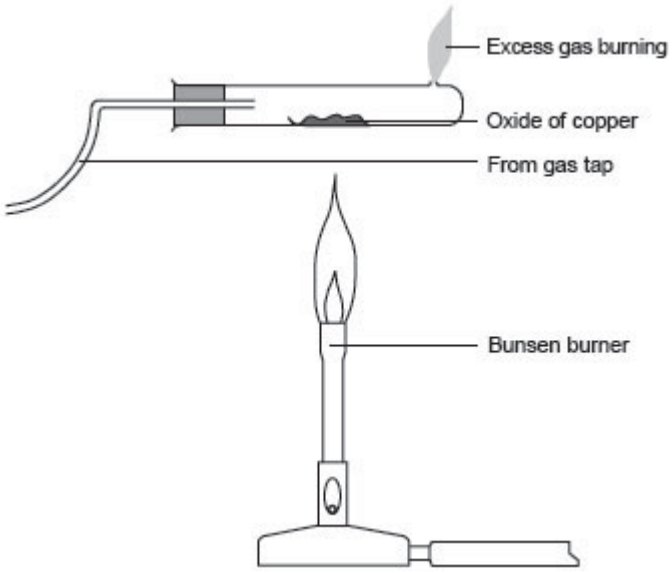
32 Iron rusts easily, hence steel structures should be treated to slow down the rusting process.

Which option describes **incorrectly** how each method protects iron from rusting and its main disadvantage?

	Method	how it protects	disadvantage
A	painting steel	provides a barrier between the iron and the atmosphere	paint scrapes off easily, exposing iron to the atmosphere
B	alloying steel with chromium to make stainless steel	chromium reacts with oxygen in the air to form a barrier of chromium oxide which prevents iron from rusting	production of stainless steel is costly
C	storing steel objects in a dry place	absence of water prevents iron from rusting quickly	difficult to keep storage place dry at all times
D	coating steel plates with zinc	zinc is less reactive than iron, and provides a barrier between iron and the atmosphere	when coating of zinc is scratched, iron will corrode in place of zinc, making it rust more quickly

33 The following set-up is used to study the reduction of an oxide of copper.

The oxide of copper is Cu_2O, which is a red solid. What would be observed when the reaction has stopped, and what is the purpose of burning the excess gas?



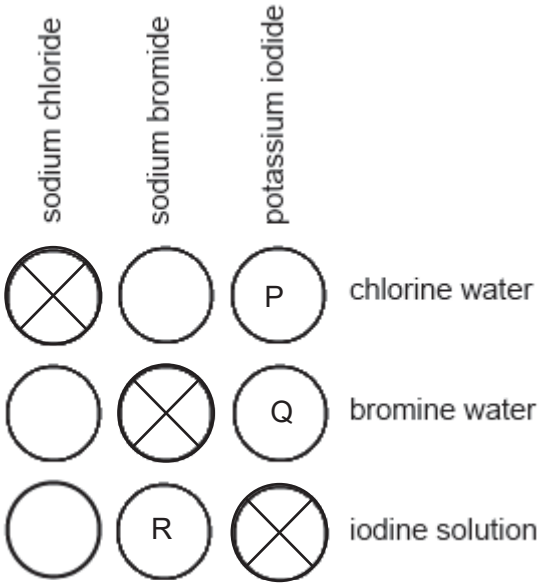
	observation	purpose for burning excess gas
A	red solid turns brown	carbon dioxide is a pollutant
B	red solid remains unchanged	carbon monoxide used to reduce oxide is poisonous
C	red solid turns brown	hydrogen gas used to reduce oxide is highly flammable
D	red solid turns black	nitrogen dioxide gas used to reduce oxide is a pollutant

34 Which substance(s) contain(s) mobile particles that can conduct electricity?

1 liquid mercury
2 solid bronze
3 distilled water
4 aqueous ammonia

A 1, 2, 3 and 4
B 1, 2, and 4 only
C 1 and 2 only
D 1 and 4 only

35 Drops of chlorine, bromine and iodine water are added to petri-dishes containing salt solutions of other halides, shown below.



Which option correctly identifies what will be observed in dishes P, Q and R?

