Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced Subsidiary
Unit 2: Application of Core Principles of Chemistry

Tuesday 4 June 2013 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
6CH02/01

Candidates may use a calculator.

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.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- A Periodic Table is printed on the back cover of this paper.

Advice

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

Turn over ▶

P41650A

10/5/6/7/

P 4 1 6 5 0 A 0 1 2 4

PEARSON

SECTION A

Answer ALL the questions in this section. You should aim to spend no more than 20 minutes on this section. For each question, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Which of the following molecules has the smallest bond angle?

☒ **A** H_2O

☒ **B** NH_3

☒ **C** CH_4

☒ **D** SF_6

(Total for Question 1 = 1 mark)

2 A charged rod is held beside a stream of liquid coming from a burette. Which of the following liquids would NOT be significantly deflected?

☒ **A** H_2O

☒ **B** CCl_4

☒ **C** C_2H_5OH

☒ **D** C_2H_5Br

(Total for Question 2 = 1 mark)

3 Which of the following statements about electronegativity is true?

☒ **A** Non-metals have lower electronegativity than metals.

☒ **B** Electronegativity decreases across a period in the Periodic Table.

☒ **C** Electronegativity decreases going down a group in the Periodic Table.

☒ **D** The bonds between atoms with equal electronegativity are always weak.

(Total for Question 3 = 1 mark)

4 In which series of compounds does the covalent character increase, going from left to right?

☒ **A** $NaCl$, $MgCl_2$, $AlCl_3$, $SiCl_4$

☒ **B** SiO_2, Al_2O_3, MgO, Na_2O

☒ **C** LiI, NaI, KI, RbI

☒ **D** KI, KBr, KCl, KF

(Total for Question 4 = 1 mark)

5 Going down Group 2 from calcium to barium

☒ **A** the first ionization energy of the element increases.

☒ **B** the strength of the metallic bonding increases.

☒ **C** the polarizing power of the 2+ ion decreases.

☒ **D** the stability of the nitrate to heat decreases.

(Total for Question 5 = 1 mark)

6 Fullerenes, graphite and diamond are all forms of carbon. Fullerenes dissolve in petrol, but diamond and graphite do not. This is because

☒ **A** the bonds between the carbon atoms in fullerenes are weaker than in diamond and graphite.

☒ **B** diamond and graphite are giant structures but fullerenes are molecular.

☒ **C** there are delocalized electrons in diamond and graphite but not in fullerenes.

☒ **D** there are covalent bonds in diamond and graphite, but not in fullerenes.

(Total for Question 6 = 1 mark)

7 Sodium chloride is more soluble in water than in hexane because

☒ **A** the intermolecular forces between water molecules are stronger than those between hexane molecules.

☒ **B** hexane molecules cannot fit between the ions in the sodium chloride lattice.

☒ **C** energy is released when the ions in sodium chloride are hydrated.

☒ **D** sodium ions and chloride ions form hydrogen bonds with water.

(Total for Question 7 = 1 mark)

8 Hydrochloric acid and sodium carbonate solution react as shown below.

$$2HCl(aq) + Na_2CO_3(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

Which sample of sodium carbonate solution will be neutralized by 20 cm^3 of 0.05 mol dm^{-3} hydrochloric acid?

	Volume of sodium carbonate/ cm^3	Concentration of sodium carbonate/ mol dm^{-3}
☒ **A**	10	0.05
☒ **B**	40	0.05
☒ **C**	40	0.10
☒ **D**	10	0.10

(Total for Question 8 = 1 mark)

9 A white solid produces oxygen when it is heated, but no other gases. The solid could be

☒ **A** lithium nitrate.

☒ **B** potassium nitrate.

☒ **C** strontium nitrate.

☒ **D** calcium oxide.

(Total for Question 9 = 1 mark)

10 A solid is soluble in water and produces steamy acidic fumes with concentrated sulfuric acid. The solid could be

☒ **A** potassium carbonate.

