Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Acids and bases

Time allowed: 55 minutes

Subject code **0620**

Chemistry

Questions from Paper 1, Paper 2, Paper 3 and Paper 4

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 54

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 54 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 Which row describes an aqueous solution for the pH shown?

	pH	description
A	1	has a very high alkalinity
B	5	is neutral
C	9	turns universal indicator yellow
D	14	contains OH^- ions

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Answer D

2 A solution containing hydroxide ions, $OH^-(aq)$, is added to a solution containing hydrogen ions, $H^+(aq)$. An equation representing the reaction is shown.

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

Which statement about the reaction is correct?

A The hydrogen ions represent an alkali.

B The reaction is a neutralisation reaction.

C The reaction is a reduction.

D As the OH^- ions are added, the pH of the reaction mixture falls.

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Answer B

3 Which statements about dilute ethanoic acid are correct?

1 It has a pH of 8.

2 It is an organic compound.

3 It turns universal indicator orange-yellow.

4 It reacts with magnesium to produce carbon dioxide.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

Introduction to organic chemistry Click for more variations

Answer C

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4 Which substances can be used to make pure crystals of sodium sulfate?

A potassium sulfate and sodium hydroxide

B sodium carbonate and sulfuric acid

C sodium nitrate and magnesium sulfate

D sulfuric acid and sodium chloride

Acids, bases, pH and neutralisation Click for more variations

Answer B

5 Some information about two dilute acids is shown.

dilute acid	acid concentration in mol/dm^3	pH
nitric acid	0.1	1.0
propanoic acid	0.4	2.6

Three statements about the acids are listed.

1 Nitric acid has a lower pH because it dissociates more than propanoic acid.

2 Propanoic acid has a lower concentration of hydrogen ions than nitric acid.

3 Propanoic acid has a higher pH because it has a higher concentration.

Which statements are correct?

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

Acids, bases, pH and neutralisation Click for more variations

Answer A

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6 This question is about acids, bases and salts.

(a) Crystals of zinc sulfate are made by warming excess solid zinc oxide with dilute sulfuric acid.

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

(i) State the meaning of the state symbol (aq).

..... [1]

(ii) State the method used to separate the excess solid zinc oxide from the reaction mixture.

..... [1]

(b) Crystals of sodium nitrate can be made by neutralising an acid with an alkali.

(i) Name the acid and the alkali used.

acid .....

alkali .....
[2]

(ii) Complete the equation for all neutralisation reactions.

$$H^+ + \text{.....} \rightarrow \text{.....}$$ [2]

(iii) Neutralisation reactions are exothermic.

Define the term exothermic.

..... [1]

(iv) Fig. 7.1 shows the reaction pathway diagram for an exothermic reaction.

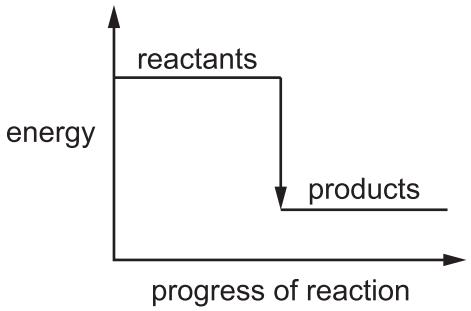


Fig. 7.1

Explain how Fig. 7.1 shows that the reaction is exothermic.

..... [1]

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(c) Methyl orange is an acid–base indicator.

State the colour of methyl orange at pH 2 and at pH 12.

colour at pH 2 .....

colour at pH 12 .....

[2]

[Total: 10]

Acids, bases, pH and neutralisation Click for more variations

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6(a)(i)	aqueous / dissolved in water	**1**
6(a)(ii)	filtration	**1**
6(b)(i)	acid: nitric (1) alkali: sodium hydroxide (1)	**2**
6(b)(ii)	$(H^+) + OH^- \rightarrow H_2O$ OH^- (1) H_2O (1)	**2**
6(b)(iii)	release of thermal energy	**1**
6(b)(iv)	the **energy** of the products is lower than the **energy** of the reactants **OR** the **energy** of the reactants is higher than the **energy** of the products	**1**
6(c)	*pH 2:* red / pink (1) *pH12:* yellow (1)	**2**

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7 Some oxides of some elements are listed.

CO CO_2 Na_2O MgO Al_2O_3

SiO_2 P_4O_{10} SO_2 Cl_2O_7 Cr_2O_3

(a) Answer the following questions using only oxides from the list. Each oxide may be used once, more than once or not at all.

Give the formula of an oxide

(i) which is the main cause of acid rain, ...

(ii) which would give a solution of pH 14 when added to water, ...

(iii) which is coloured, ...

(iv) which is the major impurity in iron ore, ...

(v) which is amphoteric, ...

(vi) which is neutral. .....

[6]

(b) Amphoteric oxides and neutral oxides are different from each other.

(i) What is meant by the term *amphoteric oxide*?

.....

..... [1]

(ii) What is meant by the term *neutral oxide*?

.....

..... [1]

[Total: 8]

Acidic, basic and amphoteric oxides Click for more variations

Reduced to 78% to fit the page (wider than A4).

7(a)(i)	SO_2	**1**
7(a)(ii)	Na_2O	**1**
7(a)(iii)	Cr_2O_3	**1**
7(a)(iv)	SiO_2	**1**
7(a)(v)	Al_2O_3 / Cr_2O_3	**1**
7(a)(vi)	CO	**1**
7(b)(i)	an amphoteric oxide **will** react with acids **AND** with bases	**1**
7(b)(ii)	a neutral oxide **will not** react with acids **or** with bases	**1**

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8 Dilute nitric acid behaves as a typical acid in some reactions but **not** in other reactions.