	P	Q	R
A	colourless solution turns brown	colourless solution turns brown	no visible reaction
B	no visible reaction	colourless solution turns brown	brown solution turns colourless
C	colourless solution turns brown	colourless solution turns red brown	colourless solution turns red brown
D	no visible reaction	no visible reaction	colourless solution turns brown

36 Tin is a metal between iron and lead in the reactivity series.

Which method is used for the extraction of tin from its ores?

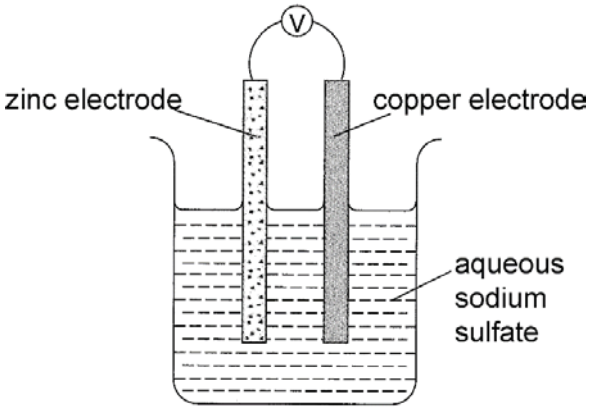
A electrolysis of the molten ore

B heat alone

C heat with aluminium powder

D heat with carbon

37 The diagram shows a simple cell.



Which option describes what happens in the cell?

A Effervescence of hydrogen gas is observed at the zinc electrode.

B Copper ionizes and becomes smaller.

C Effervescence of oxygen gas is observed at the copper electrode.

D Zinc ionizes and becomes smaller.

38 In which reaction is the sulfate ion removed from solution?

A $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$

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

C $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

D $Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$

39 10 g of X_3O_4, contains 7.5 g of X.

How many moles of X does 7.5 g of the element contain?

A $\frac{2.5}{16} \times \frac{3}{4}$

B $\frac{7.5}{16} \times \frac{3}{4}$

C $\frac{2.5}{16} \times \frac{4}{3}$

D $\frac{10}{16} \times \frac{4}{3}$

40 Potassium reacts with oxygen to form different types of oxides.

potassium oxide	K_2O
potassium peroxide	K_2O_2
potassium superoxide	KO_2

What are correct oxidation numbers of oxygen in the different anions?

	oxide ion, O^{2-}	peroxide ion, O_2^{2-}	superoxide ion, O_2^{-}
A	-2	-1	-2
B	-2	-1	-0.5
C	-1	-2	+0.5
D	-2	-2	-1

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		Key: proton (atomic) number / atomic symbol / name / relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Preliminary Examination
Secondary Four

CANDIDATE NAME							
CLASS	4			REGISTER NUMBER			
CENTRE NUMBER					INDEX NUMBER			

CHEMISTRY

6092/02

Paper 2 Theory

12 August 2020

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your class, register number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer **all three** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 21.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	/50
Section B	/30
Total	/80

This question paper consists of **20** printed pages and **2** blank pages.

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 Choose from the following reactions/processes to fill in the blanks. Each reaction/process may be used once, more than once or not at all.

Precipitation	Displacement	Reduction	Decomposition
Neutralisation	Combustion	Oxidation	Ionisation

a) When rubidium hydroxide reacts with carbonic acid…….. occurs.

b) Rusting occurs when iron undergoes ……..…..

c) Hydrogen peroxide undergoes …… to produce water and oxygen.

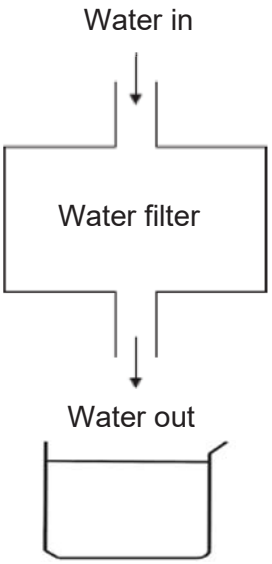
d) …….. occurs when hydrogen chloride gas dissolves in water.

e) Zinc can be obtained from zinc oxide by ……

[Total: 5]

A2 One of the processes in purification of water is filtration.

a) The diagram shows a water filter used in the home. A student collected a sample of water from the filter.

