ACIDS & ENERGETICS EQ BOOKLET

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(1.) One way of obtaining the metal copper is by heating copper(I) sulphide in air. The equation for the reaction is

$$Cu_2S + O_2 \rightarrow 2Cu + SO_2$$

(a) Explain why this reaction could be described as the oxidation of sulphur.

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(1)

(b) The sulphur dioxide produced reacts with water to form a single product. This product is an acid.

(i) Write a chemical equation for the reaction of sulphur dioxide with water.

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(1)

(ii) Identify the ion in the product which causes it to be acidic.

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(1)

(iii) Name a substance that could be added to confirm the presence of this ion. What would be seen if this ion were present?

Substance added ....

What would be seen ....

....

(2)

(2)

(a) A student added a piece of lithium to a trough of water. A piece of platinum wire is dipped into the solution formed and then held in a hot Bunsen flame.

State the colour of methyl orange in the alkaline solution formed in (a) and give the formula of the ion which causes the solution to be alkaline.

(acids topic)

Colour of methyl orange ....

Formula of ion ....

(2)

(3) (c) The gases chlorine and hydrogen react together to form hydrogen chloride gas. Hydrogen chloride gas dissolves in water to form hydrochloric acid.

Bromine reacts in a similar way to chlorine.

(i) Write a word equation for the reaction between bromine and hydrogen.

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(1)

(ii) Suggest the name of the acid formed when the product in (c)(i) dissolves in water.

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(1)

(4) (d) Hydrogen bromide and hydrogen chloride have similar chemical properties.

(i) A sample of hydrogen bromide is dissolved in water.

A piece of blue litmus paper is placed in the solution. State, with a reason, the final colour of the litmus paper.

Colour ....

Reason ....

....

(2)

(ii) A sample of hydrogen bromide is dissolved in methylbenzene.

A piece of blue litmus paper is placed in the solution. State, with a reason, the final colour of the litmus paper.

Colour ....

Reason ....

....

(2) Q7

5 Phosphorus(V) chloride, PCl_5, reacts with water to form hydrogen chloride gas and phosphoric acid, H_3PO_4.

(a) Write the chemical equation for this reaction.

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(2)

(b) State and explain the colour change seen when hydrogen chloride gas is bubbled into water containing universal indicator.

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(3)

6 (a) Magnesium carbonate can be made as a precipitate by reacting together solutions of two soluble salts.

(i) **Name** two suitable soluble salts.

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(2)

(ii) Write a chemical equation for the reaction.

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(2)

blank

(iii) Describe how you would obtain a pure, dry, sample of the magnesium carbonate formed in this reaction.

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(3) Q6

7. (a) Potassium hydroxide solution reacts with dilute nitric acid to form the salt potassium nitrate.

(i) State the type of reaction that occurs.

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(1)

(ii) Write a chemical equation for the reaction.

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(2)

(b) A titration is carried out to find the volume of dilute nitric acid that must be added to 25.0 cm^3 of potassium hydroxide solution for complete reaction.

(i) Which piece of apparatus is used to add the dilute nitric acid?

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(1)

(ii) Before the acid is added, a few drops of phenolphthalein are mixed with the potassium hydroxide solution. State the colour change of the phenolphthalein at the end point of the titration.

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(2)

(c) 35.00 cm^3 of dilute nitric acid reacted completely with 25.0 cm^3 of potassium hydroxide solution. Use this information to describe how you could obtain pure dry crystals of potassium nitrate, starting from the solutions of nitric acid and potassium hydroxide.

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(5)

(Total 11 marks)

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Q3

4

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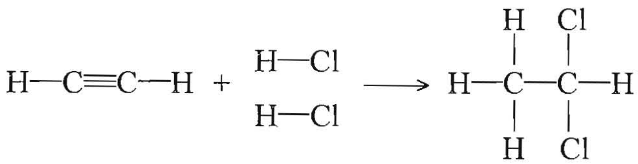
(c) Ethyne reacts with hydrogen chloride gas.



The table shows some average bond dissociation energies.

Bond	Average bond dissociation energy (kJ / mol)
H—C	412
C≡C	837
H—Cl	431
C—C	348
C—Cl	338

(i) Calculate the energy, in kJ, required to break all of the bonds in the reactants.

