Exam: Sec 4 Mid-Year / Prelims
Duration: 2 hrs 45 mins
Possible Score: 120 Marks
Level of Difficulty: Medium

Scope Tested:

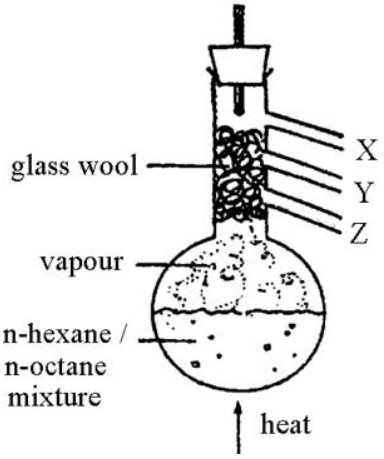
1. Measurements in Chemistry
2. Purification of Substances
3. Solids, Liquids and Gases
4. Element, Compounds and Mixtures
5. Structure of Atoms
6. Equations
7. Chemical Bonds
8. Structure of Solids
9. Relative Masses of Atoms & Molecules
10. Mole Concept
11. Acids and Bases
12. Salts
13. Chemical Analysis
14. Properties of Metals
15. Reactivity Series
16. Extraction & Uses of Metals
17. Structure of the Periodic Table
18. Group Properties
19. Oxidation and Reduction
20. Electrolysis
21. Chemical Energy
22. Speed of Reaction
23. Air
24. Ammonia
25. Fuel
26. Alkanes & Alkenes
27. Alcohols & Organic Acids
28. Macromolecules

Paper 1 (1 hr / 40 Marks)

1. What can be deduced about two gases with the same relative molecular mass?

   A. They have equal solubility in water at room temperature.
   B. They have the same number of atoms in one molecule.
   C. They have the same rate of diffusion at room temperature and pressure.
   D. They have the same melting point.

2. A mixture of n-hexane (boiling point 69°C) and n-octane (boiling point 126°C) is separated through fractional distillation as shown below. Fractions are drawn off at the points labelled X, Y and Z.



   Compared with the fractions drawn off at Y and Z, the fraction drawn off at X is likely to have

   A. the highest boiling point and the highest proportion of n-hexane.
   B. the highest boiling point and the lowest proportion of n-hexane.
   C. the lowest boiling point and the highest proportion of n-hexane.
   D. the lowest boiling point and the lowest proportion of n-hexane.

3. A student wishes to determine the concentration of ethanoic acid in vinegar. The student titrates a 20.0 cm^3 sample of a standard sodium hydroxide solution with a diluted vinegar solution from a burette. Four experiments were carried out and the following titration results were obtained: 21.6 cm^3, 22.3 cm^3, 22.3 cm^3 and 22.4 cm^3.

   The discrepancy in the first titration could be due to the student washing

   A. the conical flask with sodium hydroxide solution only.
   B. the pipette with water only.
   C. the burette with water only.
   D. the pipette with sodium hydroxide solution only.

4. Element X can be represented by $^{28}_{13}X$ and element Y has an electronic configuration of 2,6.

What is the formula of the compound formed between X and Y?

A. XY_2
B. X_2Y
C. X_2Y_3
D. X_3Y_2

5. When the isotope of radium, $^{226}_{88}Ra$, decays, it forms radon $^{222}_{86}Rn$.

Which of the following represents the particles given out by the radium atom during its decay?

A. 2 electrons
B. 2 protons
C. 2 electrons & 2 protons
D. 2 protons & 2 neutrons

6. Which of the following conducts electricity after undergoing chemical changes?

A. Graphite
B. Mercury
C. Zinc chloride
D. Ethanol

7. Chemical bonding involves the rearrangement of

A. molecules
B. atoms
C. electrons
D. ions

8. Solid carbon dioxide, CO_2, (dry ice) is used as a refrigerating agent because it readily changes directly from the solid into the vapour state at a low temperature.
Based on the above information, what is the main intermolecular bonding in CO_2 (s) likely to be?

A. covalent bonding
B. ionic bonding
C. hydrogen bonding
D. Van der Waals forces

9. Which of the following does not contain covalent bonds?

A. Graphite
B. Gold
C. Ice
D. Diamond

10. Which of the following gases will not turn moist blue litmus paper red?

A. Carbon dioxide
B. Chlorine
C. Hydrogen chloride
D. Nitrogen monoxide

11. The metal rubidium is three places below lithium in Group I of the Periodic Table. If the reaction of lithium with water is described as moderately slow, the reaction of rubidium with water is likely to be

A. very fast.
B. moderately fast.
C. as slow as that of lithium.
D. so slow that no reaction is noticeable.

12. Which of the following correctly described the solution formed and the gas evolved when potassium reacts with water?

	Solution	*Gas*
A.	alkaline	neutral
B.	acidic	neutral
C.	alkaline	acidic
D.	neutral	neutral

13. The equation for the burning of hydrogen is: $2H_2\ (g) + O_2\ (g) \rightarrow 2H_2O\ (g)$

One mole of hydrogen gas is made to react with one mole of oxygen gas. What will be present after the reaction?

A. 1 mol of steam only
B. 1 mol of steam + 0.5 mol of oxygen gas
C. 1 mol of steam + 1 mol of hydrogen gas
D. 2 mol of steam + 0.5 mol of oxygen gas

14. One way to remove poisonous nitrogen monoxide (NO) from motor vehicle exhaust is to inject a stream of ammonia gas into the exhaust vapour.

$$6NO\ (g) + 4NH_3\ (g) \rightarrow 5N_2\ (g) + 6H_2O\ (g)$$

A car emits 3 dm^3 of nitrogen monoxide for each kilometre it moves. If it is driven 40000 km a year, what is the volume of ammonia gas needed per annum to clean up the exhaust gas?

A. 40 000 dm^3
B. 60 000 dm^3
C. 80 000 dm^3
D. 120 000 dm^3

15. Which compound does not have the empirical formula CH_2O?

A. Ethanol, CH_3CH_2OH
B. Glucose, $C_6H_{12}O_6$
C. Methanal, HCHO
D. Methyl methanoate, HCO_2CH_3

16. The compound SO_2Cl_2 reacts with water according to the following equation.

$$SO_2Cl_2 + 2H_2O \rightarrow H_2SO_4 + 2HCl$$

How many moles of sodium hydroxide will neutralise the solution produced by one mole of SO_2Cl_2 and excess water?

