

# Reactions of Acids

## Mark Scheme 1

Level	GCSE (9-1)
Subject	Combined Science: Trilogy - Chemistry
Exam Board	AQA
Topic	5.4 Chemical Changes
Sub-Topic	Reactions of Acids
Difficulty Level	Gold Level
Booklet	Mark Scheme 1

Time Allowed: 60 minutes

Score: /57

Percentage: /100

Grade Boundaries:

**M1.(a)** bonded pair of electrons and

6 non-bonded electrons on chlorine

1

(b) **Level 3 (5–6 marks):**

A detailed and coherent explanation of comparative results of a reaction in terms of concentration and ionisation. The response makes logical links between the points raised and uses sufficient examples to support these links.

**Level 2 (3–4 marks):**

A description of a reaction with results is given but may miss some details. Links are made but may not be fully articulated and / or precise.

**Level 1 (1–2 marks):**

Simple statements are made. The response may fail to make logical links between the points raised.

**0 marks:**

No relevant content

### Indicative content

Simple statements / descriptions of a reaction

- correct comparative pH, such as, 0–3 (strong) 4–6 (weak)
- named reaction, such as, with a reactive metal or a named carbonate
- comparative results or observations of the named reaction, such as, faster reaction (strong) or greater volume of gas produced in a given time (strong)

Explanations of different results

- weak acids are only partially ionised in aqueous solution
- strong acids are completely ionised in aqueous solution / greater concentration of  $\text{H}^+$  ions
- aqueous solutions of acids at the same concentration / same state of division  
of metal / powder, same temperature

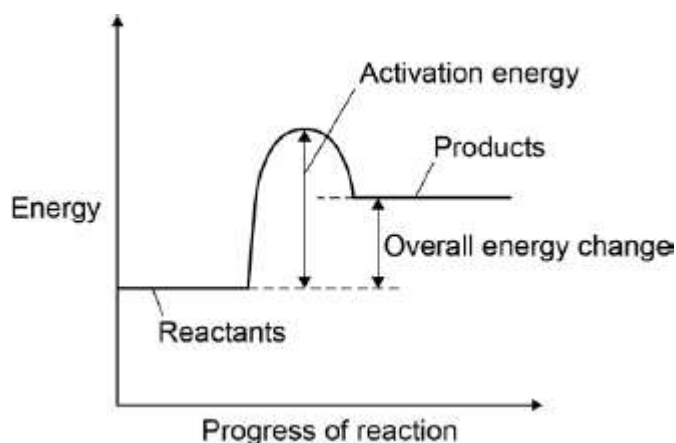
6

[7]

**M2.(a)** the relative energies of the reactants, products and the overall energy change

1

the activation energy



1

(b)  $(4 \times 413) + (2 \times 498) = 2\,648$

1

$(2 \times 805) + (4 \times 464) = 3\,466$

1

$(3466 - 2648 =) 818 \text{ (kJ / mol)}$

1

*allow max 2 marks for one ecf*

(c) **Level 3 (5–6 marks):**

A coherent method is described with relevant detail, which demonstrates a broad understanding of the relevant scientific techniques and procedures. The steps in the method are logically ordered with the dependent and control variables correctly identified. The method would lead to the production of valid results.

**Level 2 (3–4 marks):**

The bulk of a method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques and procedures. The method may not be in a completely logical sequence and may be missing some detail.

**Level 1 (1–2 marks):**

Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques and procedures. The response may lack a logical structure and would not lead to the production of valid results.

**0 marks:**

No relevant content

### Indicative content

#### Named apparatus

- thermometer
- measuring cylinder
- stirring rod
- spatula
- plastic cup (with lid) or beaker
- stopwatch
- filter paper or watch glass
- balance

#### Method

- weigh the same mass of each metal in each same state of division eg powder
- measure a set volume of sulfuric acid into a plastic cup or beaker
- measure and record the temperature of the sulfuric acid
- add metal W into the plastic cup or beaker
- stir and record the highest temperature or record the temperature after a set time
- calculate the increase in temperature
- repeat the method for metals X, Y and Z
- repeat for each metal at least three times to calculate a mean

#### Safe use

- comment on safe use should include wearing safety glasses

6

(d) **W>Y>X>Z**

1

reason for position of **W** and **Z**

***W** reacts with most solutions whereas **Z** reacts with none of the solutions*

1

reason for position of **X** and **Y**

***Y** is more reactive than **X** because **Y** reacts more with sulfuric acid*

1

(e) magnesium is most reactive because not displaced by any metal

1

zinc is second most reactive because displaced by only one metal

1

copper and hydrogen cannot be placed in order of reactivity or are least reactive because

1

they both are displaced by the most / three metals

1

experiment – add sulfuric acid to copper because copper is less reactive than hydrogen  
then copper would not react with sulfuric acid to displace hydrogen

1

[19]

**M3.(a) Level 3 (5–6 marks):**

A full, detailed and coherent plan covering all the major steps is provided, which outlines the apparatus required and sets out the steps needed in a logical manner that could be followed by another person to produce a pure, dry sample of copper nitrate.