(a) Dilute nitric acid behaves as a typical acid when reacted with copper(II) oxide and with copper(II) carbonate.

Describe what you would **see** if excess dilute nitric acid is added separately to solid samples of copper(II) carbonate and copper(II) oxide followed by warming the mixtures.

copper(II) carbonate

.....

.....

copper(II) oxide

.....

.....

[4]

(b) When dilute nitric acid is added to pieces of copper and heated, a reaction takes place and copper(II) nitrate is formed.

(i) Part of the chemical equation for the reaction between copper and dilute nitric acid is shown.

Complete the chemical equation by inserting the formula of copper(II) nitrate and balancing the equation.

.....$Cu(s) + 8HNO_3(aq) \rightarrow$ .....$(aq) + 4H_2O(l) + 2NO(g)$

[2]

(ii) How is the reaction of dilute nitric acid with copper different from that of a typical metal with a typical acid?

.....

..... [1]

[Total: 7]

Acids, bases, pH and neutralisation Click for more variations

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8(a)	*copper(II) carbonate* fizzes / bubbles / effervescence dissolves / disappears *copper(II) oxide* dissolves / disappears blue (solution formed)	**2** **2**
8(b)(i)	$Cu(NO_3)_2$ 3Cu **AND** $3Cu(NO_3)_2$	**2**
8(b)(ii)	hydrogen (gas) is not produced (when copper reacts with nitric acid)	**1**

9 **(a)** Match the following pH values to the solutions given below.

1 **3** **7** **10** **13**

The solutions all have the same concentration.

solution	**pH**
aqueous ammonia, a weak base	.....
dilute hydrochloric acid, a strong acid	.....
aqueous sodium hydroxide, a strong base	.....
aqueous sodium chloride, a salt	.....
dilute ethanoic acid, a weak acid	.....

[5]

(b) Explain why solutions of hydrochloric acid and ethanoic acid with the same concentration, in mol / dm^3, have a different pH.

.....

.....

..... [2]

(c) Measuring pH is one way of distinguishing between a strong acid and a weak acid. Describe another method.

method .....

.....

results .....

.....

[2]

[Total: 9]

Acids, bases, pH and neutralisation Click for more variations

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9 **(a)** Match the following pH values to the solutions given below.

1 3 7 10 13

The solutions all have the same concentration.

solution	**pH**
aqueous ammonia, weak base	10
dilute hydrochloric acid, a strong acid	1
aqueous sodium hydroxide, a strong base	13
aqueous sodium chloride, a salt	7
dilute ethanoic acid, a weak acid	3

[5]

(b) Hydrochloric acid strong acid **or** ethanoic acid weak acid [1]

OR: hydrochloric acid completely ionised **or** ethanoic acid partially ionised

hydrochloric acid greater concentration of/more H^+ ions (than ethanoic acid) [1]

(c) Rate of reaction with Ca, Mg, Zn, Fe [1]

Strong (hydrochloric) acid bubbles faster **or** more bubbles **or** dissolves faster [1]

OR: rate of reaction with (metal) carbonate [1]

strong (hydrochloric) acid faster **or** more bubbles **or** dissolves faster (only if carbonate insoluble) [1]

OR: electrical conductivity [1]

strong (hydrochloric) acid better conductor [1]

[Total: 9]

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10 Nitric acid, HNO_3, and sulfuric acid, H_2SO_4, are strong acids. Ethanoic acid, CH_3COOH, is a weak acid.

(a) One mole of each acid is added separately to 1000 cm^3 of distilled water to form a dilute solution. All three acids dissociate in distilled water.

(i) State the formula of the common cation produced when each of the three acids dissociates in water.

..... [1]

(ii) Explain, in terms of dissociation, why:

- nitric acid is described as a strong acid

.....

- ethanoic acid is described as a weak acid.

.....
[2]

(iii) State which of the three dilute acids will have the highest pH value.

..... [1]

(iv) State the colour of thymolphthalein in all three dilute acids.

..... [1]

(v) Give the formula of the anion formed when:

- sulfuric acid dissociates in water

.....

- ethanoic acid dissociates in water.

.....
[2]

(vi) Name the **two** gaseous products formed during the electrolysis of dilute sulfuric acid using inert electrodes.

..... and ..... [2]

(vii) Name the salt formed when calcium reacts with ethanoic acid.

..... [1]

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(b) Aluminium nitrate, $Al(NO_3)_3$, is made when dilute nitric acid reacts with aluminium hydroxide, $Al(OH)_3$.

(i) $Al(OH)_3$ acts as a base in this reaction.

Define the term base.

..... [1]

(ii) $Al(OH)_3$ is **not** an alkali.

State what this tells you about the solubility of $Al(OH)_3$.

..... [1]

(iii) Name **one other** compound which forms aluminium nitrate when added to dilute nitric acid.

..... [1]

(iv) The oxidation number of the O atoms in $Al(NO_3)_3$ is –2.
The formula of the aluminium ion in $Al(NO_3)_3$ is Al^{3+}.

Determine the oxidation number of the N atoms in $Al(NO_3)_3$.
Show your working.

oxidation number of N = ... [2]

[Total: 15]

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10(a)(i)	H^+	1
10(a)(ii)	**M1** complete (dissociation) **M2** partial (dissociation)	2
10(a)(iii)	ethanoic (acid)	1
10(a)(iv)	colourless	1
10(a)(v)	**M1** SO_4^{2-} **M2** CH_3COO^-	2
10(a)(vi)	**M1** hydrogen **M2** oxygen	2
10(a)(vii)	calcium ethanoate	1
10(b)(i)	proton acceptor	1
10(b)(ii)	insoluble	1
10(b)(iii)	aluminium oxide	1
10(b)(iv)	**M1** use of –18 or (9 × –2) or (3 × 3 × –2) **M2** +5	2

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