A. 1
B. 2
C. 3
D. 4

17. Titanium is manufactured from a mixture of iron(II) titanate, $FeTiO_3$, and iron(III) titanate, $Fe_2(TiO_3)_3$.

What are the oxidation numbers of titanium in these two compounds?

A. +2, +2
B. +4, +4
C. +2, +3
D. +4, +2

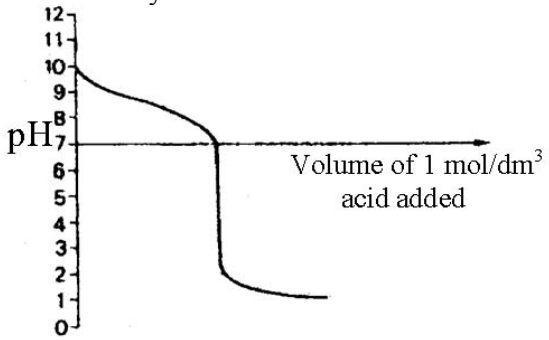
18. Which of the following compounds can be classified as a normal salt?

I. K_2SO_4
II. Zn(OH)Cl
III. $NaHCO_3$
IV. CH_3COONa

A. I and II only
B. II and IV only
C. I, II and III
D. I and IV only

19. A titration curve is shown below. Which pair of substances could this curve apply to?

I. Sodium hydroxide and hydrochloric acid.
II. Sodium hydroxide and ethanoic acid.
III. Aqueous ammonia and hydrochloric acid.

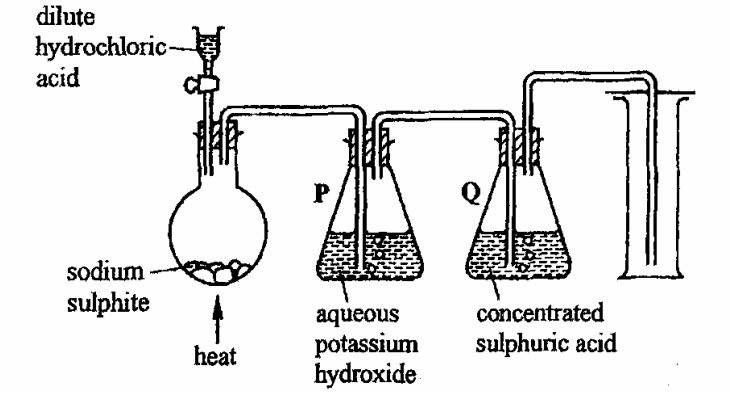


A. All of the above
B. I and II only.
C. I and III only.
D. III only.

20. When ammonia is manufactured by the Haber process, about 10% of the unreacted gases consist of argon, which may be extracted commercially from this mixture. Which methods could best be used for this separation?

A. Fractional distillation of the liquefied unreacted gases.
B. Reacting the hydrogen catalytically with oxygen and removal of the water formed.
C. Reacting the hydrogen by sparking with oxygen and removal of the water formed.
D. Recycling the reaction mixture through the manufacturing plant until only argon remains.

21. The diagram shows an unsuccessful attempt to prepare and collect sulphur dioxide.



Which modification would make the experiment successful?

A. Omitting flask P entirely.
B. Omitting flask Q entirely.
C. Using dilute sulphuric acid instead of hydrochloric acid.
D. Collecting by upward delivery.

22. The formation of hydrogen iodide from hydrogen and iodine is an endothermic reaction.

$$H\text{-}H + I\text{-}I \rightarrow H\text{-}I + H\text{-}I$$

What may be deduced from this information?

A. The number of bonds broken is greater than the number of bonds formed.
B. The formation of H-I bonds absorbs energy.
C. The products possess less energy than the reactants.
D. The total energy change in bond formation is less than that in bond breaking.

23. Which of the following methods could not be used to prepare the solid lead salt listed below?

	Method	Solid lead salt
A.	Boil lead(II) chloride in water, then add sulphuric acid.	Lead(II) sulphate
B.	Add nitric acid to lead(II) carbonate, then add aqueous sodium iodide.	Lead(II) iodide
C.	Add sulphuric acid to lead(II) carbonate.	Lead(II) sulphate
D.	Add aqueous sodium carbonate to aqueous lead(II) nitrate.	Lead(II) carbonate

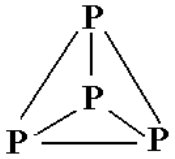
24. After acidification with dilute nitric acid, a colourless solution X reacts with aqueous silver nitrate to give a yellow precipitate. What could X be?

A. Calcium iodide
B. Copper(II) chloride
C. Iron(II) iodide
D. Sodium chloride

25. Photochemical smog is seen in many industrialised cities. Which of the following is not responsible for its formation?

A. Nitrogen dioxide
B. Sulphur dioxide
C. Pentane
D. Ozone

26. Nitrogen exists as the molecule $N \equiv N$. Phosphorus exists as the molecule shown below.



Imagine that nitrogen were to form a similar molecule, N_4.

$$2N_2\ (g) \rightarrow N_4\ (g)$$

By considering the bonds broken and the bonds formed, what would be the value of ΔH for the above reaction?