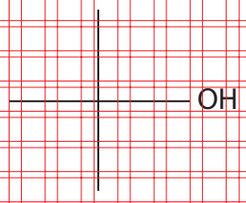
☒ **B** magnesium sulfate.

☒ **C** silver chloride.

☒ **D** sodium chloride.

(Total for Question 10 = 1 mark)

11



The systematic name of the compound with skeletal formula shown above is

☒ **A** 1,1-dimethylethanol.

☒ **B** 2,2-dimethylethanol.

☒ **C** 2-methylpropan-1-ol.

☒ **D** 2-methylpropan-2-ol.

(Total for Question 11 = 1 mark)

12 Samples of 1-chloropropane and 1-bromopropane are warmed with water containing dissolved silver nitrate in the presence of ethanol. The 1-chloropropane reacts more slowly because

☒ **A** the C—Cl bond is more polar than the C—Br bond.

☒ **B** the C—Cl bond is stronger than the C—Br bond.

☒ **C** 1-chloropropane is less soluble than 1-bromopropane.

☒ **D** 1-chloropropane is a weaker oxidising agent than 1-bromopropane.

(Total for Question 12 = 1 mark)

13 The reaction of 1-chloropropane with water containing dissolved silver nitrate in the presence of ethanol is

☒ **A** a redox reaction.

☒ **B** a nucleophilic substitution.

☒ **C** an electrophilic substitution.

☒ **D** a free radical substitution.

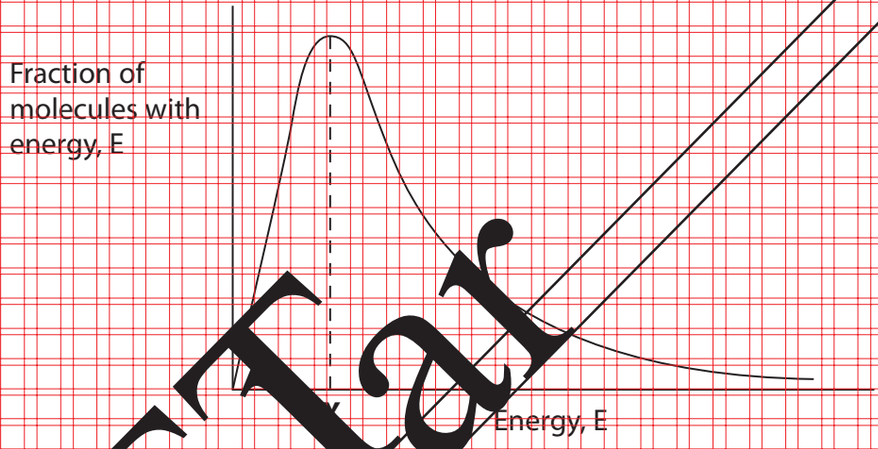
(Total for Question 13 = 1 mark)

14 The compound with formula $CH_3CH(NH_2)CH_3$ can be made by reacting alcoholic ammonia with

- ☒ **A** propane.
- ☒ **B** propene.
- ☒ **C** 2-chloropropane.
- ☒ **D** propan-2-ol.

(Total for Question 14 = 1 mark)

15



The energy marked on the Maxwell-Boltzmann distribution shows

- ☒ **A** the most common energy of the molecules.
- ☒ **B** the activation energy of the reaction.
- ☒ **C** the activation energy of a catalysed reaction.
- ☒ **D** the number of molecules with energy greater than the activation energy.

(Total for Question 15 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

16 In the industrial process involving gas phase reactions to produce ammonia, many collisions between molecules are unsuccessful because

- ☒ **A** gas phase reactions are reversible.
- ☒ **B** the collisions are not energetic enough to break the bonds in the molecules.
- ☒ **C** gas phase reactions can only occur when a catalyst is present.
- ☒ **D** gas phase reactions can only occur when UV light is present.

