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Surname		Other names	
Pearson Edexcel		Centre Number	Candidate Number
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<h1 style="margin: 0;">Chemistry</h1> <p style="margin: 5px 0;">Unit: 4CH0</p> <p style="margin: 5px 0;">Paper: 2CR</p>			
Wednesday 13 June 2018 – Morning		Paper Reference	
Time: 1 hour		4CH0/2CR	
You must have: Ruler, 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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THE PERIODIC TABLE

Group	3	4	5	6	7	0
1						
2						

Period

7

$${}^1_1\text{H}$$

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

2

3

4

5

6

7

Key

Relative atomic mass	Symbol	Name	Atomic number
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Answer ALL questions.

- 1 The table shows some information about five gases.

Gas	Formula of molecule	Boiling point in °C
chlorine	Cl ₂	-35
oxygen	O ₂	-183
carbon monoxide	CO	-191
nitrogen	N ₂	-196
hydrogen	H ₂	-253

Choose gases from the table to answer this question.

You may use each gas once, more than once, or not at all.

- (a) Name the gas that is a compound. (1)

- (b) Name the gas necessary for rusting to occur. (1)

- (c) Name the gas that bleaches moist litmus paper. (1)

- (d) Name the gas that has the highest percentage by volume in air. (1)

- (e) Name the gas that has the highest boiling point. (1)

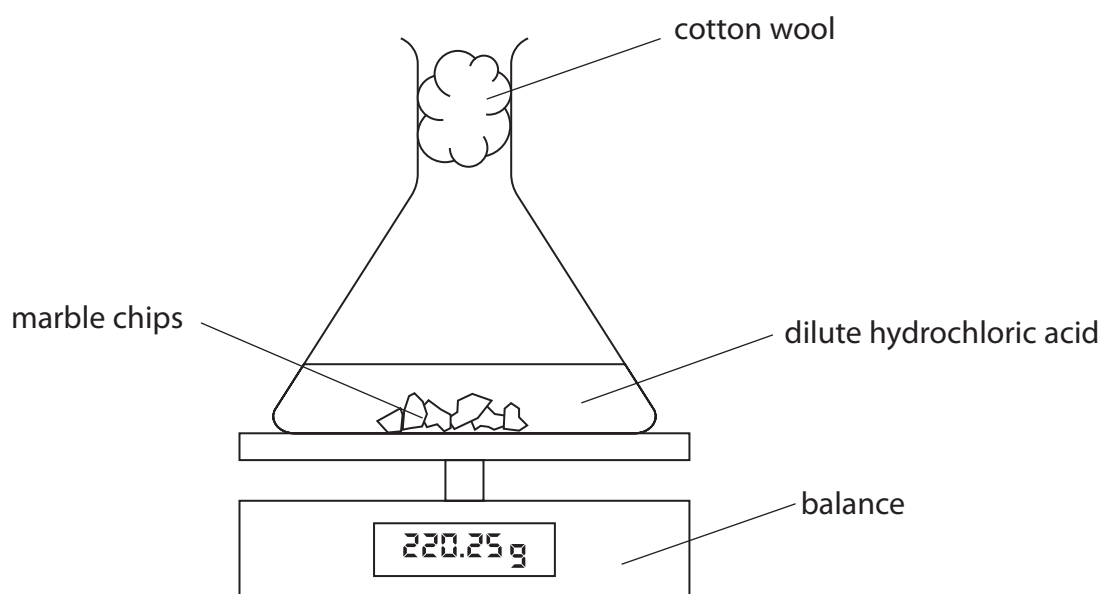
- (f) Determine the two gases that have the same relative formula mass. (1)

1
2

(Total for Question 1 = 6 marks)



- 2 A student uses this apparatus to study the rate of the reaction between marble chips and dilute hydrochloric acid.



She uses this method.