(Bond energies: N-N, 160 kJ/mol; $N \equiv N$, 994 kJ/mol)

A. 1 028 kJ/mol
B. 1 348 kJ/mol
C. 1 954 kJ/mol
D. 2 628 kJ/mol

27. An element reacts with steam but not with cold water. Its oxide can be reduced by heating it with carbon. When it is placed in a solution containing iron(II) ions, a grey deposit is formed. The element is most likely to be

A. Lead
B. Magnesium
C. Zinc
D. Copper

28. Which of the following equations does not represent a redox reaction?

A. $Sn^{2+}\ (aq) + 2Fe^{3+}\ (aq) \rightarrow Sn^{4+}\ (aq) + 2Fe^{2+}\ (aq)$
B. $Ca\ (s) + 2HCl\ (aq) \rightarrow CaCl_2\ (aq) + H_2\ (g)$
C. $Ag^{+}\ (aq) + Cl^{-}\ (aq) \rightarrow AgCl\ (s)$
D. $Zn\ (s) + 2H^{+}\ (aq) \rightarrow Zn^{2+}\ (aq) + H_2\ (g)$

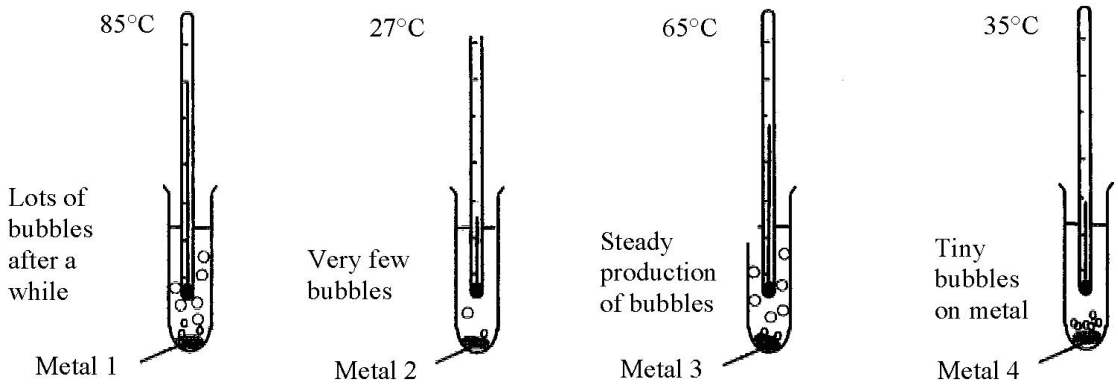
29. The information below concerns 3 elements X, Y and Z.

X: Its oxide is decomposed by heat to the element.
Y: Its carbonate is not decomposed by heat.
Z: Its oxide is not decomposed by heat but its carbonate decomposes.

In order of decreasing reactivity, the 3 elements should be arranged as:

A. YZX
B. XYZ
C. YXZ
D. XZY

30. Equal masses of different metals 1 to 4 are placed in test-tubes containing an equal volume of hydrochloric acid. The thermometers show the maximum temperature recorded for the reaction. (The surrounding room temperature is 24°C)



Which of the following is true?

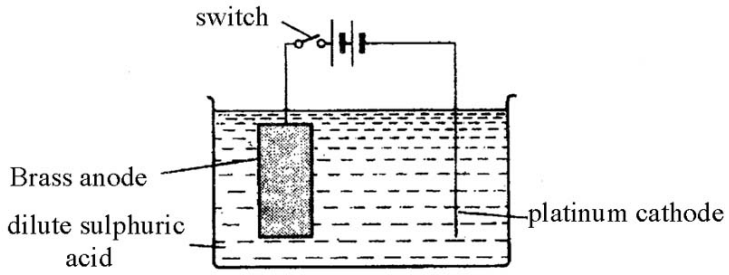
I Metal 3 will displace Metals 2 and 4 from their aqueous salt solutions.
II Metal 2 can be extracted by chemical reduction of its oxide by carbon.
III Metal 1 can be obtained by electrolysis of its molten chloride.

A. All of the above.
B. I and II only.
C. I and III only.
D. II and III only.

31. During the electrolysis of concentrated sodium chloride in a cell, chlorine, hydrogen and sodium hydroxide are produced. What is the molar ratio of these products?

	Chlorine	Hydrogen	Sodium hydroxide
A.	1	1	1
B.	1	1	2
C.	2	1	1
D.	2	2	1

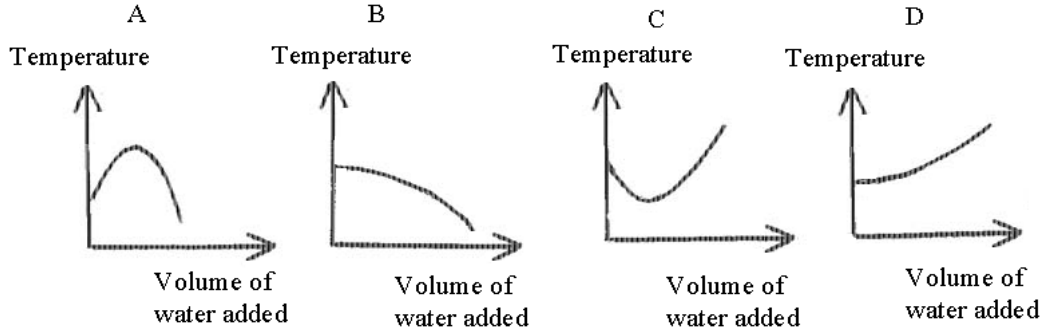
32. The circuit shown in the diagram was set up, with brass (an alloy made up of copper and zinc) as the anode.



Which electrode reactions will occur on closing the switch?

	Anode reaction	*Cathode reaction*
A.	Copper dissolves preferentially.	Copper is deposited.
B.	Copper dissolves preferentially.	Hydrogen is evolved.
C.	Zinc dissolves preferentially.	Hydrogen is evolved.
D.	Zinc and copper both dissolve.	Copper is deposited.

33. When water is stirred with glucose, strong hydrogen bonds are initially formed between glucose molecules and water molecules but as more water is added, these hydrogen bonds are broken. Which of the below graph sketches best represents the observed temperature changes?



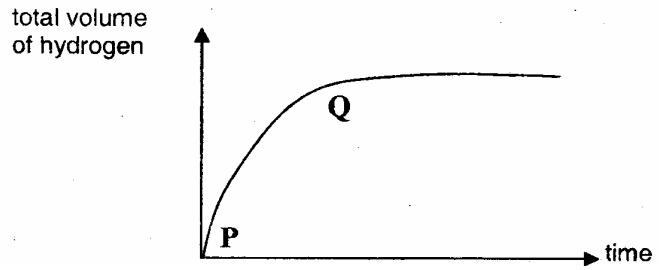
34. Two experiments were carried out in which hydrochloric acid was added to limestone.