(2)

(ii) Calculate the energy, in kJ, given out when all of the bonds in the product are formed.

(2)

(iii) Calculate the value of ΔH, in kJ / mol, for the reaction.

(1)

Q9

(Total 12 marks)

9 (e) The equation for the combustion of hydrogen is

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

The table shows the values of some average bond dissociation energies.

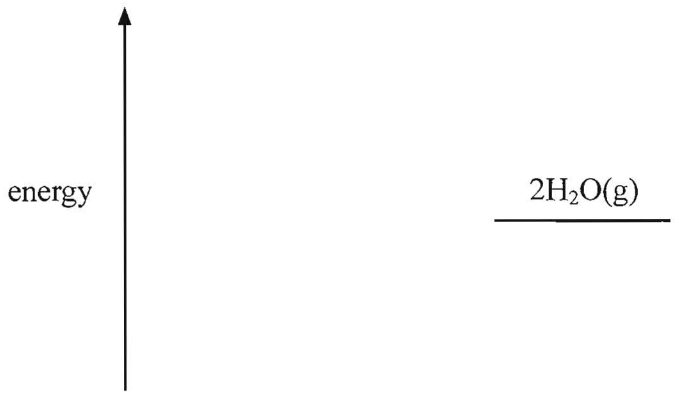
Bond	H—H	O═O	O—H
Dissociation energy (kJ/mol)	436	496	463

Use the values in the table to calculate the energy change for the combustion of hydrogen.

(3)

(f) The reaction can be represented by an energy level diagram.

Complete the diagram by inserting the reactants.



(1)

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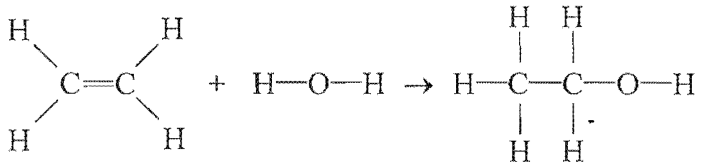
10. One industrial process for making ethanol involves reacting ethene with steam.



(a) Identify the catalyst and one other condition used for this reaction.

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(2)

(b) The table shows the values of some average bond dissociation energies.

Bond	C—C	C=C	C—H	C—O	O—H
Dissociation energy (kJ/mol)	348	612	412	360	463

Use these values to calculate:

(i) The energy required, in kJ/mol, to break the bonds in the reactants.

(1)

(ii) The energy given out, in kJ/mol, when the bonds in the product are formed.

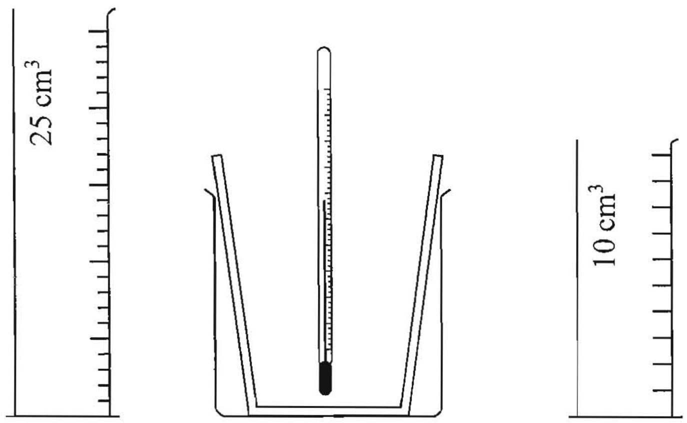
(1)

(iii) The enthalpy change, in kJ/mol, for this reaction.

(1)

11. When aqueous sodium hydroxide is added to dilute nitric acid an exothermic reaction takes place.

The following apparatus is used in an experiment to measure the temperature increase.



A student used the following method.

- Using a measuring cylinder, add 25 cm^3 aqueous sodium hydroxide to the polystyrene cup and record the temperature.
- Using a different measuring cylinder, add 5 cm^3 dilute nitric acid to the cup and stir the mixture.
- Record the temperature of the mixture.
- Add a further 5 cm^3 dilute nitric acid, stir the mixture and record the temperature.
- Continue adding 5 cm^3 portions of dilute nitric acid until a total of 35 cm^3 has been added.

