Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced Subsidiary
Unit 2: Application of Core Principles of Chemistry

Thursday 20 January 2011 – 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 ▶

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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 The equation for the reaction between limewater and hydrochloric acid, including state symbols, is

☒ **A** $CaOH(s) + HCl(aq) \rightarrow CaCl(aq) + H_2O(l)$

☒ **B** $Ca(OH)_2(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(aq)$

☒ **C** $CaOH(aq) + HCl(aq) \rightarrow CaCl(aq) + H_2O(aq)$

☒ **D** $Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$

(Total for Question 1 = 1 mark)

2 As you go down Group 2 of the Periodic Table, which of the following decreases?

☒ **A** The reactivity of the elements.

☒ **B** The solubility of the hydroxides of the elements.

☒ **C** The solubility of the sulfates of the elements.

☒ **D** The thermal stability of the carbonates of the elements.

(Total for Question 2 = 1 mark)

3 Which concentrated acid would be best for mixing with a salt to carry out a flame test?

☒ **A** Hydrochloric acid

☒ **B** Nitric acid

☒ **C** Phosphoric(V) acid

☒ **D** Sulfuric acid

(Total for Question 3 = 1 mark)

4 The flame produced by a compound containing barium in a flame test is

☒ **A** colourless.

☒ **B** green.

☒ **C** red.

☒ **D** yellow.

(Total for Question 4 = 1 mark)

5 Which of the following is a greenhouse gas?

☒ **A** Argon

☒ **B** Nitrogen

☒ **C** Oxygen

☒ **D** Water vapour

(Total for Question 5 = 1 mark)

---

6 For parts (a) and (b), use your knowledge of intermolecular forces to predict the compound with the highest boiling temperature.

(a) ☒ **A** HF

☒ **B** H_2O

☒ **C** NH_3

☒ **D** CH_4

(1)

(b) ☒ **A** 1-iodobutane

☒ **B** 1-chlorobutane

☒ **C** 2-methyl-2-iodopropane

☒ **D** 2-methyl-2-chloropropane

(1)

(Total for Question 6 = 2 marks)

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

7 Consider the following organic liquids:

A ethanal

B ethanol

C tetrachloromethane

D trichloromethane

(a) Each liquid is run from a burette. Which liquid would **not** be deflected significantly by a charged rod?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which liquid would react with phosphorus(V) chloride to give a gas which fumes in moist air?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) Which liquid would you expect to have the peak at the greatest mass/charge ratio in its mass spectrum?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(d) Which liquid has an infrared spectrum with a broad absorption due to hydrogen bonding?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 7 = 4 marks)

8 Which of the following best defines the meaning of the term **anthropogenic** change?

It is a change caused by

☒ **A** nature.

☒ **B** plants.

☒ **C** animals.

☒ **D** humans.

(Total for Question 8 = 1 mark)

9 Which of the following equations represents the change when concentrated sulfuric acid is added to solid potassium chloride at room temperature?

☒ **A** $8KCl + 5H_2SO_4 \rightarrow 4K_2SO_4 + H_2S + 4Cl_2 + 4H_2O$

☒ **B** $2KCl + 3H_2SO_4 \rightarrow 2KHSO_4 + SO_2 + Cl_2 + 2H_2O$

☒ **C** $6KCl + 4H_2SO_4 \rightarrow 3K_2SO_4 + S + 3Cl_2 + 4H_2O$

☒ **D** $KCl + H_2SO_4 \rightarrow KHSO_4 + HCl$

(Total for Question 9 = 1 mark)

10 The Maxwell-Boltzmann distribution of molecular energies is useful for explaining why increasing temperature affects the rate of a chemical reaction.

(a) Which of the following statements describes how the shape of the Maxwell-Boltzmann distribution curve changes as temperature increases?

(1)

☒ **A** The peak decreases in height and moves to the left.

☒ **B** The peak increases in height and moves to the left.

☒ **C** The peak decreases in height and moves to the right.

☒ **D** The peak increases in height and moves to the right.

(b) The **main** reason that reaction rates increase with temperature is that

(1)

☒ **A** all the molecules move faster.

☒ **B** all the molecules collide more frequently.

☒ **C** more molecules collide with the correct orientation.

☒ **D** a larger proportion of molecules have high energies.