Experiment A: 500 cm^3 of 1.0 mol/dm^3 hydrochloric acid added to an excess of limestone.
Experiment B: 100 cm^3 of 5.0 mol/dm^3 hydrochloric acid added to an excess of limestone.

The initial rate of evolution of carbon dioxide and the total volume of carbon dioxide evolved were measured in each experiment. How do the results in experiment A compare with those in experiment B when all other conditions are identical?

	Rate of evolution of carbon dioxide	Total volume of carbon dioxide formed
A.	It is slower in A than in B.	It is the same in A and B.
B.	It is faster in B than in A.	It is greater in B than in A.
C.	It is slower in B than in A.	It is greater in B than in A.
D.	It is the same in A and B.	It is greater in A than in B.

35. The graph shows how the total volume of hydrogen produced changes when iron filings are reacted with excess dilute sulphuric acid.



Which statement best describes the section PQ of the curve?

A. The acid is slowly used up which results in the reaction slowing down.
B. The decreasing mass of the iron filings results in the reaction slowing down.
C. Water is produced in the reaction that dilutes the acid which slows down the reaction.
D. Hydrogen gas produced slows down the reaction.

36. Methane gas reacts extremely slowly with air at room temperature. If a piece of warm platinum is held in a methane-air mixture, the methane ignites. What differences are there between the reaction with the platinum and the reaction without the platinum?

For the reaction with the platinum:

I. The activation energy is lower.
II. The energy change is greater.
III. The energy of the reactants is higher.
IV. The rate of reaction is greater.

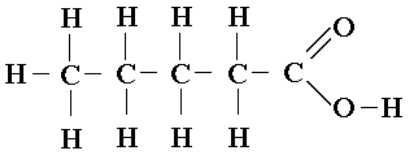
A. I and II only.
B. I and III only,
C. I and IV only.
D. II and IV only.

37. Cracking is a common process in the petroleum industry.

Which of the following gives the most appropriate explanation for carrying out cracking?

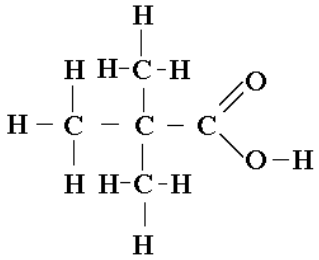
A. It forms more useful fractions for commercial use.
B. There is too much of the heavier fraction of petroleum present.
C. It is easier to form useful fuel fractions through this means then through fractional distillation of petroleum.
D. The reaction is exothermic.

38. The molecular formula of an organic acid is shown below.

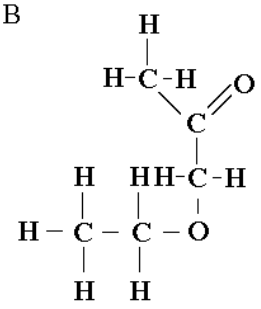


Which structure is not an isomer of this acid?

A



B



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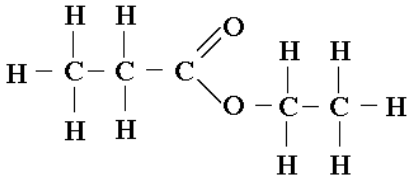

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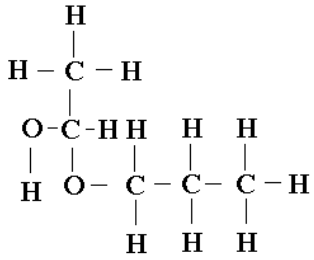
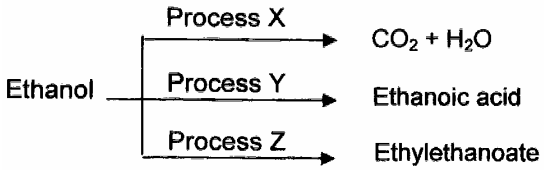


39.



Name the processes X, Y and Z.

	X	Y	Z
A.	respiration	reduction	acidification
B.	respiration	oxidation	hydrogenation
C.	cracking	oxidation	neutralisation
D.	combustion	oxidation	esterification

40. Which of the following properties does not change in the polymerisation of tetrafluoroethene?

A. boiling point
B. melting point
C. mass
D. relative molecular mass

Paper 2 (1 hour 45 mins / 80 Marks)

Section A: 50 Marks [Answer all questions.]

1. The melting points of the oxides of third period elements are given below.

Compound	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_3	SO_2	Cl_2O
Melting point /°C	1275*	2800	2045	1700	24	-73	-20

* sublimes

(a) Briefly explain why the melting points of SiO_2 and P_2O_3 are so different. (2)

(b) Draw a 'dot and cross' diagram to illustrate the bonding in Cl_2O, showing only the outermost electrons. (2)

(c) Which oxides can conduct an electric current in the liquid state? (1)

(d) Give one use of one of the oxides named in (c) above. (1)

2(a) The reaction of aluminium chloride with water is as follows:

$$2AlCl_3 + 6H_2O \rightarrow 2Al(OH)_3 + 6HCl$$

Each of the following compounds

aluminium bromide ($AlBr_3$),
aluminium nitride (AlN) and
aluminium carbide (Al_4Cl_3)

reacts with water in a similar way. Predict the formula of the compound produced, other than aluminium hydroxide in each case. (3)

(b) $NaNO_3$ NH_3 $CuSO_4$ $MgCO_3$ Al_2O_3

Choose from the above list of compounds one which contains:

(i) an element found in Group II of the Periodic Table. (1)

(ii) a metallic element showing an oxidation number of +3. (1)

(iii) a non-metallic element showing an oxidation number of -3. (1)