- place a conical flask on a balance
- put 15 g of large marble chips in the flask
- add 25 cm³ of dilute hydrochloric acid to the flask
- record the mass of the flask and contents, and start a timer
- record the mass of the flask and contents every 30 seconds until the reaction ends

The equation for the reaction is



- (a) (i) Explain what happens to the mass of the flask and contents during the reaction.

(2)

.....

.....

.....

.....

- (ii) State why the reaction ends, even though some marble chips remain in the flask.

(1)

.....

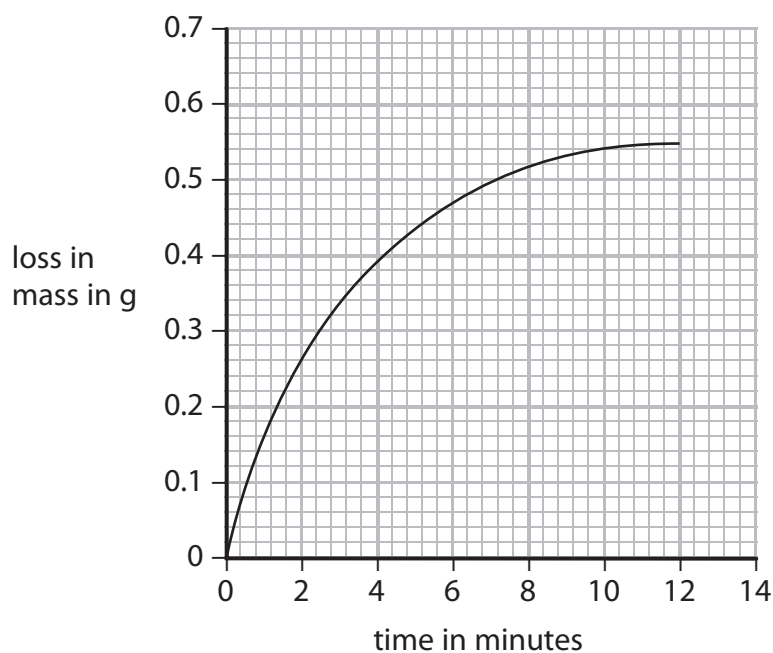
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(iii) State how the student would know when the reaction has ended.

(1)

(b) The student plots her results on a grid.



(i) At which time is the rate of reaction greatest?

(1)

- ☐ A 1 minute
- ☐ B 4 minutes
- ☐ C 6 minutes
- ☐ D 8 minutes

(ii) The student repeats the experiment with the same volume and concentration of acid, but with 15 g of smaller marble chips.

On the grid, sketch the curve you would expect for this experiment.

(2)



- (c) Explain how decreasing the concentration of the hydrochloric acid affects the rate of reaction.

Refer to particle collision theory in your answer.

(3)

(Total for Question 2 = 10 marks)



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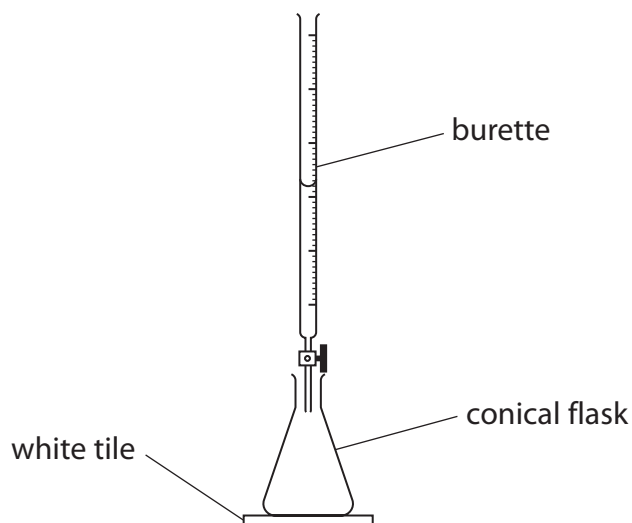
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- 3 A student is provided with a solution of sodium hydroxide, NaOH, and a solution of 0.0200 mol/dm^3 phosphoric(V) acid, H_3PO_4

She does a titration to find the volume of the phosphoric(V) acid that reacts with 25.0 cm^3 of the sodium hydroxide.