(Total for Question 16 = 1 mark)

17 The molecular (parent) ion in the mass spectrum of a hydrocarbon containing ^{12}C and ^{1}H only

- ☒ **A** is the peak with highest relative abundance.
- ☒ **B** is the peak with highest charge.
- ☒ **C** is the peak produced by the most stable fragment.
- ☒ **D** is the peak with highest mass to charge ratio.

(Total for Question 17 = 1 mark)

18 A compound which has major peaks with mass / charge ratio at 29, 57 and 58 in the mass spectrum could be

- ☒ **A** propanal, CH_3CH_2CHO
- ☒ **B** propanone, CH_3COCH_3
- ☒ **C** propan-1-ol, $CH_3CH_2CH_2OH$
- ☒ **D** propan-2-ol, $CH_3CH(OH)CH_3$

(Total for Question 18 = 1 mark)

19 Which of the following would **not** be used to assess whether the use of a biofuel produced from a crop of sugar cane is carbon neutral?

The amount of

- ☒ **A** fuel used to operate farm machinery.
- ☒ **B** pesticides and fertilisers used.
- ☒ **C** energy released per tonne of biofuel.
- ☒ **D** fuel used to process the crop.

(Total for Question 19 = 1 mark)

20 The principal reason why scientists have recommended that chlorofluorocarbons (CFCs) are not used in aerosols is that they cause

- ☒ **A** global warming.
- ☒ **B** acid rain.
- ☒ **C** ozone depletion.
- ☒ **D** water pollution.

(Total for Question 20 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

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SECTION B

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

21 (a) (i) An alkaline solution is produced when barium reacts with cold water. Write the equation for this reaction, including all state symbols.

(2)

(ii) The reaction in (a)(i) is a redox reaction. State the initial and final oxidation number of any element that changes its oxidation number.

(2)

(b) Dilute hydrochloric acid is added to the solution produced in (a)(i). Write the equation for the reaction which occurs. State symbols are **not** required.

(1)

(c) Dilute sulfuric acid is added to another sample of the solution produced in (a)(i). How would the appearance of the resulting mixture differ from the mixture produced in (b)? Explain this difference.

(2)

Appearance .....

Explanation .....

(d) (i) Two white powders are known to be barium carbonate and magnesium carbonate.

How could you distinguish between the two powders by heating them? [No practical details are required.]

Include the equation for the action of heat on one of these carbonates. State symbols are not required.

✓ **(2)**

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Equation:

(ii) Suggest another test, other than heating, the use of an acid, which could be used to distinguish between magnesium carbonate and barium carbonate. State the results for both compounds.

(2)

Test .....

Result with magnesium carbonate .....

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Result with barium carbonate .....