**Level 2 (3–4 marks):**

The substantive content of a plan is present but may be missing some steps. The plan may not be in a completely logical sequence but leads towards the production of a pure, dry sample of copper nitrate.

**Level 1 (1–2 marks):**

Simple statements relating to relevant apparatus or steps are made but they may not be in a logical order. The plan would not allow another person to produce the sample.

**0 marks:**

No relevant content

**Indicative content**

- pour a suitable volume of nitric acid into a suitable container
- add a small amount of copper carbonate to the acid and stir until the effervescence stops
- continue to add small amounts of copper carbonate to the acid and each time stir until any effervescence stops
- eventually when there is no reaction / effervescence when the copper carbonate is added filter the mixture to remove the excess copper

- carbonate
- pour the filtrate (copper nitrate solution) into an evaporating basin and heat to evaporate a small amount of the water
- leave the copper nitrate solution to crystallise
- remove the crystals from the solution remaining and dry the crystals

6

(b) 1 mole carbon dioxide =  $14 + (16 \times 2) = 46$  g

1

14 g is 0.30 mole

1

1 mole is  $6.02 \times 10^{23}$  molecules

1

so 14 g has  $1.81 \times 10^{23}$  molecules

*allow  $1.81 \times 10^{23}$  with no working shown for 4 marks*

1

*answer not given in standard form max. 3 marks*

[10]

**M4.(a)** (i) silver nitrate

*allow  $\text{AgNO}_3$*

1

(ii) potassium carbonate **or**

*allow  $\text{K}_2\text{CO}_3$*

sodium carbonate

*allow  $\text{Na}_2\text{CO}_3$*

1

(b) base

*allow ionic*

*ignore insoluble or soluble*

*ignore alkali*

1

(c) (i) evaporate  
**or**  
crystallise

*allow heat or boil or leave (to evaporate)*

*allow cool*

*ignore filtration unless given as an alternative*

*do **not** accept freeze or solidify*

1

(ii) 2 (HNO<sub>3</sub>)

*accept multiples*

1

(iii) 9

*accept nine*

1

(d) 6.21 / 207      0.72 / 16

*1 mark for dividing mass by A<sub>r</sub>*

1

= 0.03

= 0.045

*1 mark for correct proportions (allow multiples)*

1

2

3

*1 mark for correct whole number ratio (allow multiples). Can be awarded from formula.*

1

Pb<sub>2</sub>O<sub>3</sub>

*allow O<sub>3</sub>Pb<sub>2</sub>*

***ecf** allowed throughout if sensible attempt at step 1  
correct formula with no working gains 1 mark*

1

[10]

**M5.(a)** Sulfur dioxide causes acid rain.

1

(b) red / orange / yellow

*do **not** accept any other colours*

1

because sulfur dioxide (when in solution) is an acid

1

- (c) (there are) weak forces (of attraction)  
*do **not** accept any reference to covalent bonds breaking*

1

between the molecules  
*do **not** accept any other particles*

1

(these) take little energy to overcome  
*award third mark only if first mark given*

1

- (d) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

### **0 marks**

No relevant content

### **Level 1 (1 – 2 marks)**

A relevant comment is made about the data.

### **Level 2 (3 – 4 marks)**

Relevant comparisons have been made, and an attempt made at a conclusion.

### **Level 3 (5 – 6 marks)**

Relevant, detailed comparisons made and a justified conclusion given.

### **examples of the points made in the response**

#### **effectiveness**

- W removes the most sulfur dioxide
- D removes the least sulfur dioxide

#### **material used**

- Both W and D use calcium carbonate
- Calcium carbonate is obtained by quarrying which will create scars on landscape / destroy habitats
- D requires thermal decomposition, this requires energy
- D produces carbon dioxide which may cause global warming / climate change
- S uses sea water, this is readily available / cheap



### waste materials

- W product can be sold / is useful
- W makes carbon dioxide which may cause global warming / climate change
- D waste fill landfill sites
- S returned to sea / may pollute sea / easy to dispose of

6

[12]