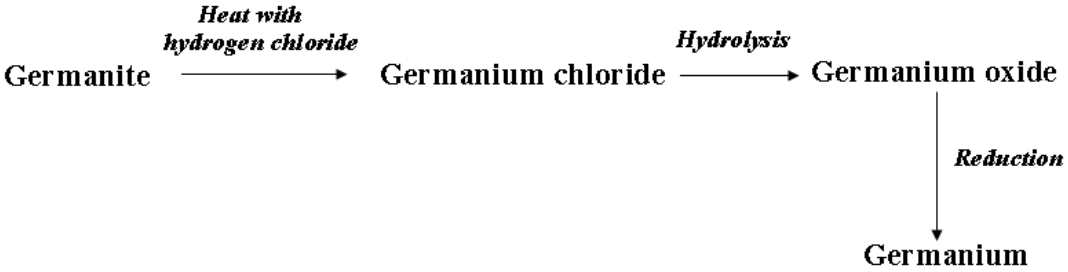
(iv) a non-metallic element showing an oxidation number +5. (1)

3(a) Lead white, a white pigment used in old paintings, contains lead(II) carbonate. It darkens when exposed to air containing traces of hydrogen sulphide, due to the formation of black lead(II) sulphide, PbS. The white colour can be restored by treating the painting with aqueous hydrogen peroxide which converts the lead(II) sulphide into lead(II) sulphate and water.

(i) Write the chemical equation between lead(II) sulphide and hydrogen peroxide. (1)

(ii) Calculate the volume of 0.100 mol/dm^3 hydrogen peroxide required to react with 0.25 g of lead(II) sulphide. (2)

(b) The element germanium (Ge) was once an important component of transistors. The flow chart below shows how germanium can be made from its ore germanite.



When 1.00 g of germanite was treated in this way, the germanium present was completely converted into 0.177 g of a chloride containing 33.9% by mass of germanium.

(i) Determine the empirical formula of the chloride. (2)
(ii) Write down the valency of germanium in the chloride. (1)

(iii) Calculate the percentage of germanium in germanite. (1)

4. A double-glazed window is made of two sheets of glass mounted in an aluminium frame. Between these two sheets of glass is a polyester film coated with a very thin layer of silver. This arrangement controls the transmission of heat and light.

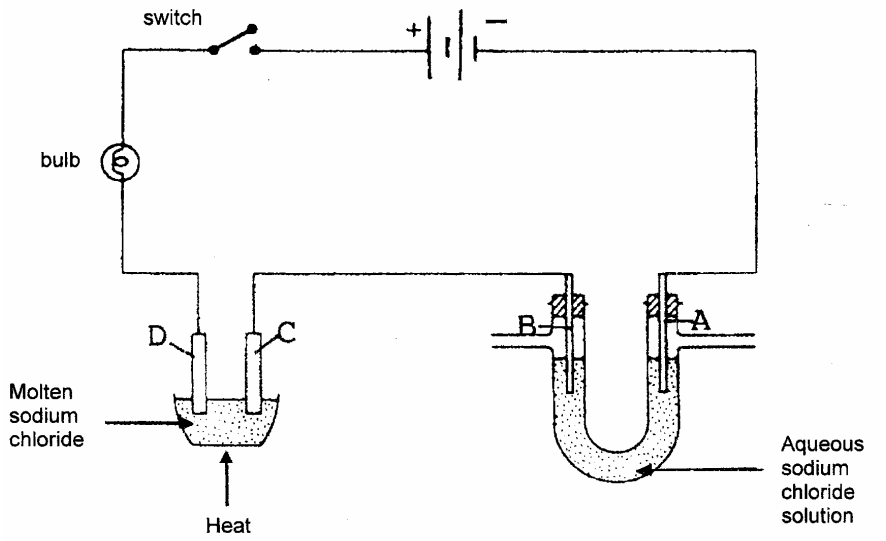
(a) Name the linkage found in polyester and draw the structure of this linkage. (2)

(b) A chemical analyst was asked to test if the polyester film had been coated with silver. A piece of the polyester is to be dropped into dilute nitric acid, which will in turn dissolve the silver. Suggest how the solution formed could be tested for silver ions. (2)

(c) The window was improved by filling the space between the glass with krypton, a noble gas. Krypton is a poorer conductor of heat than air. Suggest a reason for this property of krypton. (1)

(d) Name another noble gas, and state its use. (1)

5. The below apparatus was used to investigate the electrolysis of sodium chloride using carbon electrodes. The crucible contained molten sodium chloride. The U-tube contained an aqueous solution of sodium chloride. The bulb lit when the switch was closed.



(a) Write down the formula of all the ions present in the crucible and U-tube. (1)

(b) A colourless gas was formed at electrode A. Write an equation for the reaction at A. (1)

(c) Name the product at C. (1)

(d) What would be observed at D? (1)

(e) What would happen to the bulb in the experiment if the heat supply under the crucible is removed and the contents allowed to cool to room temperature? Explain. (2)

6. Zinc sulphate can be prepared by reacting zinc oxide with dilute sulphuric acid according to the equation shown below.

$$ZnO\,(s) + H_2SO_4\,(aq) \rightarrow ZnSO_4\,(aq) + H_2O\,(l)$$

If 10 cm^3 of 2.0 mol/dm^3 of sulphuric acid was used to react with excess zinc oxide, calculate:

(a) the number of moles of acid present in 10 cm^3 of the acid. (1)

(b) the expected mass of zinc sulphate produced. (2)

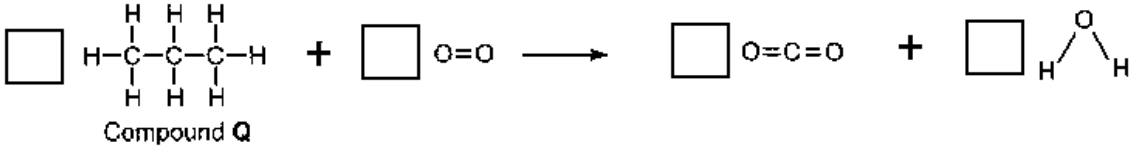
7(a) Describe the preparation of pure lead(II) chloride in the laboratory starting from a sample of lead(II) carbonate. (3)

(b)(i) Silicon is in the same group as carbon. Write down the formula of a compound that contains silicon and hydrogen atoms only. (1)

(ii) What kind of bonding is found between the atoms in each molecule of the compound stated in part (c)(i)? (1)

(c) Explain briefly why a coating of paint helps to prevent iron from rusting. (1)