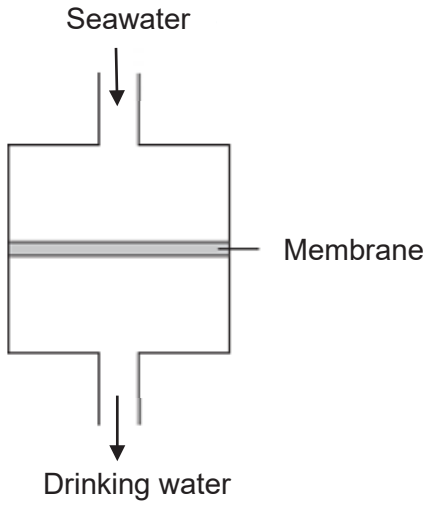


Describe how the student could show that the filtered water contains dissolved salts without using a chemical test. [1]

……..

……..

b) Seawater is purified to make drinking water by forcing it through a membrane.



Suggest why water molecules can pass through the membrane, but sodium ions and chloride ions cannot. [1]

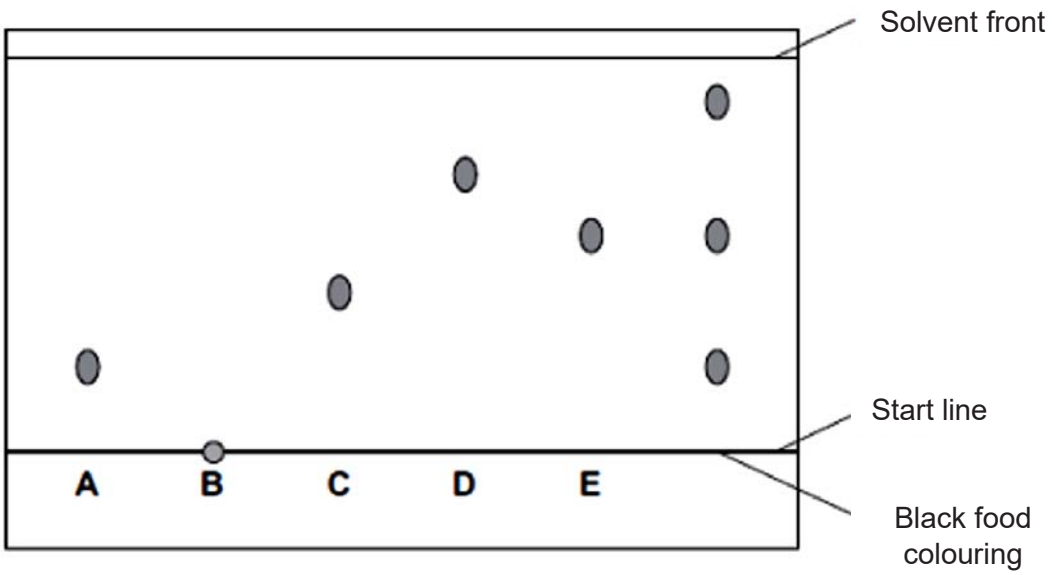
……

……

c) Chromatography can be used to separate components of a mixture.

A student used paper chromatography to analyse a black food colouring. The student placed spots of known food colours, **A**, **B**, **C**, **D** and **E**, and the black food colouring on a sheet of chromatography paper and carried out paper chromatography using ethanol as the solvent.

The results are shown on the chromatogram below.



i) Which of the known food colours is the least soluble in ethanol? …… [1]

ii) What does the chromatogram tell you about the composition of the black food colouring? [2]

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The table below gives the results of chromatography experiments that were carried out on some known food colours, using ethanol as the solvent.

Name of food colour	Distance from start line to solvent front in mm	Distance moved by food colour in mm	R_f value
Ponceau 4R	62	59	0.95
Carmoisine	74	45	0.61
Fast red	67	27	0.40
Erythrosine	58	17	0.29

iii) Using the results of the chromatogram and the information in the table, suggest which of the food colours in the table could be food colour **C**? Explain your answer, showing clearly the necessary calculations. [2]

[Total: 7]

A3 Hydrogen fluoride, HF, has a simple molecular structure. It is soluble in water.

a) Suggest two other physical properties of hydrogen fluoride. [2]

1 ……

2 ……...

b) Hydrogen fluoride dissolves in water to form dilute hydrofluoric acid, a ***weak acid***.

i) With the help of an equation, explain why hydrofluoric acid is a ***weak acid***. [2]

.....