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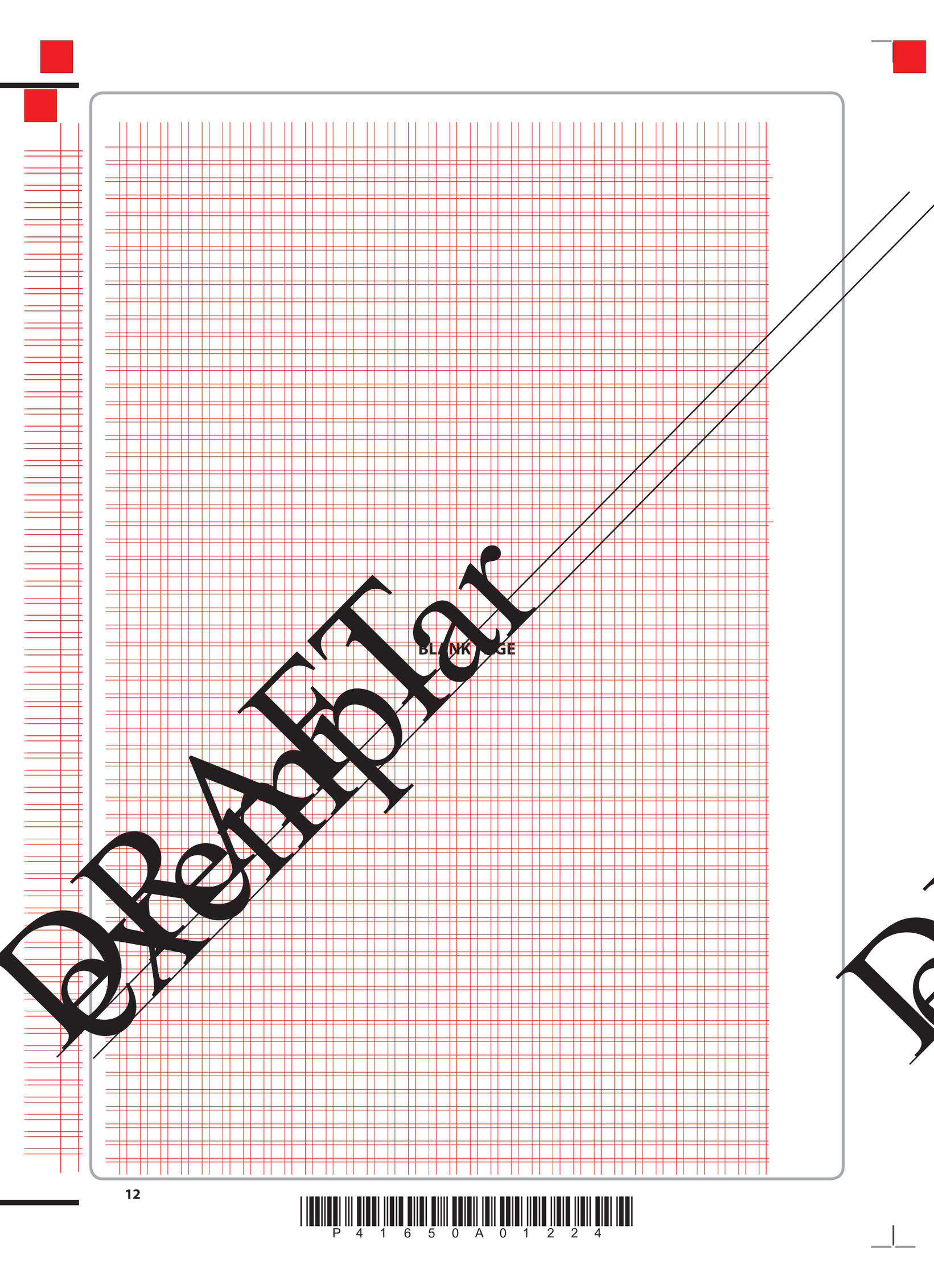
(Total for Question 21 = 11 marks)



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

22 (a) The products of the reaction when 2-chlorobutane is heated with sodium hydroxide depend on the conditions.

(i) What condition, other than a suitable temperature and sodium hydroxide concentration, would produce a mixture of but-1-ene and but-2-ene?

(1)

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(ii) What type of reaction occurs in (a)(i)?

(1)

.....

(iii) What condition, other than a suitable temperature and sodium hydroxide concentration, would produce butan-2-ol in the reaction of 2-chlorobutane with sodium hydroxide?

(1)

.....

(iv) Suggest the mechanism for the reaction of 2-chlorobutane with hydroxide ions to form butan-2-ol. Use curly arrows to show the movement of electron pairs.

(2)

(b) Phosphorus(V) chloride, PCl_5, can be used to test for the –OH group.

Describe what would be seen when phosphorus(V) chloride is added to butan-2-ol. Give the equation for the reaction. State symbols are not required.

(2)

Observation .....

Equation

(c) A tertiary alcohol, **A**, is an isomer of butan-2-ol.

(i) Butan-2-ol and **A** can be distinguished by warming separate samples with a mixture of potassium dichromate(VI) and sulfuric acid. State the observations which would be made with each alcohol.

(2)

Observation with butan-2-ol .....

.....

Observation with **A** .....

.....

(ii) Give the structural formula of the organic product which forms when butan-2-ol is oxidised.