8. The unbalanced chemical equation for the complete combustion of compound Q is given below:



(a) In which homologous series of organic compounds does compound Q belong? (1)

(b) Write down the chemical name of compound Q. (1)

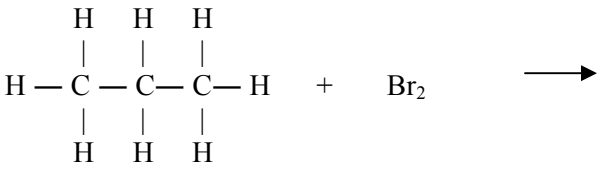
(c) Compound Q can be described as a saturated hydrocarbon. Define the terms "saturated" and "hydrocarbon". (2)

(d) Balance the chemical equation for the complete combustion of compound Q by writing the correct numbers in the boxes provided. (1)

(e) Using the following average bond energy data, calculate the energy change when one mole of compound Q is completely burnt in air. (3)

C ─ C average bond energy = 348 kJ mol^{-1}
C ─ H average bond energy = 412 kJ mol^{-1}
O = O average bond energy = 496 kJ mol^{-1}
C = O average bond energy = 743 kJ mol^{-1}
O ─ H average bond energy = 463 kJ mol^{-1}

(f) Compound Q undergoes a substitution reaction with bromine in the presence of ultra-violet light as shown in the diagram below. Give the structural formula of a possible organic reaction product that could be formed when compound Q reacts with bromine and hence balance the chemical equation. (1)



Section B: 30 Marks [Answer questions 1 & 2, and either question 3 or 4.]

1. The table below shows the time taken for the same mass of magnesium to dissolve completely in sulphuric acid of various concentrations at room temperature and pressure.

	Dilute sulphuric acid				**Concentrated sulphuric acid**		
Concentration (mol/dm^3)	0.5	1.0	2.0	4.0	8.0	12.0	18.0
Time (s)	450	45	22	5	106	750	Very little reaction

(a)(i) Write the ionic equation, with state symbols, for the reaction between magnesium and sulphuric acid. (2)

(ii) Explain the change in the rate of reaction as the concentration increases from 0.5 mol/dm^3 to 4.0 mol/dm^3. (2)

(iii) There was very little reaction when the concentration of the acid was 18.0 mol/dm^3. What does this suggest about the degree of ionisation of concentrated sulphuric acid? (1)

(b)(i) If the rate of each of the above reactions was followed by measuring the volume of hydrogen gas evolved, sketch the graph (volume of hydrogen in cm^3 against time in seconds) obtained when 1.20 g of magnesium ribbon is reacted in excess 4.0 mol/dm^3 sulphuric acid. (3)

(ii) Calculate the maximum volume of hydrogen gas produced. Indicate this volume in the graph that you have sketched. (1)

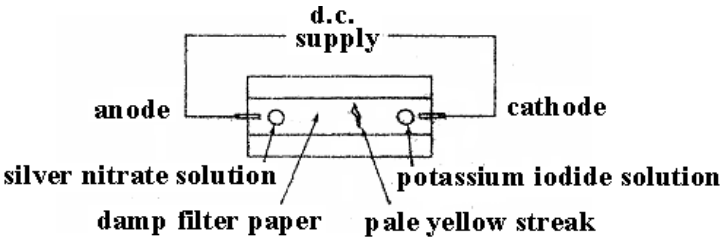
(iii) Explain why the reaction stops. (1)

2(a) An aqueous solution of calcium hydroxide is electrolysed between carbon electrodes.

(i) What gas is expected to be produced at the anode? (1)

(ii) It is observed that during the electrolysis, the mass of the anode decreases and the solution around it becomes milky.
Suggest an explanation for these observations. (2)

(b) A strip of moistened filter paper is laid on a microscope slide. A drop of silver nitrate solution is placed near one end of the paper and a drop of potassium iodide solution near the other end. Using inert electrodes, the apparatus is connected to a suitable d.c. supply. After some time, a pale yellow streak appears as shown in the diagram below.



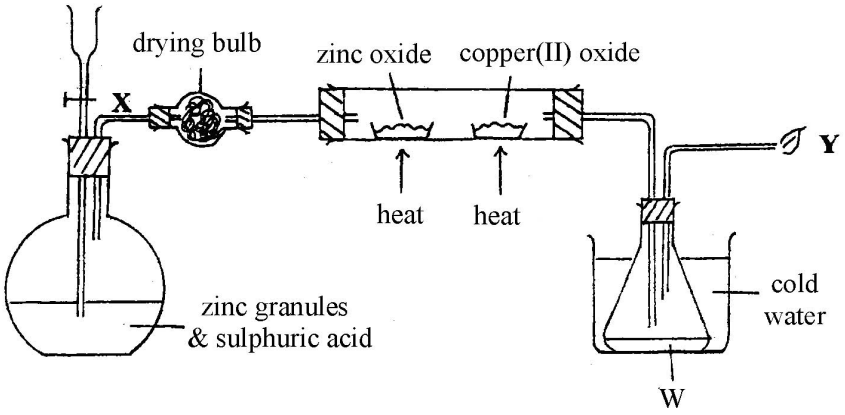
(i) Give the formula of all possible ions present in the solutions of silver nitrate and potassium iodide. (2)

(ii) Name the compound responsible for the pale yellow streak and write ionic equation for its formation. (2)

(iii) Explain the process leading to the formation of the streak and explain why the streak appears nearer the cathode than the anode. (2)

EITHER:

3. In the experiment shown below, the gas X produced by the action of dilute sulphuric acid on the zinc granules was passed over two heated metallic oxides.
   A colourless liquid W was collected and the excess gas X was burnt off at Y.



(a) What is the gas X? Write the ionic equation for the formation of the gas. (2)

(b) State what is observed of:

(i) zinc oxide and

(ii) copper(II) oxide?