……..

ii) Dilute hydrofluoric acid reacts with excess magnesium. The salt formed is magnesium fluoride.

Calculate the volume of gas produced if the acid solution contains 0.200 g of hydrofluoric acid. [2]

iii) Explain, in terms of structure and bonding, why magnesium fluoride has a high melting point. [2]

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iv) Draw a dot and cross diagram to show the bonding in magnesium fluoride. [2]

[Total: 10]

A4 Sodium peroxodisulfate reacts with potassium iodide solution. The ionic equation for this reaction is as shown.

$$S_2O_8^{2-}(aq) + 2I^-(aq) \longrightarrow 2SO_4^{2-}(aq) + I_2(aq)$$

The table shows how the relative rate of this reaction changes when different concentrations of peroxodisulfate ions and iodide ions are used.

Experiment	Concentration of $S_2O_8^{2-}$ in mol/dm^3	Concentration of I^- in mol/dm^3	Relative rate of reaction
1	0.008	0.02	1.7
2	0.016	0.02	3.3
3	0.032	0.02	6.8
4	0.008	0.04	3.4
5	0.008	0.08	6.9

a) Describe an observation for the reaction. [1]

……

b) Describe, using the information in the table, how increasing the concentration of peroxodisulfate ions affects the relative rate of reaction. [1]

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c) Explain, in terms of oxidation states, why this is a redox reaction. [2]

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d) Iron(III) ions, Fe^{3+}, catalyse this reaction. Explain how catalysts increase the rate of a reaction. [1]

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e) Describe a chemical test you would carry out to determine if the iron(III) ions were still present at the end of the reaction. State what you would expect to observe. [2]

Test .....

Observation.....

(f) Peroxodisulfate ions also react with iron(II) ions. The products are iron(III) ions and sulfate ions. Construct the ionic equation for this reaction. [1]

.....

[Total: 8]

A5 A 1.50 g sample of solid lead(II) nitrate is added to 125 cm^3 of 0.100 mol/dm^3 sodium iodide solution.

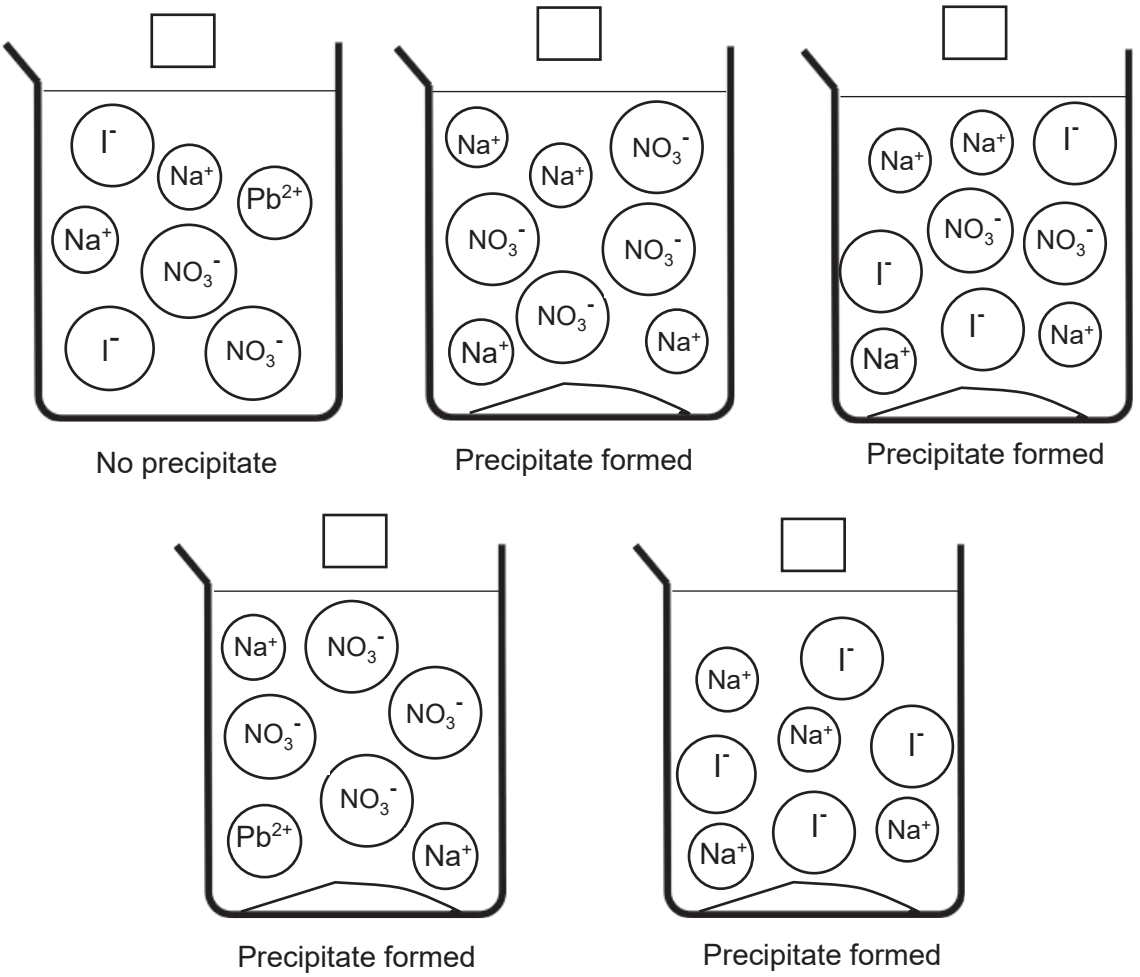
a) Write the equation for the reaction. [1]

