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Write your name here

Surname	Other names

Pearson Edexcel Certificate
Pearson Edexcel International GCSE

Centre Number | | | | | |

Candidate Number | | | | |

Chemistry

Unit: KCH0/4CH0
Paper: 2C

Wednesday 14 June 2017 – Morning
Time: 1 hour

Paper Reference
KCH0/2C
4CH0/2C

You must have:
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.*
- Show all the steps in any calculations and state the units.
- Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Information

- The total mark for this paper is 60.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 4 8 0 8 3 A 0 1 2 0

Pearson

THE PERIODIC TABLE

Period	1	2											3	4	5	6	7	0
	Group																	
1	1 H Hydrogen 1																	4 He Helium 2
2	7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
3	23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
4	39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
5	86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
7	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key

Relative atomic mass
Symbol
Name
Atomic number

Answer ALL questions.

1 Sodium sulfate is a compound with many uses.

(a) The formula of the main compound used as the source of sodium sulfate is $Na_2SO_4.10H_2O$

How many different elements are shown in this formula?

(1)

☐ **A** 2

☐ **B** 3

☒ **C** 4

☐ **D** 5

1.08

(b) Sodium sulfate can be made from sodium hydroxide and sulfuric acid.

Balance the equation for the reaction between sodium hydroxide and sulfuric acid.

(1)

1.25

2 NaOH + H_2SO_4 → Na_2SO_4 + 2 H_2O

(c) Sodium hydroxide is manufactured by the electrolysis of brine in the diaphragm cell.

Sulfuric acid is manufactured using the contact process.

The table contains some statements about these two processes.

Place ticks (✓) in the boxes to show the two correct statements.

(2)

NOT IN SPEC

brine is a solution of sodium chloride in water	✓
the temperature used in the contact process is greater than 1000 °C	
an equation for the contact process is $SO_2 + H_2O \rightarrow H_2SO_4$	
the reactions in the diaphragm cell are displacement reactions	
the catalyst used in the contact process is vanadium(V) oxide	✓

(Total for Question 1 = 4 marks)

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2 The diagram shows the positions of some elements in part of the Periodic Table.

							He
Li		B		N		F	
	Mg		Si		S		Ar

(a) How many periods and groups are shown in this diagram?

(1)

	Periods	Groups
☐ **A**	2	4
☐ **B**	3	4
☐ **C**	2	8
☒ **D**	3	8

(b) How many elements shown in the diagram are noble gases?

(1)

☐ **A** 1

☒ **B** 2

☐ **C** 3

☐ **D** 4

(c) What is the formula of the compound formed between magnesium and fluorine?

(1)

☐ **A** MgF

☐ **B** Mg_2F

☒ **C** MgF_2

☐ **D** Mg_2F_2

(d) The table shows the percentage composition by mass of a sample of silicon.

Isotope	^{28}Si	^{29}Si	^{30}Si
Percentage (%)	92.2	4.70	3.10

1.17
1.18

Calculate the relative atomic mass of this sample of silicon.

Give your answer to one decimal place.

(2)

$$A_r = \frac{(28 \times 92.2) + (29 \times 4.7) + (30 \times 3.1)}{100}$$

$$= 28.1$$

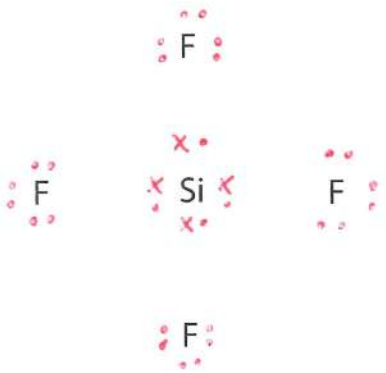
relative atomic mass = 28.1

1.46

(e) A molecule of silicon tetrafluoride (SiF_4) contains covalent bonds.

Draw a dot and cross diagram to show the outer electrons in this molecule.

(2)



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(f) The table shows the boiling points of some compounds containing silicon. All of these compounds contain covalent bonds.