(a) Why is it better to mix the solutions in a polystyrene cup rather than in a glass beaker?

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(1)

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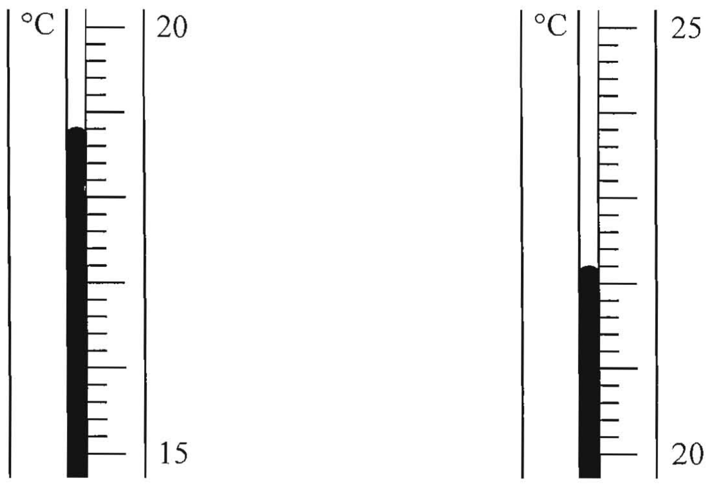
(b) These are the thermometer readings in one experiment before and after adding 5 cm^3 dilute nitric acid.

Temperature before adding acid | **Temperature after adding acid**



Write down the temperatures shown and work out the temperature increase.

Temperature before adding acid ....°C

Temperature after adding acid ....°C

Temperature increase ....°C

(3)

(c) The teacher suggested using a burette instead of a measuring cylinder to add the volumes of nitric acid because all of the acid needed can be placed in the burette at the start of the experiment.
Suggest one other advantage of using a burette.

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(1)

(d) A second student used the same method, but followed the teacher's suggestion and added the dilute nitric acid from a burette.

The table shows her results.

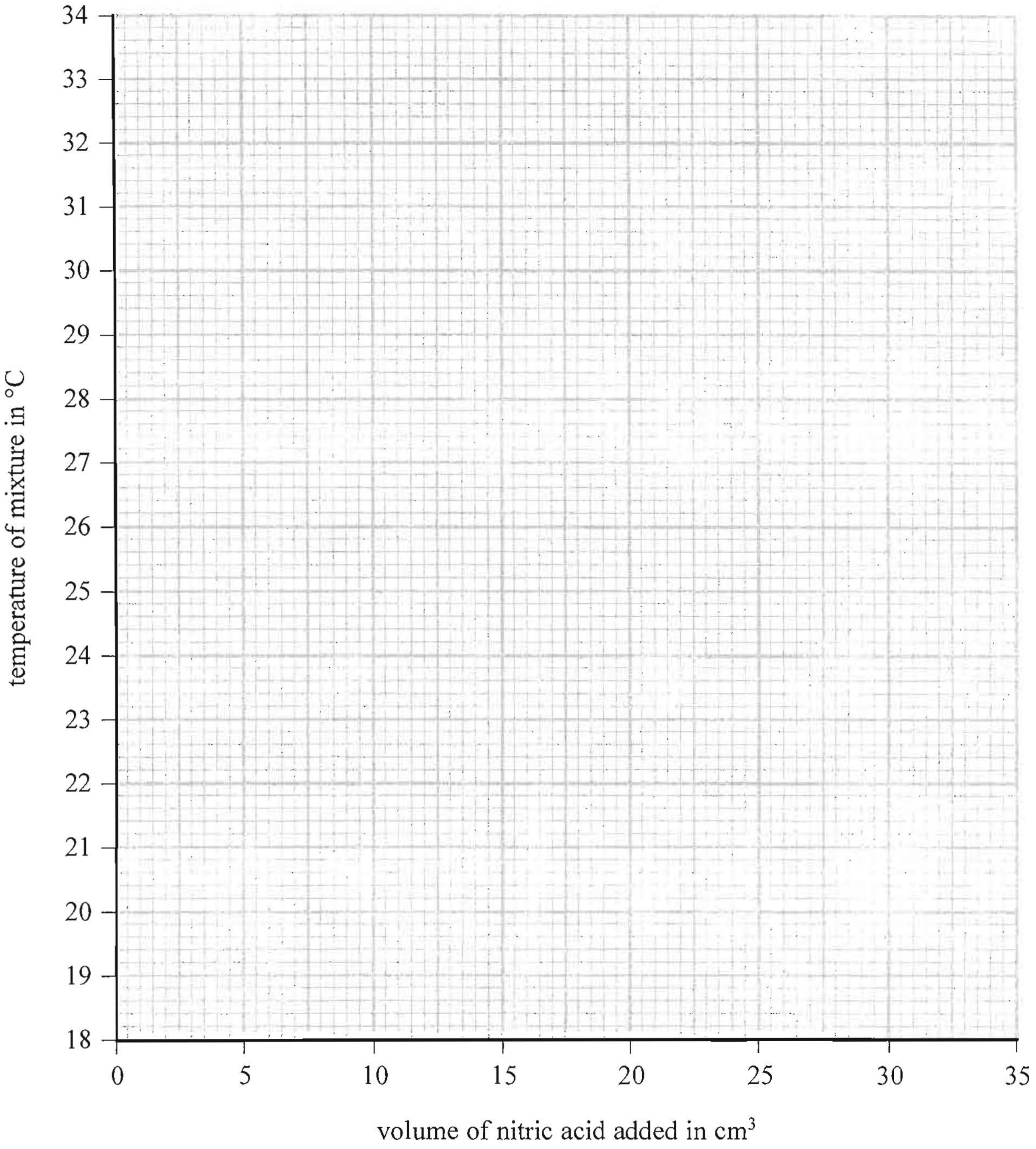
Volume of acid added (cm^3)	0	5	10	15	20	25	30	35
Temperature of mixture (°C)	18.0	20.8	23.5	24.2	29.0	28.6	27.6	26.5