(Total for Question 10 = 2 marks)

11 Four organic reactions are given below:

A $CH_3CH_3 \rightarrow CH_2{=}CH_2 + H_2$

B $nCH_2{=}CH_2 \rightarrow -(-CH_2{-}CH_2-)_n-$

C $CH_2{=}CH_2 + HBr \rightarrow CH_3CH_2Br$

D $CH_3CH_2Br + H_2O \rightarrow CH_3CH_2OH + HBr$

(a) Which reaction is a substitution reaction?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which reaction is an electrophilic addition reaction?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) Which reaction involves initial attack by a nucleophile?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(d) Which reaction requires an initiator?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 11 = 4 marks)

12 Which of the following statements is true?

☒ **A** CFCs and nitrogen monoxide, NO, are involved in the depletion of the ozone layer.

☒ **B** CFCs act as catalysts for the depletion of the ozone layer, while nitrogen monoxide, NO, does not.

☒ **C** CFCs and ozone are free radicals.

☒ **D** CFCs and nitrogen monoxide, NO, are decomposed by UV radiation.

(Total for Question 12 = 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.

13 This question is about iodine and its compounds.

(a) (i) The element iodine can be obtained from seaweed. One step in the procedure is to extract the iodine from aqueous solution by shaking with a hydrocarbon solvent in a separating funnel.

Draw a diagram of a separating funnel containing the separated layers. Label the hydrocarbon layer, and state its colour.

[Density of hydrocarbon layer 0.660 g cm^{-3}]

(3)

Diagram

Colour of hydrocarbon layer .....

(ii) Iodine is also formed when an aqueous solution containing iodide ions reacts with an aqueous solution of iron(III) ions.

Write the ionic equation for this reaction. State symbols are **not** required.

(1)

(b) Hydrogen iodide gas is usually prepared by adding phosphoric(V) acid to solid potassium iodide.

(i) Suggest why phosphoric(V) acid is used in this preparation rather than concentrated sulfuric acid.

(1)

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(ii) Describe what you would see if a test tube of hydrogen iodide gas was inverted in a beaker of water.

(1)

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(iii) When hydrogen iodide gas reacts with ammonia, dense white fumes form. Write the equation for this reaction, including state symbols.

(2)

(c) 1-iodobutane can be made by reacting butan-1-ol with phosphorus(III) iodide, PI_3, formed by reacting moist red phosphorus with iodine.

(i) Complete the following equation for the formation of 1-iodobutane.

(1)

PI_3 + ... $C_4H_9OH \rightarrow$

(ii) Identify the intermolecular forces present between molecules of 1-iodobutane.

(1)

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.....

.....

(iii) 1-iodobutane reacts with hot aqueous silver nitrate solution. Describe what you would see when this reaction takes place.

(1)

.....

(iv) Give the structural formula for the organic product of the reaction between 1-iodobutane and ammonia.

(1)

(Total for Question 13 = 12 marks)

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14 This question is about methanol, CH_3OH, and ethanol, CH_3CH_2OH.

(a) (i) Draw a dot and cross diagram for **methanol**, showing outer electrons only.

(1)

(ii) Give the approximate values for the HCH and COH bond angles in methanol. Justify your answers.

(4)

HCH angle .....

Justification .....

.....

.....

COH angle .....

Justification .....

.....

.....

(iii) Using displayed formulae, draw a diagram to show a hydrogen bond between two methanol molecules. On your diagram, show the bond angle around the hydrogen atom of the hydrogen bond and give its value.

(2)

(b) Methanol reacts with sodium.

(i) State what you would observe in this reaction.

(2)

.....

.....

(ii) Write the equation for this reaction. State symbols are **not** required.

(1)

(c) **Ethanol** can be used to make ethanal.

(i) Identify, by name or formula, the two chemicals you would use to make ethanal from ethanol in the laboratory.

(2)

.....

.....

(ii) Draw a diagram of the apparatus you would use to prepare ethanal from ethanol in the laboratory and collect the product.

(2)

(iii) Both ethanal and propane have a molar mass of 44 g mol^{-1}, but their boiling temperatures are different.

Suggest which substance has the higher boiling temperature. Justify your answer by comparing the intermolecular forces in each compound.