(1)

(iii) Explain how infrared spectroscopy could be used to detect whether butan-2-ol has been oxidized.

(1)

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(Total for Question 22 = 11 marks)

23 The boiling temperatures of fluorine and two of its compounds are given below.

Substance	F_2	CH_3F	HF
T_b /K	85	195	293

(a) A molecule of F_2 has 18 electrons.

Which intermolecular force depends to a large extent on the number of electrons in the molecule?

(1)

(b) Calculate the number of electrons in a molecule of CH_3F.

(1)

(c) Explain why the boiling temperature of CH_3F is greater than that of F_2, referring to the intermolecular forces present.

(1)

Explain why the boiling temperature of HF is the highest in the series.

(2)

(e) Explain why the values of the boiling temperatures for Cl_2, CH_3Cl and HCl do not follow the same trend as F_2, CH_3F and HF.

(1)

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(Total for Question 23 = 6 marks)

24 The percentage by mass of tin in a piece of rock containing tin(IV) oxide, SnO_2, was determined as described in the procedure below.

Step 1 A sample of rock, with mass 10.25 g, was crushed and dissolved in sulfuric acid.

Step 2 The solution was treated with a reducing agent to convert the Sn^{4+} to Sn^{2+} ions.

Step 3 50 cm^3 of aqueous iodine solution with concentration 0.250 mol dm^{-3} was added to the solution of Sn^{2+} ions. The following reaction occurred:

$$Sn^{2+}(aq) + I_2(aq) \rightarrow Sn^{4+}(aq) + 2I^-(aq)$$

Step 4 The **excess** iodine was titrated with sodium thiosulfate solution with concentration 0.100 mol dm^{-3}. The volume of sodium thiosulfate solution required was 11.60 cm^3.

(a) Thiosulfate ions react with iodine as shown below.

$$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$$

(i) Calculate the number of moles of sodium thiosulfate which were used in **Step 4**.

(1)

(ii) Calculate the number of moles of iodine which reacted with this amount of sodium thiosulfate.

(1)

(iii) Calculate the number of moles of iodine added to the solution of Sn^{2+} ions in **Step 3**.

(1)

(iv) Use your results from (ii) and (iii) to calculate the number of moles of iodine which reacted with the Sn^{2+} ions from the rock.

(1)

(v) Hence calculate the percentage by mass of tin in the rock.

(2)

(b) (i) What change could be made in **Step 4** to improve the reliability of the result?

(1)

(ii) The error each time the burette was read was ± 0.05 cm^3. Calculate the percentage error in the titre value of 11.[illegible] cm^3.

(1)

(iii) How could the percentage error in the titre value be reduced without using a different burette?

(1)

(c) The titration can be carried out with or without an indicator. What colour **change** would be seen at the end-point if an indicator was **not** used? The tin ions are colourless.

(1)

(Total for Question 24 = 10 marks)

TOTAL FOR SECTION B = 38 MARKS

SECTION C

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

25 (a) Sea water is a source of chemicals. The most abundant chemical dissolved in sea water is sodium chloride. Compounds of magnesium and bromine are also present. Magnesium occurs at 1300 parts per million (ppm) and bromine at 60 ppm by mass.

The solution left after crystallizing sodium chloride from sea water is even richer in bromine, and contains around 2.2 g dm^{-3} of bromine.

Bromine is extracted from this solution by passing in chlorine gas. The mixture is acidified to prevent hydrolysis of bromine by the reaction

$$Br_2(aq) + H_2O(l) \rightleftharpoons 2H^+(aq) + Br^-(aq) + BrO^-(aq)$$

The bromine can be separated by heating the solution to collect bromine vapour which is then condensed, or by blowing air through the solution.

(i) Show by calculation that a solution containing 2.2 g dm^{-3} of bromine is richer in bromine than one containing 60 ppm.

[Assume that the mass of 1 dm^3 of the bromine solution is 1000 g]

(1)

(ii) Write an ionic equation, including state symbols, for the reaction in which chlorine reacts with bromide ions in solution to produce bromine.