This is the student's method.

- add phosphoric(V) acid to a clean burette until it is nearly full
- record the burette reading
- use a measuring cylinder to add 25.0 cm^3 of the sodium hydroxide to a clean conical flask
- add a few drops of phenolphthalein indicator to the flask
- place the flask on a white tile
- add phosphoric(V) acid from the burette until the indicator changes colour
- record the burette reading
- wash the flask using distilled water and then dry the flask
- repeat the titration



- (a) (i) Name a piece of apparatus that would give a more precise measurement of the volume of sodium hydroxide.

(1)

- (ii) Suggest why the student places the flask on a white tile.

(1)

- (iii) Give the colour change of the phenolphthalein indicator during the titration.

(2)

at start

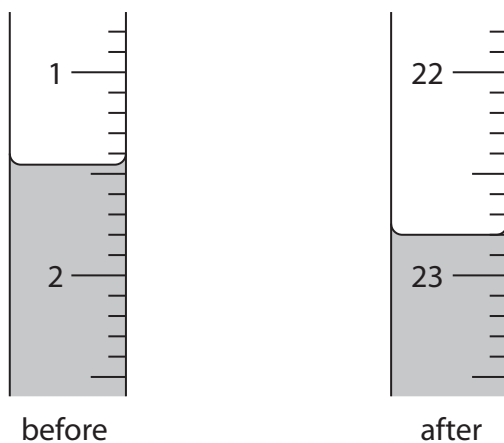
at end

- (iv) The student dries the flask after washing it with distilled water.
Suggest why it is not necessary to dry the flask before repeating the titration.

(1)



- (b) The diagram shows the student's burette readings for her titration, before and after adding the acid.



Use the readings to complete the table, giving all values to the nearest 0.05 cm³.

(2)

burette reading after adding the acid	22.80
burette reading before adding the acid	
volume in cm ³ of acid added	

- (c) Another student does the experiment four times.

The table shows his results.

Volume in cm ³ of acid added	21.80	21.50	21.35	21.40
Concordant results (✓)				

Concordant results are those within 0.20 cm³ of each other.

- (i) Place ticks in the table to show which results are concordant.

(1)

- (ii) Use the concordant results to calculate the average (mean) volume of acid added.

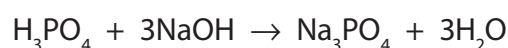
(2)

average volume = cm³

- (d) The titration is repeated many times.

The average result from all these titrations shows that 25.0 cm³ sodium hydroxide reacts with 21.30 cm³ of 0.0200 mol/dm³ phosphoric(V) acid.

The equation for the reaction is



Calculate the concentration, in mol/dm³, of the sodium hydroxide solution.

(3)

concentration of sodium hydroxide solution = mol/dm³

(Total for Question 3 = 13 marks)



4 The box shows the molecular formulae of some organic compounds.

P CH_4	Q C_2H_4	R C_2H_6
S C_3H_6	T $\text{C}_2\text{H}_4\text{Br}_2$	U C_4H_8

(a) Choose compounds from the box to answer this question.

You may use each compound once, more than once or not at all.

(i) Identify a compound that is not a hydrocarbon.

(1)

(ii) Identify a compound that has the same empirical formula as its molecular formula.

(1)

(b) (i) Draw the displayed formula for compound P.

(1)

(ii) Draw the displayed formula for two straight-chain isomers of compound U.

(2)

Isomer 1	Isomer 2
----------	----------



- (c) (i) Compound Q reacts with bromine to form compound T.

Describe the observation that would be made during this reaction.

(1)

- (ii) Suggest how compound R could be converted into compound T.