Write equation(s) for any change observed. (2)

(c) Explain your observations made in (b)(i) and (ii). (2)

(d) Give a chemical test to identify the liquid W. (1)

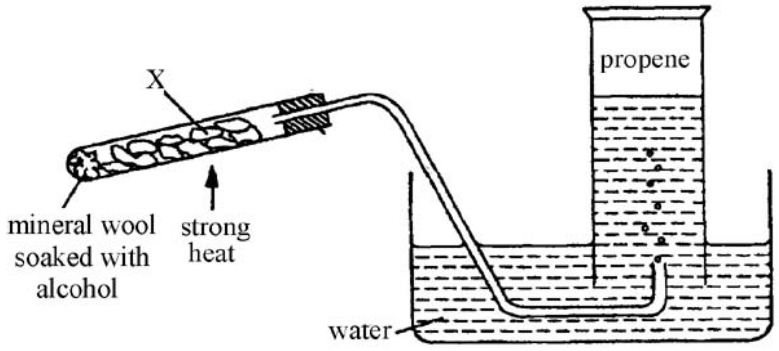
(e) Suggest a suitable drying agent to be placed inside the drying bulb. (1)

(f) Why was the excess gas X burnt off at Y? (1)

(g) What precautions should be taken before the excess gas was lit? (1)

OR:

4(a) Alkenes can be conveniently prepared in the laboratory by the dehydration of alcohols. The apparatus shown below can be used to prepare a sample of propene. The material X can be a ceramic such as broken brick or broken crockery.



(i) Give the full structural formula of an alcohol that can be used to prepare propene. (1)

(ii) Write an equation for the dehydration of the alcohol you have quoted in (a)(i). (1)

(iii) What is the chemical name of a substance that might be present in X? (1)

(iv) What purpose does X serve in this reaction? (1)

(v) Suggest why X needs to be strongly heated. (1)

(vi) The material X becomes black in colour. Suggest what substance is responsible for this black colour and how it arises in the reaction. (2)

(b) One renewable source of methane is the following anaerobic fermentation of glucose carried out by certain micro-organisms.

$$C_6H_{12}O_6\ (aq) \rightarrow 3CO_2\ (g) + 3CH_4\ (g) \qquad \Delta H = -132\ kJ\ mol^{-1}$$

A different fermentation of glucose produces ethanol.

$$C_6H_{12}O_6\ (aq) \rightarrow 2C_2H_5OH\ (aq) + 2CO_2\ (g) \qquad \Delta H = -68\ kJ\ mo1^{-1}$$

Comment on the relative advantages and disadvantages of these two types of fermentation as sources of fuel from glucose. (3)

Answers:

Paper 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
C	C	B	C	D	C	C	D	B	D	A	A	B	C	A	D	B	D	D	A

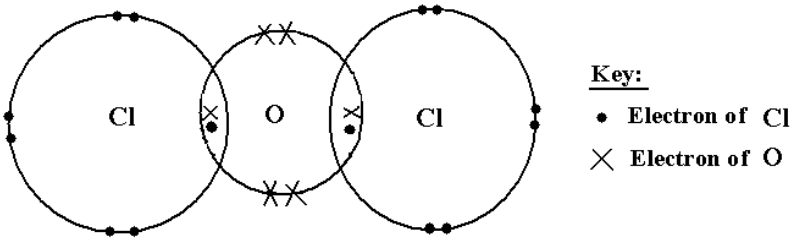
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
A	D	C	A	B	A	C	C	A	A	B	C	A	A	B	C	A	D	D	C

Paper 2 (Section A)

1(a) - SiO_2 has a giant molecular structure. The covalent bonds between the atoms are strong, and thus large amounts of heat energy are needed to overcome these bonds, resulting in its high melting point.

- In contrast, P_2O_3 has a simple molecular structure. The Van der Waals forces between the molecules are weak, and thus little amount of heat energy is needed to overcome these intermolecular forces, resulting in its low melting point.

(b)



(c) Na_2O, MgO, Al_2O_3

(d) Magnesium oxide: used to line the inside of furnaces.

2(a) Aluminium bromide: HBr produced

Aluminium nitride: NH_3 produced

Aluminium carbide: CH_4 produced

(b)(i) $MgCO_3$

(ii) Al_2O_3

(iii) NH_3

(iv) $NaNO_3$

3(a)(i) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

(ii) Number of moles of PbS = Mass / Molar mass
= 0.25 / (207 + 32)
= 0.001046

1 mole of PbS reacts with 4 moles of H_2O_2.
0.001046 moles of PbS react with 0.001046 / 1 x 4 = 0.004184 moles of H_2O_2.

Volume of H_2O_2 required = Number of moles / Concentration
= 0.004184 / 0.100
= <u>0.0418 dm^3</u>

(b)(i)

Elements	Germanite	Chloride
Mass in %	33.9	66.1
Ar	73	35.5
Number of moles	33.9/73 = 0.464	66.1/35.5 = 1.861
Divide by smallest number	0.464/0.464 = 1	1.861/0.464 = 4

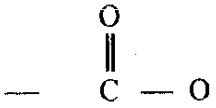
⇨ Empirical formula: $GeCl_4$

(ii) Valency: 4

(iii) Mass of germanium in germanium chloride = 33.9 / 100 x 0.177
= 0.0600 g

Percentage of germanium in germanite = 0.0600 / 1.00 x 100%
= <u>6.00%</u> (3 sf)

4(a) Name of linkage: Ester link
Structure of linkage:



(b) - To a portion of the solution, add an equal volume of aqueous sodium chloride / aqueous hydrochloric acid.
- A white precipitate is seen.

(c) Krypton has a larger relative atomic mass, and thus travels more slowly than normal air molecule.

(d) Neon; used in advertising lights.

5(a) H^+, Na^+, OH^- and Cl^-

(b) $2H^+ + 2e \rightarrow H_2$

(c) Sodium metal.

(d) A greenish-yellow gas with a pungent smell that bleaches moist blue litmus paper is observed.

(e) - The compound solidifies and is unable to conduct electricity.
- This is because the ions are held in fixed positions in the solid state, and thus are not free to move about to conduct electricity.

6(a) Number of moles of acid = Concentration in mol/dm^3 x Volume
= 2.0 mol/dm^3 x (10 ÷ 1 000 dm^3)
= <u>0.0200 mol</u>

(b) 1 mole of H_2SO_4 produces 1 mole of $ZnSO_4$.
0.0200 moles of H_2SO_4 produce 0.0200 moles of $ZnSO_4$.