Compound	Boiling point in °C
SiF_4	−86
$SiCl_4$	58
SiO_2	2950

SiF_4 and $SiCl_4$ have simple molecular structures.

SiO_2 has a giant covalent structure.

(i) Explain why the boiling point of $SiCl_4$ is greater than the boiling point of SiF_4

(2)

1.48

- Intermolecular forces between molecules are stronger in $SiCl_4$ / weaker in SiF_4

(ii) Explain why the boiling point of SiO_2 is very much greater than the boiling point of $SiCl_4$

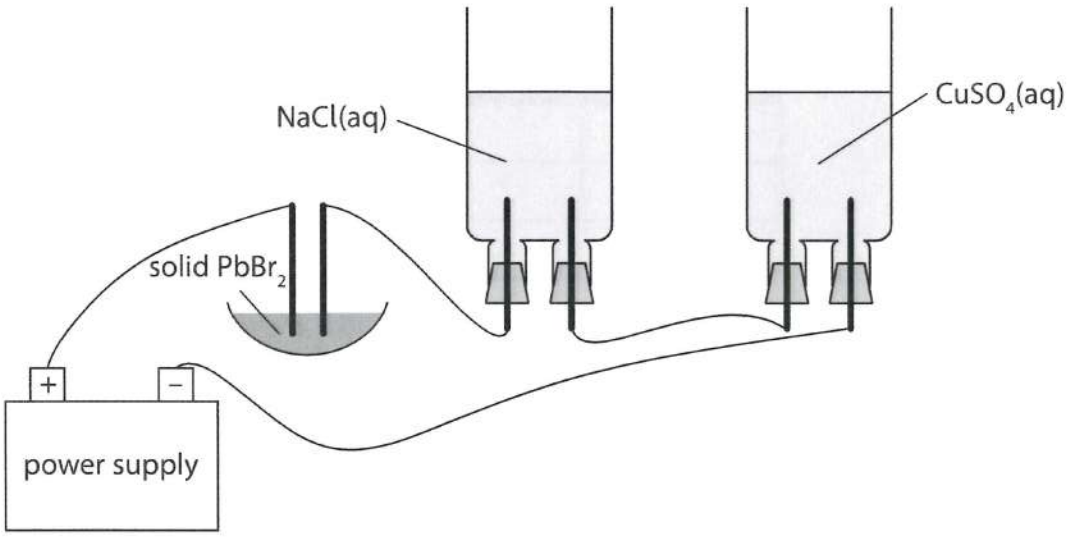
(2)

1.4c

- SiO_2 has strong covalent bonds (that must be broken)
- $SiCl_4$ has weak intermolecular forces

(Total for Question 2 = 11 marks)

3 This apparatus can be used to investigate electrolysis.



1.60C (a) Name the particles that move through the connecting wires to form an electric current.

(1)

Electrons

1.24 (b) The electrodes are made of platinum, which is an inert metal.

State what is meant by the term **inert**.

(1)

Not reactive

1.56C (c) Explain why the electrolytic cell containing $PbBr_2$ needs to be heated before electrolysis can occur.

(2)

• $PbBr_2$ needs to be molten so that ions can flow

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(d) When NaCl(aq) is electrolysed, two gases form at the positive electrode and one gas forms at the negative electrode.

The formulae of the species in NaCl(aq) are Na^+, Cl^-, H^+, OH^- and H_2O.

(i) Name the gases formed at each electrode.

(2)

positive electrode Chlorine and Oxygen

negative electrode Hydrogen

1.58C

(ii) Give ionic half-equations to show the formation of each gas.

(3)

1.59C

$2Cl^- \rightarrow Cl_2 + 2e^-$

$2H_2O \rightarrow 4H^+ + O_2 + 4e^-$

$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

(e) The ionic half-equation for one of the reactions in the cell containing copper(II) sulfate solution is

$$Cu^{2+} + 2e^- \rightarrow Cu$$

During the electrolysis, a charge of 0.040 faradays passes through this cell.

Calculate the mass of copper metal formed.