(2)

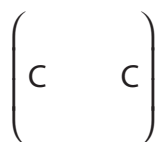
- (d) Compound Q is used as the starting material in the manufacture of polymers such as poly(ethene) and poly(chloroethene).

- (i) What type of polymers are poly(ethene) and poly(chloroethene)?

(1)

- (ii) Complete the diagram to show the displayed formula of poly(chloroethene).

(2)



- (e) Nylon is a polymer formed by a different polymerisation process.

- (i) Give the name of this polymerisation process.

(1)

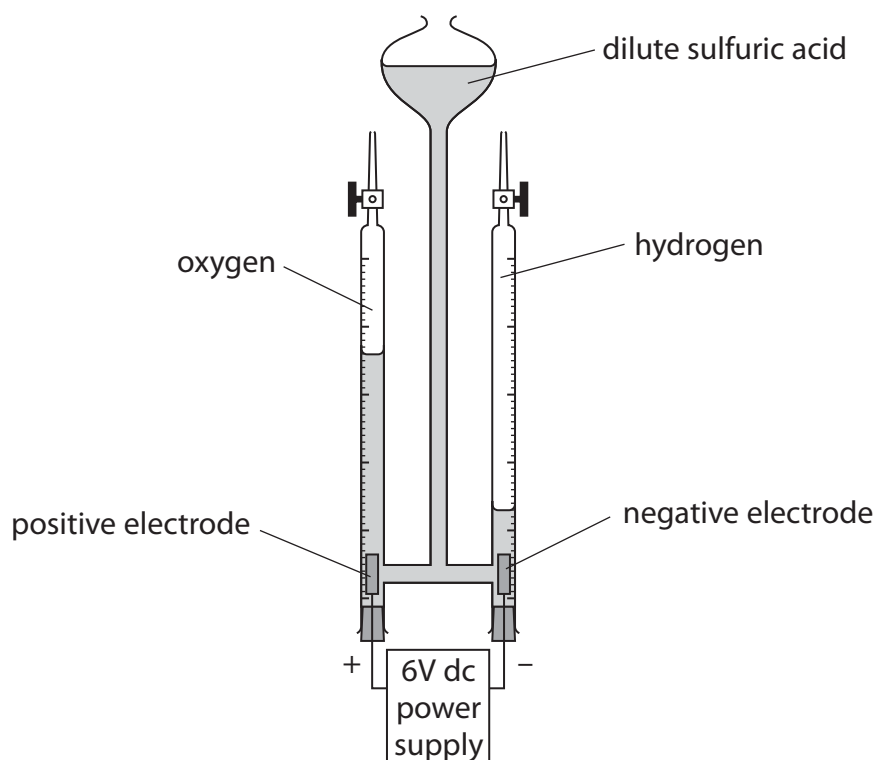
- (ii) State a difference between the two polymerisation processes.

(1)

(Total for Question 4 = 13 marks)



- 5 This apparatus is called a Hofmann voltameter. It is used to collect the gases produced when an electric current passes through a solution of dilute sulfuric acid.



- (a) (i) Name the process that takes place in the Hofmann voltameter. (1)

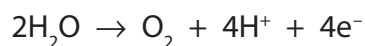
- (ii) State why zinc should not be used for the electrodes. (1)

- (b) (i) Describe a test to show that the gas produced at the positive electrode is oxygen. (1)

- (ii) Write an ionic half-equation to represent the reaction that produces hydrogen at the negative electrode. (1)



- (c) An ionic half-equation for the reaction at the positive electrode is



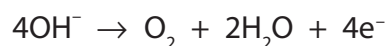
Calculate the maximum volume of oxygen that could be formed at room temperature and pressure (rtp) if a charge of 0.010 faraday is passed through the dilute sulfuric acid.