…….

b) Identify the limiting reactant in the reaction, showing your calculations clearly. [2]

c) Using your answer in **(b)**, calculate the concentration of the nitrate ions in the mixture after the reaction is complete. [2]

d) Place a √ in the box to indicate the diagram that best represents the mixture when the reaction is complete. The diagrams do not show the actual number and ratio of ions present. [1]



e) Describe how a pure, dry sample of lead(II) nitrate crystals can be prepared from insoluble lead(II) oxide. [3]

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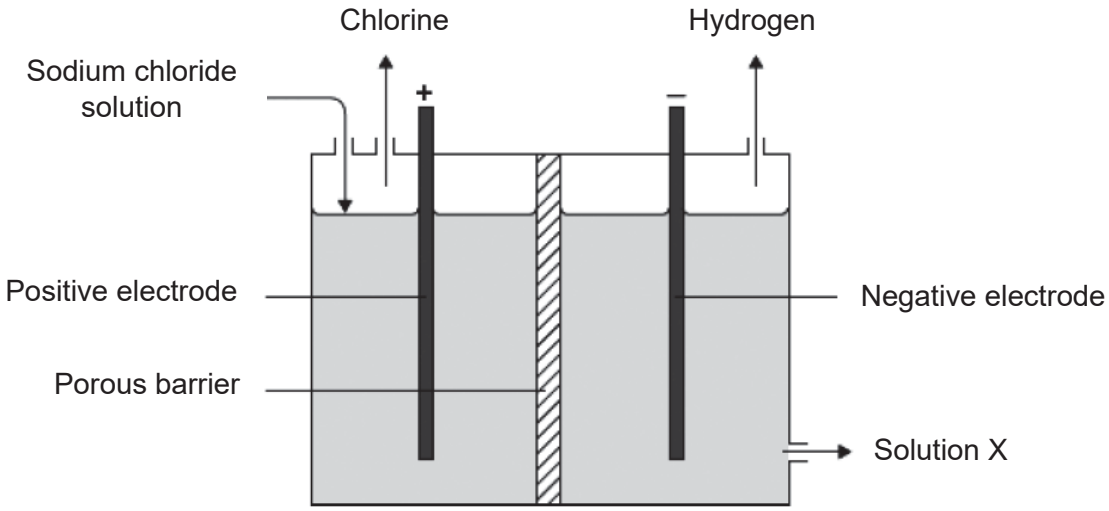
[Total: 9]

A6 The electrolysis of concentrated sodium chloride solution is an industrial process which produces three products; chlorine, hydrogen and solution X.



a) Graphite electrodes are used in the electrolysis. Explain, in terms of structure and bonding, why graphite conducts electricity. [2]

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b) Solution X is alkaline. Name solution X and explain how it is produced in the electrolysis. [3]

Solution X is ……

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[Total: 5]

A7 A group of students were given three different colourless solutions in separate beakers.