(2)

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(Total for Question 14 = 16 marks)

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15 The ingredients list on the label of a commercial indigestion remedy states that each tablet contains 680 mg of calcium carbonate.

To check this, the following experiment was carried out.

One tablet was crushed. 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid, an excess, was then added and the mixture was transferred to a volumetric flask. The volume was made up to exactly 100 cm^3 with distilled water. 10.0 cm^3 of this solution was titrated with 0.300 mol dm^{-3} sodium hydroxide solution. The following results were obtained.

Run	Rough	1	2
Final burette reading / cm^3	21.80	33.20	44.40
Initial burette reading / cm^3	10.00	21.80	33.20
Volume added / cm^3	11.80	11.40	11.20

(a) (i) What should be used to crush the tablet?

(1)

.....

(ii) Name a suitable indicator for the titration. State the colour change you would expect to see.

(2)

Indicator .....

Colour change from ..... to .....

(b) (i) Select appropriate readings and calculate the mean titre.

(1)

(ii) Calculate the number of moles of sodium hydroxide used.

(1)

(iii) Use your answer to (ii) to write down the number of moles of hydrochloric acid left in 10.0 cm^3 of the solution used in the titration.

(1)

(iv) Calculate the number of moles of hydrochloric acid left in 100 cm^3 of solution.

(1)

(v) 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid contains 0.0500 mol of hydrochloric acid.

Use this and your answer to (iv) to calculate the number of moles of hydrochloric acid that reacted with the indigestion tablet.

(1)

(vi) The equation for the reaction between hydrochloric acid and calcium carbonate is:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

Use this, and your answer to (v), to calculate the number of moles of calcium carbonate in one tablet.

(1)

(vii) Calculate the mass of calcium carbonate in one tablet.

[Assume that the molar mass of $CaCO_3$ is 100 g mol^{-1}]

(1)

(viii) Suggest a reason, other than experimental error, why your value differs from the value given on the label.

(1)

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.....

(Total for Question 15 = 11 marks)

TOTAL FOR SECTION B = 39 MARKS

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SECTION C

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

16 This question is about some reactions which can be used in the manufacture of hydrogen.

Reaction 1 uses two naturally occurring chemicals, water and natural gas. Steam is reacted with methane to form carbon monoxide and hydrogen in an equilibrium reaction.

Reaction 1 $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$ $\Delta H = +210 \text{ kJ mol}^{-1}$

In reaction 2, carbon monoxide and steam are passed over copper at high temperature. This forms carbon dioxide and hydrogen.

Reaction 2 $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

The carbon dioxide formed is removed by passing it through potassium carbonate solution in reaction 3.

Reaction 3 $K_2CO_3(aq) + CO_2(g) + H_2O(l) \rightarrow 2KHCO_3(aq)$

The potassium carbonate is regenerated by heating the potassium hydrogencarbonate solution in reaction 4. The carbon dioxide gas produced is released into the atmosphere.

Reaction 4 $2KHCO_3(aq) \rightarrow K_2CO_3(aq) + CO_2(g) + H_2O(l)$

(a) For each of the first three reactions, state the initial and final oxidation numbers of any elements that change their oxidation numbers. Hence decide which are redox reactions.

(5)

Reaction 1 .....

.....

.....

Reaction 2 .....

.....

.....

Reaction 3 .....

.....

.....

*(b) (i) Discuss, with reasons, the conditions of temperature and pressure that would favour the production of hydrogen in **reaction 1**. You should consider the effect of the conditions on both yield and rate.

(7)

(ii) Excess steam is used in **reaction 1**. State why an excess of a reagent is used and suggest why steam, rather than methane, is chosen.

(2)

(c) Copper is a catalyst in **reaction 2**. Explain how a catalyst increases the rate of a reaction.

(2)

(d) (i) State **one** economic advantage of **reaction 4**.

(1)

*(ii) **Reaction 4** contributes to global warming. Identify the substance formed in this reaction which is likely to be responsible and explain the processes that lead to an increase in global temperatures.

Suggest **two** effects an increase in global temperatures might have on the environment.

(4)

(Total for Question 16 = 21 marks)

TOTAL FOR SECTION C = 21 MARKS
TOTAL FOR PAPER = 80 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8) (18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									(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	58.9 Co cobalt 27	58.7 Ni nickel 28	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	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag 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							

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