[molar volume of oxygen gas is $24\,000\text{ cm}^3$ at rtp]

(3)

maximum volume of oxygen = cm^3

- (d) The ionic half-equation for the reaction at the positive electrode is sometimes shown as



Suggest why this half-equation is not the best way to show the reaction at the positive electrode when an electric current is passed through a solution of dilute sulfuric acid.

(1)

(Total for Question 5 = 8 marks)



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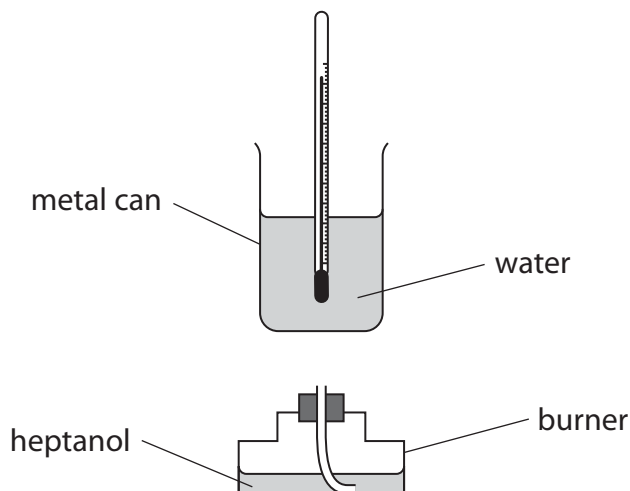
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6 Heptanol and hydrogen are both used as fuels.

- (a) A student uses this apparatus to find the heat energy released from the combustion of heptanol.



He uses this formula

$$Q = m \times 4.18 \times \Delta T$$

[Q = heat energy released, m = mass of water in g, ΔT = change in temperature of water]

1.00 cm³ water has a mass of 1.00 g.

- (i) State the measurements that the student needs to record to find a value for the heat energy released.

(2)

- (ii) The student burns 0.75 g of heptanol and calculates Q to be 19 kJ.

Use this information to calculate the molar enthalpy change, in kJ/mol, for the combustion of heptanol.

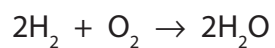
[M_r of heptanol = 114]

(3)

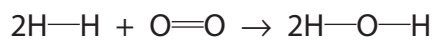
molar enthalpy change = kJ/mol



(b) The equation for the combustion of hydrogen is



(i) This equation shows the reaction, including the covalent bonds in the molecules.



The table gives the average (mean) bond energies.

Bond	Average bond energy in kJ/mol
H—H	436
O=O	498
H—O	464

Use the values in the table to calculate the enthalpy change, ΔH , for the reaction.

Include the sign in your answer.

(3)

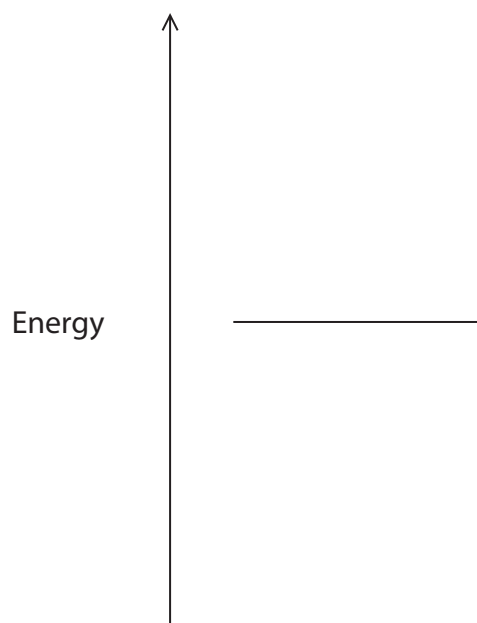
$\Delta H =$ kJ



- (ii) Complete the energy level diagram for the reaction between hydrogen and oxygen by showing the reactants and products.

Label the enthalpy change, ΔH , for the reaction.

(2)



(Total for Question 6 = 10 marks)

TOTAL FOR PAPER = 60 MARKS



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