Mass of $ZnSO_4$ = Number of moles x Molar mass
= 0.0200 x (65 + 32 + 16 x 4)
= <u>3.22 g</u>

7(a) - Lead(II) carbonate is added bit by bit with constant stirring to warm dilute nitric acid in a beaker until no further lead(II) carbonate dissolves in the acid. The lead(II) nitrate solution formed is then filtered to remove the excess lead(II) carbonate.
- Dilute hydrochloric acid is then added to the filtrate of aqueous lead(II) nitrate. A precipitate is formed.
- The solution is filtered, and the precipitate of lead(II) chloride – residue – is rinsed with distilled water and dried between sheets of filter paper.

(b)(i) SiH_4

(ii) Covalent

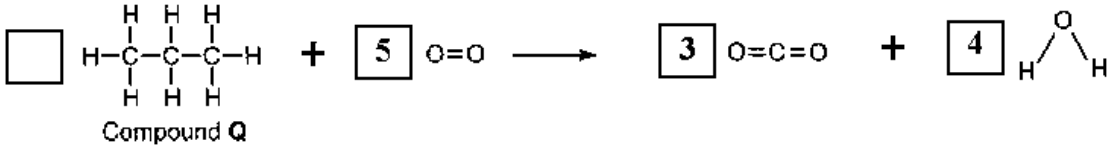
(c) The paint prevents the iron from coming into contact with oxygen and moisture in the air.

8(a) Alkanes

(b) Propane

(c) - A saturated organic compound is one that has only single C-C bonds.
- Hydrocarbons are organic compounds that contain only the elements hydrogen and carbon.

(d)

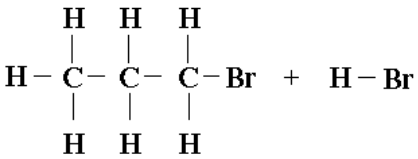


(e) Energy absorbed to break bonds = (412 x 8) + (348 x 2) + (496 x 5)
= 6 472 kJ

Energy released to form bonds = -[(743 x 6) + (463 x 8)]
= -8 162 kJ

Energy change = 6 472 + (-8 126)
= -1 690 kJ

(f)



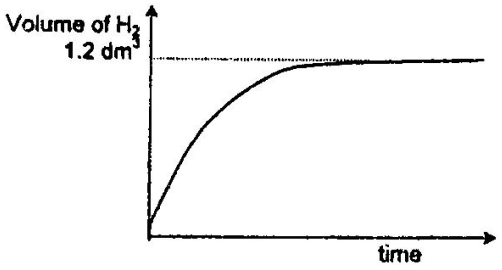
Section B

1(a)(i) $Mg\,(s) + 2H^+\,(aq) \rightarrow Mg^{2+}\,(aq) + H_2\,(g)$

(ii) - Rate of reaction increases.
- At higher concentrations, there are more particles per unit volume of the reactants. Thus, collisions are more frequent and the reaction speed increases.

(iii) The acid is only partially ionised.

(b)(i)



(ii) Number of moles of H_2 = Mass / Molar mass
= 1.2 / 24
= 0.0500 mol

1 mole of Mg is produced from 1 mole of H_2
0.0500 mole of Mg is produced from 0.0500 mole of H_2

Volume of H_2 produced = Number of moles x Molar volume
= 0.0500 x 24
= <u>1.20 dm^3</u>

(iii) The magnesium is used up.

2(a)(i) Oxygen

(ii) - The carbon anode decreases in size because it reacts with the oxygen produced to give carbon dioxide gas.
- The carbon dioxide then reacts with the calcium hydroxide solution to give a white precipitate, causing the solution to look milky.

(b)(i) $AgNO_3$: Ag^+, NO_3^-, H^+, OH^-
KI: K^+, I^-, H^+, OH^-

(ii) Silver iodide.
$Ag^+ (aq) + I^- (aq) \rightarrow AgI (s)$

(iii) - Silver ions in silver nitrate solution move to the cathode, while iodide ions in potassium iodide solution move to the anode.
- The two ions react to form silver iodide, which is the pale yellow streak.
- As the iodide ions are heavier than silver ions, the iodide ions take longer to migrate to the anode. Thus the yellow streak is nearer to the cathode.

3(a) Hydrogen gas.
$Zn + 2H^+ \rightarrow Zn^{2+} + H_2$

(b)(i) Zinc oxide turns from white to yellow.

(ii) Copper(II) oxide turns from black to pink.
$CuO + H_2 \rightarrow Cu + H_2O$

(c) - Zinc is above hydrogen in the reactivity series. Thus zinc oxide will not be reduced by hydrogen to zinc. Upon being heated, zinc oxide will change its colour from white to yellow.
- Copper is below hydrogen in the reactivity series. Thus copper(II) oxide will be reduced to form pink copper.

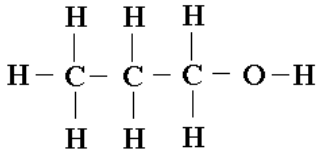
(d) W is tested with anhydrous cobalt(II) chloride paper. If W is water, the cobalt(II) chloride paper will turn from blue to pink.

(e) Fused calcium chloride.

(f) Because hydrogen gas is flammable and a mixture of hydrogen and air is highly explosive.

(g) Ensure that there is no leakage in the apparatus.

4(a)(i)



(ii) $C_3H_7OH \rightarrow C_3H_6 + H_2O$

(iii) Aluminium oxide / iron(III) oxide / silicon(IV) oxide.

(iv) As a catalyst.

(v) To provide the activation energy to start the reaction.

(vi) - Carbon.
- Carbon is formed from the thermal decomposition of the organic substance in X / Propene undergoes incomplete combustion to form carbon.

(b) Advantages of method 1:
- As a gaseous product, methane can be easily isolated from glucose after carbon dioxide is removed.
- From one mole of glucose, three moles of methane can be obtained compared to two moles of ethanol.

Disadvantage of method 1:
- By comparing the enthalpy change, it is seen that the methane produced contain less energy that can be utilised as an energy source.