They knew that the solutions were potassium iodide, calcium nitrate and ammonium sulfate.

But they did not know which solution was in each beaker. They decided to test each solution with acidified silver nitrate and acidified barium chloride.

	Potassium iodide	**Calcium nitrate**	**Ammonium sulfate**
Test with acidified silver nitrate		No change observed	No change observed
Test with acidified barium chloride			

a) Complete the table to give the expected observations for each solution. [3]

b) Their teacher suggested that the students could also identify the solutions using aqueous sodium hydroxide.

Do you agree? …….

Explain your answer by tabulating the expected observations in a table similar to the one above.

[3]

[Total: 6]

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Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

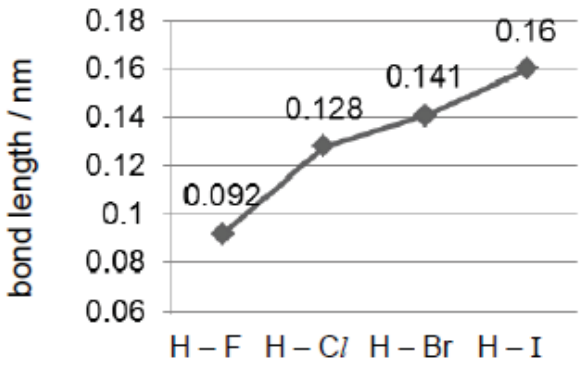
B8 Read the information about hydrogen halides and their chemical properties.

Hydrogen halides are formed when halogens react with hydrogen. The observations for these reactions are shown below.

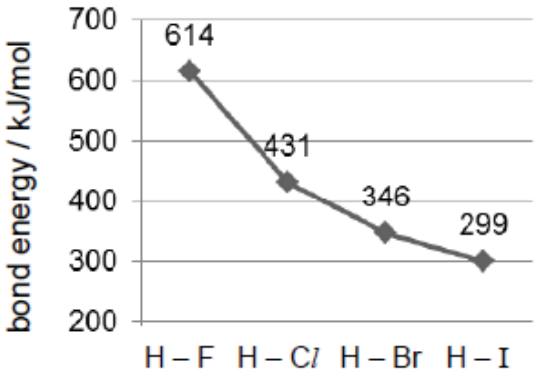
Reaction	Observation
$H_2 + F_2 \rightarrow 2HF$	Reacts explosively even in the dark at -200°C
$H_2 + Cl_2 \rightarrow 2HCl$	Reacts explosively in sunlight but takes place slowly in the dark
$H_2 + Br_2 \rightarrow 2HBr$	
$H_2 + \rightleftharpoons I_2$ 2HI	Reacts very slowly in sunlight even on heating with platinum

Stability of hydrogen halides is affected by bond length and bond energy of the halides.

Graphs 1 and 2 show how bond length and bond energy vary for the different halides.



Graph 1



Graph 2

Bond length refers to the average distance between the nuclei of two bonded atoms in a molecule.

Bond energy is a measure of the bond strength in a chemical bond. It is the energy required to break one mole of molecules into their individual atoms.

When heated, the hydrogen halides decompose into its constituent elements.