(2)

$n(Cu) = \frac{0.040}{2}$

$= 0.020 mol$

$m(Cu) = 63.5 \times 0.020$

$= 1.3g$

1.60C

mass of copper = 1.3 g

(Total for Question 3 = 11 marks)

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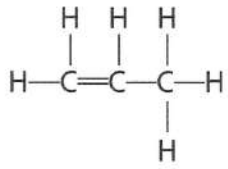
4 Compounds containing C=C double bonds are used to manufacture alcohols such as ethanol and addition polymers such as PVC.

The table shows the formulae of some compounds containing C=C bonds.

A $CH_2=CH_2$	**B** 
C C_4H_8	**D** C_2H_3Cl

4.01 (a) (i) Explain which three of these compounds are hydrocarbons.

(2)

A, B, C as they contain only hydrogen and oxygen

4.02 (ii) Explain which compound is shown as a displayed formula.

(2)

B, it shows all the bonds in the molecule

(b) Ethanol can be manufactured from compound A using reaction 1.
Ethanol can also be manufactured from glucose using reaction 2.

The equations for these reactions are

reaction 1 $C_2H_4 + H_2O \rightarrow C_2H_5OH$

reaction 2 $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

Give two advantages of using each reaction to manufacture ethanol.

(4)

ANY 2

reaction 1

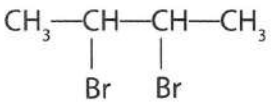
- Produces pure ethanol
- Faster reaction
- Greater atom economy
- NO CO_2 produced

4.32 + 4.33C

reaction 2 ANY 2

- Uses renewable resources
- Uses atmospheric pressure
- Works at just above room temp

(c) Compound C reacts with bromine to form a product with this formula.



(i) Use this formula to determine the name of compound C.

(2)

But-2-ene

4.2E

(ii) State the colour of the product formed when compound C reacts with bromine.

(1)

colourless

4.28

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(d) Compound X is an isomer of compound C.

(i) Explain what is meant by the term **isomers**.

(2)

4.03

• Same molecular formula, different ~~arrangement~~ structural formula

(ii) The equation for the conversion of compound X to an alcohol is

$$CH_2{=}CH{-}CH_2{-}CH_3 + H_2O \rightarrow CH_3{-}\underset{\displaystyle OH}{\underset{|}{CH}}{-}CH_2{-}CH_3$$

Place ticks (✓) in the boxes to show the two correct descriptions of this reaction.

(2)

4.06

addition	✓
dehydration	
hydration	✓
oxidation	
reduction	

(e) Compound D, chloroethene, can be used to manufacture the polymer PVC.

(i) State the full name of PVC.

(1)

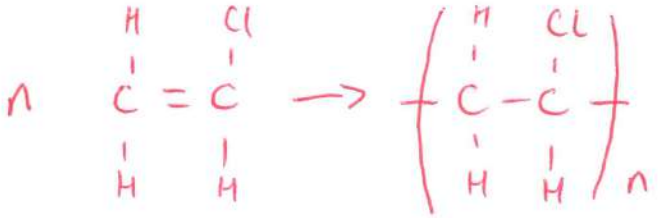
4.45

poly(chloroethene)

(ii) Write an equation, containing displayed formulae, to represent the reaction that occurs in the manufacture of PVC.

(3)

4.45



(Total for Question 4 = 19 marks)

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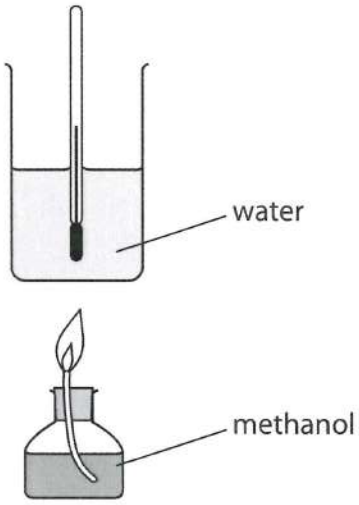
5 A student uses this apparatus to find the increase in temperature of water when methanol, CH_3OH, is burned.



(a) There are several reasons why the increase in temperature is less than expected.