The results show that the temperature increases at first, but then decreases.

9.

Plot these results on the grid.

Draw a straight line of best fit through the points that show a temperature increase up to 29.0 °C.
Draw a second straight line of best fit through the remaining points.
Make sure that the two lines cross each other.



(4)

(e) The point where the lines cross indicates the maximum temperature reached during the experiment.

(i) What is the maximum temperature, in °C, reached during the experiment?

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(1)

(ii) What volume, in cm^3, of dilute nitric acid completely reacts with the 25 cm^3 of aqueous sodium hydroxide?

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(1)

(f) One of the results is anomalous. It shows a temperature lower than it should be. The teacher asked some other students to suggest a reason for this anomalous result. Here are their suggestions.

Student	Suggestion
A	More than 5 cm^3 of acid was added
B	The concentration of the acid was wrong
C	She added 5 cm^3 of aqueous sodium hydroxide instead of 5 cm^3 of dilute nitric acid
D	She did not stir the mixture
E	She waited too long before adding the 5 cm^3 of acid

(i) Circle on the graph the result that is anomalous.

(1)

(ii) Explain why Student A's suggestion is not correct.

....

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(1)

(iii) Explain why Student B's suggestion is not correct.

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(1)

Leave blank

(iv) Explain why Student C's suggestion is not correct.

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(1)

(v) Explain why Student D's suggestion might be correct.

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(1)

(vi) State, with a reason, whether Student E's suggestion is correct or not.

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(1)

12

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(g) A third student used the same method and recorded these results.

Volume of aqueous sodium hydroxide used = 25 cm^3

Starting temperature of aqueous sodium hydroxide = 18.5°C

Maximum temperature of mixture = 30°C

Volume of nitric acid used to give maximum temperature = 20 cm^3

The quantity of heat, in joules, produced in this experiment can be calculated using this equation:

heat produced = total volume of mixture × 4.2 × temperature increase

Calculate:

(i) the total volume, in cm^3, of the mixture

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(1)

(ii) the temperature increase in °C

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(1)

(iii) the heat produced

in joules ....

....

in kilojoules ....

....

(2)

Q3

(Total 21 marks)

13