Hydrogen halide	HF	HCl	HBr	HI
Thermal decomposition at 1000°C	none	negligible	0.5 %	33 %

Hydrogen halides are extremely soluble in water, forming acidic solutions.

a) Predict the observation for the reaction of bromine with hydrogen gas. [1]

……

b) Suggest why platinum is added when iodine is reacted with hydrogen gas. [1]

……

c) Describe the relationship between the bond length and bond energy of the hydrogen halides. Hence explain why the reaction of iodine with hydrogen is a reversible reaction unlike the other reactions. [2]

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d) Describe what would be observed when a hot glass rod is plunged into separate gas jars containing HCl and HI. [2]

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ei) Given that the bond energy of the Br – Br bond is 193 kJ/mol and the bond energy of the H – H bond is 432 kJ/mol, calculate the enthalpy change for the formation of hydrogen bromide from hydrogen and bromine. [2]

ii) Explain, in terms of bond breaking and bond making, whether this reaction is exothermic or endothermic. [2]

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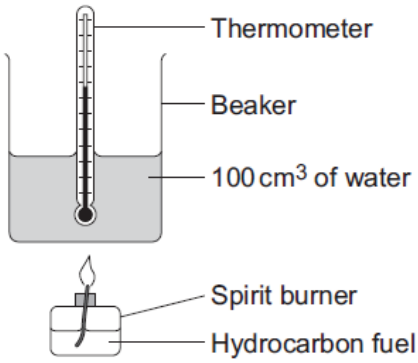
iii) Draw a labelled energy profile diagram for this reaction, showing clearly the activation energy and enthalpy change of the reaction. [2]

[Total: 12]

B9 A group of students investigated the energy released by the combustion of four hydrocarbon fuels using the apparatus shown.



Each hydrocarbon fuel was burned for two minutes. The table shows the students' results.

	After two minutes				
Name and formula of hydrocarbon fuel	**Mass of fuel used in g**	**Temperature increase of water in °C**	**Energy released by fuel in kJ**	**Energy released by 1.0 g of fuel in kJ**	**Relative amount of smoke in the flame**
Hexane, C_6H_{14}	0.81	40	16.80	20.74	very little smoke
Octane, C_8H_{18}	1.10	54	22.68	20.62	some smoke
Decane, $C_{10}H_{22}$	1.20	58	24.36		smoky
Dodecane, $C_{12}H_{26}$	1.41	67	28.14	19.96	very smoky

a) Calculate the energy released by 1.0 g of decane in kJ. [1]

b) Suggest one key source of error present in this experiment and describe how this error affects the results. [1]

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……

c) The students noticed that the bottom of the beaker became covered in a black substance when burning these fuels.

i) Explain the presence of the black substance. [1]

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……

ii) Suggest why hexane, C_6H_{14}, produced less black substance when burned compared to hexene, a compound with formula C_6H_{12}. [1]

……

……

d) A student concluded that hexane is the best of the four fuels.
Give two reasons why the results in the table support this conclusion. [2]

1……..

2……..

e) Most car engines use liquid petrol as a fuel. Car engines could be developed to use hydrogen as a fuel. Describe one advantage and one disadvantage of using hydrogen instead of petrol as a fuel.

[2]

Advantage: ……

……

……

Disadvantage: ……..

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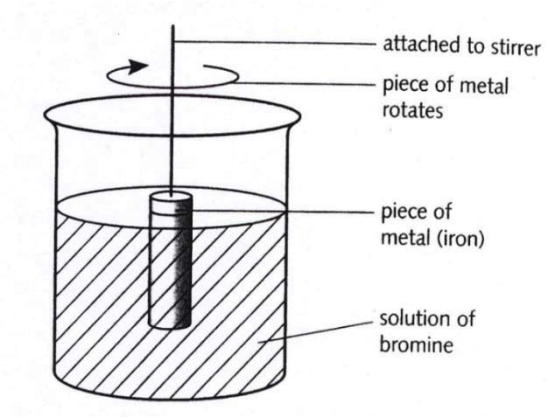
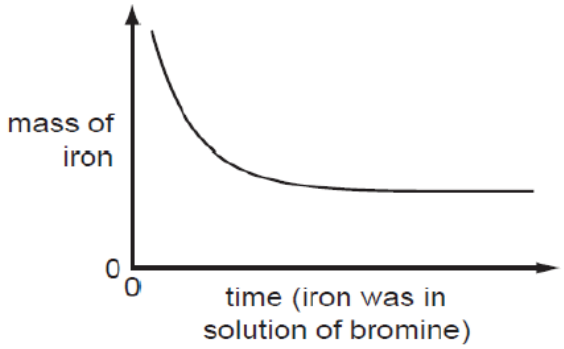
[Total: 8]

EITHER

B10 The rate of reaction between a metal and bromine can be studied using the apparatus shown below.