(2)

(iii) What would be observed when the reaction in (ii) occurs?

(1)

.....

.....

(iv) Explain why the addition of an acid, such as hydrochloric acid, prevents hydrolysis of bromine.

(2)

(v) Assuming the hydrolysis of bromine is endothermic, explain how an increase in temperature would affect the equilibrium position for the hydrolysis of bromine.

(2)

(vi) Use your knowledge of activation energy to explain why an increase in temperature increases the rate of hydrolysis of bromine.

(1)

(vii) Use the equation for the hydrolysis of bromine to show that it is a disproportionation reaction.

$$Br_2(aq) + H_2O(l) \rightleftharpoons 2H^+(aq) + Br^-(aq) + BrO^-(aq)$$

(2)

(b) At the surface of the sea, there is a dynamic equilibrium between carbon dioxide gas in air and dissolved carbon dioxide in the surface sea water.

$$CO_2(g) \rightleftharpoons CO_2(aq)$$

(i) State **two** features of a system which has reached dynamic equilibrium.

(2)

1. .....

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2. .....

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*(ii) Carbon dioxide dissolves more easily in seawater than in pure water because seawater contains carbonate ions, $CO_3^{2-}(aq)$, and the following reaction occurs.

$$CO_2(aq) + H_2O(l) + CO_3^{2-}(aq) \rightleftharpoons 2HCO_3^-(aq)$$

Explain how an increase in concentration of carbonate ions in sea water affects the amount of carbon dioxide gas in the atmosphere.

(2)

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Carbon dioxide and water vapour both contain polar bonds.

What effect does infrared radiation have on the bonds in these molecules?

(1)

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*(iv) Outline the mechanism by which molecules such as carbon dioxide and water cause global warming.

(2)

*(v) Without water vapour in the atmosphere, the earth would be many degrees colder than it is at present. Why are many climate change scientists more concerned about warming due to carbon dioxide in the atmosphere, than warming due to the presence of water vapour? Refer to the difference between anthropogenic climate change and natural climate change in your answer.

(4)

(Total for Question 25 = 22 marks)

TOTAL FOR SECTION C = 22 MARKS
TOTAL FOR PAPER = 80 MARKS

The Periodic Table of Elements

1	2										3	4	5	6	7	0 (8)
																(18)
																4.0 **He** helium 2
(1)	(2)										(13)	(14)	(15)	(16)	(17)	
6.9 **Li** lithium 3	9.0 **Be** beryllium 4										10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	[illegible] **Co** cobalt	58.7 **Ni** nickel	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	95.9 **Mo** molybdenum 42	[98] **Tc** technetium 43	101.1 **Ru** ruthenium 44	[illegible] **Rh** rhodium 45	[illegible] **Pd** palladium	112.4 **Cd** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La*** lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **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							

Key

1.0 **H** hydrogen 1

relative atomic mass
atomic symbol
name
atomic (proton) number

Elements with atomic numbers 112-116 have been reported but not fully authenticated

140 **Ce** cerium 58	141 **Pr** praseodymium 59	144 **Nd** neodymium 60	[147] **Pm** promethium 61	150 **Sm** samarium 62	152 **Eu** europium 63	157 **Gd** gadolinium 64	159 **Tb** terbium 65	163 **Dy** dysprosium 66	165 **Ho** holmium 67	167 **Er** erbium 68	169 **Tm** thulium 69	173 **Yb** ytterbium 70	175 **Lu** lutetium 71
232 **Th** thorium 90	[231] **Pa** protactinium 91	238 **U** uranium 92	[237] **Np** neptunium 93	[242] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[245] **Bk** berkelium 97	[251] **Cf** californium 98	[254] **Es** einsteinium 99	[253] **Fm** fermium 100	[256] **Md** mendelevium 101	[254] **No** nobelium 102	[257] **Lr** lawrencium 103

* Lanthanide series

* Actinide series