(i) One reason is the incomplete combustion of methanol to form only carbon monoxide and water.

Write the chemical equation for this incomplete combustion.

(2)

1.25

$CH_3OH + O_2 \rightarrow CO + 2H_2O$

(ii) State another reason why the increase in temperature is less than expected.

(1)

3.08

Heat lost to surroundings

(b) The student records these results.

mass of burner and methanol before combustion	84.7 g
mass of burner and methanol after combustion	83.2 g
mass of water	125 g
temperature of water at start	22 °C
temperature of water at end	58 °C

(i) Calculate the heat energy change (Q), in joules, in this experiment using the expression

$$Q = m \times 4.2 \times \Delta T$$

where m is the mass of water in grams and ΔT represents the increase in temperature.

(2)

$Q = 125 \times 4.2 \times (58 - 22)$

$= 18900\text{J}$

3.0

$Q =$ 18900 J

(ii) The relative molecular mass of methanol is 32

Use this information and your value for Q to calculate the molar enthalpy change, ΔH, for the combustion of methanol.

Give your answer in kJ/mol.

(4)

3.0

mass $(CH_3OH) = 84.7 - 83.2$

$= 1.5\text{g}$

$n(CH_3OH) = \frac{1.5}{32}$

$= 0.046875\text{mol}$

$\Delta H = -\frac{18900}{0.046875}$

$= -403200\text{J/mol}$

$\therefore \Delta H = -400\text{kJ/mol}$

OR

$= \frac{18900}{1.5}$

$= 12600$

$\Delta H = -12600 \times 32$

$= -400\text{kJ/mol}$

$\Delta H =$ −400 kJ/mol

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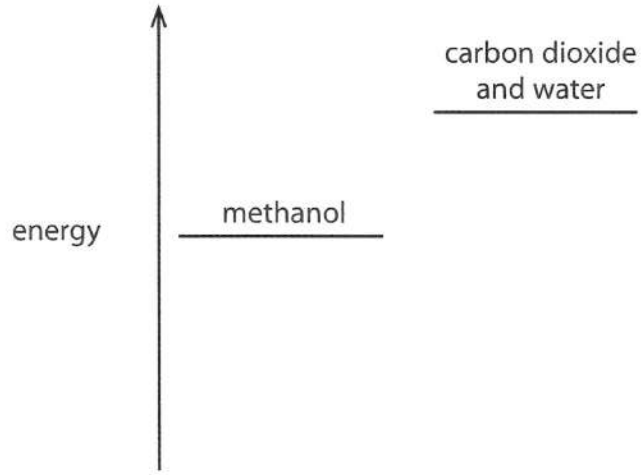
(iii) The student draws an energy level diagram for the complete combustion of methanol.



Identify the two mistakes in his diagram.

(2)

(3.08)

1 oxygen reactant missing

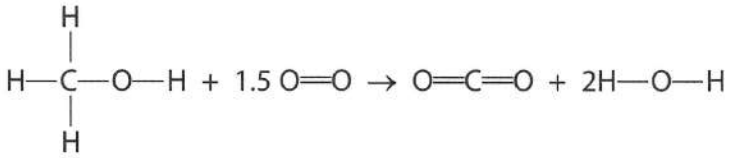
3.05C

2 Product level above reactant level

(c) The student is given this table of average (mean) bond energies.

Bond	C—H	C—O	O—H	O=O	C=O
Average bond energy in kJ/mol	412	360	463	496	743

The equation for the complete combustion of methanol is



Use this equation and the information in the table to calculate another value for the molar enthalpy change, ΔH, for the combustion of methanol.

(4)

Σ (bonds broken) = (412×3) + 360 + 463 + (496×1.5)
= 2803 kJ/mol

Σ (bonds made) = (743×2) + (463×4)
= 3338 kJ/mol

ΔH = 2803 − 3338
= −535 kJ/mol

Alternate working accepted

3.07

ΔH = −535 kJ/mol

(Total for Question 5 = 15 marks)

TOTAL FOR PAPER = 60 MARKS

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