A cylindrical piece of iron, was weighed and placed in the solution as shown above. The iron was removed at regular intervals and the stopwatch was paused. The piece of iron was washed, dried, weighed and then placed in the solution again. The stopwatch was restarted and the reaction continued. The mass of iron was plotted against time. The graph shows the results obtained.



a) Explain the shape of the graph. [3]

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b) From the results (mass of metal and time), the rate of the reaction can be calculated.

How would the rate of the reaction change if the cylindrical piece of iron was hammered to form a flat sheet of iron and placed in the bromine solution? Explain your answer. [2]

……

……

……

c) The experiment was conducted using two solutions of bromine of equal volume but different concentration. A piece of iron with equal mass was placed in each solution. The mass of the iron was measured at one minute intervals. The table shows the loss in mass of the iron after one minute.

Experiment	Concentration of bromine solution	Loss in mass of iron after one minute
1	0.05 mol/dm^3	10 mg
2	0.1 mol/dm^3	20 mg

Explain, in terms of collisions between particles, the difference in the results obtained. [2]

……

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……

d) Iron also reacts with iodine solution. Predict the loss in mass of iron after one minute if 0.05 mol/dm^3 of iodine solution of equal volume was used instead of bromine solution. Suggest a reason for your answer. [1]

Loss in mass of iron = ……

……

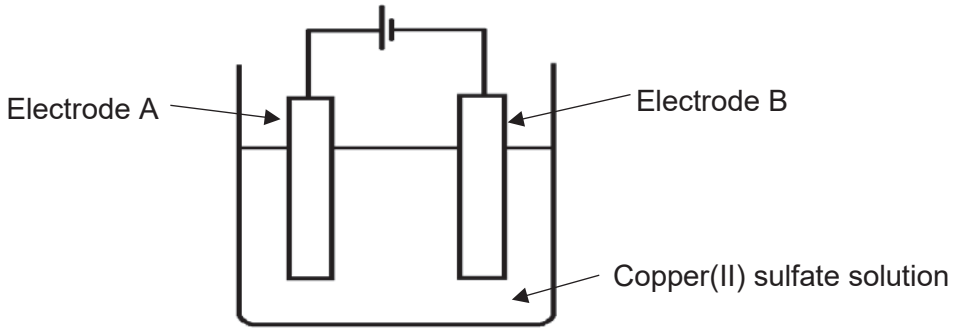
……

e) When solid iron is heated in bromine gas, iron(III) bromide is formed. Calculate the minimum mass of iron required to react with 1200 cm^3 of bromine gas. [2]

[Total: 10]

OR

B10 A student investigated the electrolysis of copper(II) sulfate solution using copper electrodes. The student's method is shown below.



Step 1 Weigh two clean strips of copper.

Step 2 Use one strip as electrode A and the other as electrode B.

Step 3 Carry out electrolysis.

Step 4 After electrolysis, wash both copper strips with ethanol (a liquid that boils at 78°C).

Step 5 Dry the strips of copper and re-weigh them.

a) Suggest why the copper strips would dry more quickly when washed with ethanol rather than with water. [1]

……..

b) Give the ionic half-equation, with state symbols, for the reaction at electrode A. [2]

……

c) The student's results are shown in the table.

	Electrode A	Electrode B
Mass before electrolysis/g	8.78	7.95
Mass after electrolysis/g	**x**	8.25

i) Electrode B increases in mass. Explain why this happens. [1]

……....

……..

……..

ii) Predict the theoretical value of **x** in the table. …….. [1]

iii) The actual value of **x** obtained in the experiment was less than the theoretical value. Assuming that the experiment was carried out correctly, suggest a reason for this discrepancy. [1]

……..

……...

d) Given that 1 Faraday is the electrical charge of 1 mole of electrons, calculate the number of Faradays that would cause electrode B to increase by 0.300 g. [2]

e) The student repeated the investigation using graphite electrodes instead. Compare the results obtained from this electrolysis with the results obtained when copper strips were used. Explain the difference in results. [2]

…….

……....

……..

…….

……

[Total: 10]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		Key proton (atomic) number atomic symbol name relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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