Monitoring Chemical Reactions (F)

1. Hydrogen gas, H_2, reacts with oxygen gas, O_2, to make water, H_2O.

$2H_2 + O_2 \rightarrow 2H_2O$

What is the **atom economy** for this reaction?

M_r : H_2 = 2, O_2 = 32, H_2O = 18.

A 50%
B 53%
C 89%
D 100%

Your answer ☐ **[1]**

2. Which statement describes the **atom economy** of a reaction?

A A measure of how many atoms in the reactants form the waste products.
B A measure of how many atoms in the reactants form the desired product.
C A measure of the actual yield of product compared to the predicted yield of product.
D A measure of how many atoms form waste products compared to desired products.

Your answer ☐ **[1]**

3. Ammonium nitrate, NH_4NO_3, is fertiliser made from ammonia.

Ammonium nitrate is made by reacting ammonia with nitric acid.

$NH_3 + HNO_3 \rightarrow NH_4NO_3$

i. Calculate the mass of **ammonium nitrate** that could be made from 25.5 tonnes of ammonia.

A_r: H = 1.0, N = 14.0, O = 16.0

Mass of ammonium nitrate = ... tonnes **[3]**

ii. A student makes some ammonium nitrate in the laboratory.

He predicts that he should make 12.5 g of ammonium nitrate.

His percentage yield is 80%.

Calculate the **actual mass** of ammonium nitrate that the student makes.

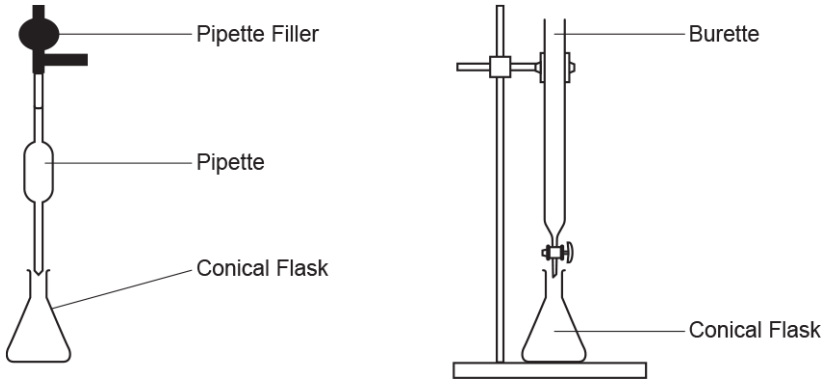
Actual mass of ammonium nitrate = ... g **[2]**

4 (a). A student neutralises an alkali with an acid in a titration experiment.

Complete the word equation for the reaction of an acid with an alkali.

acid + alkali → ..... + ... **[2]**

(b). Look at the student's method for her experiment.



- Measure 25.0 cm^3 of alkali solution into a conical flask using a pipette.
- Add a few drops of universal indicator to the alkali solution.
- Fill the burette to above the 0.0 cm^3 line with acid.
- Quickly add the acid to alkali until the indicator changes colour.
- Repeat the experiment until consistent results are obtained.

Describe and explain **one** improvement the student should make to her method to get a more accurate titration result.

---**[2]**

(c). The student repeats the experiment three times.

Look at the student's results.

Titration number	1	2	3
Volume of acid (cm^3)	25.75	23.60	23.70

Calculate the **accurate** volume of the acid that reacts with the alkali.

Accurate volume of acid = ... cm^3 **[2]**

5. Ammonium sulfate is a salt.

It is manufactured using the reaction between the alkali ammonia and sulfuric acid.

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

A sample containing 17.0 g of ammonia completely reacts with sulfuric acid.

A mass of 66.0 g of ammonium sulfate is made.

Show that the maximum mass of ammonium sulfate that can be made from 51.0 g of ammonia is 198.0 g.

[1]

6. The reversible reaction between carbon dioxide and hydrogen makes methane and water.

$$\text{carbon dioxide} + \text{hydrogen} \rightleftharpoons \text{methane} + \text{water}$$

Kayvan investigates this reaction.

He predicts that 11.0 g of carbon dioxide should make 4.0 g of methane.

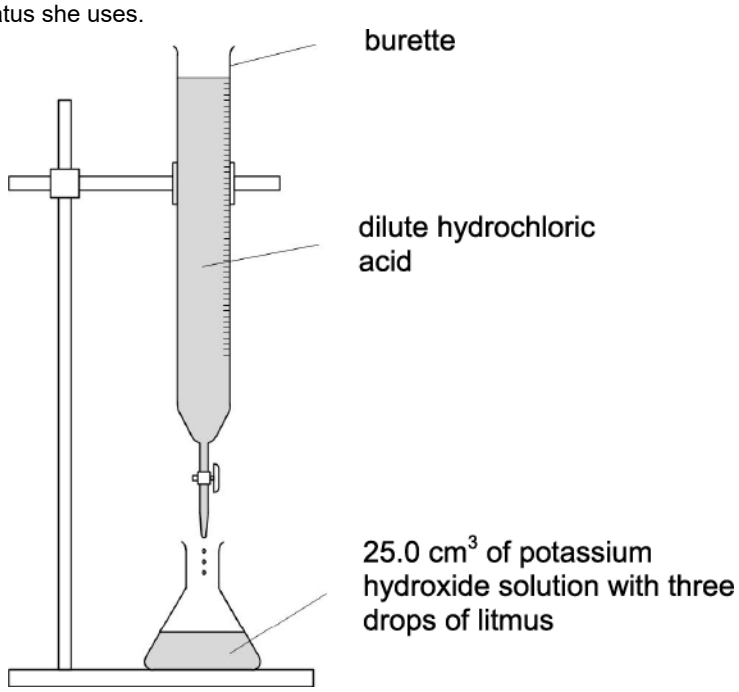
In an experiment, he finds that 11.0 g of carbon dioxide makes 2.2 g of methane.

Calculate the percentage yield of methane.

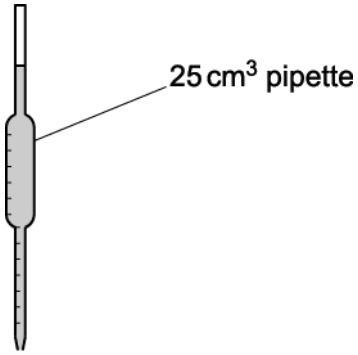
Percentage yield = …… % **[2]**

7 (a). Sarah does three titrations with dilute hydrochloric acid and potassium hydroxide solution.

Look at the apparatus she uses.



Sarah uses a pipette to measure out the 25.0 cm^3 of potassium hydroxide solution.



Describe and explain one safety precaution Sarah uses with the pipette.

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[2]

(b). In her first titration Sarah measures the initial volume of hydrochloric acid in the burette.

She slowly adds the acid until the potassium hydroxide is just neutralised.

She then measures the volume of the hydrochloric acid again.

Describe how Sarah can tell when the potassium hydroxide solution is just neutralised.

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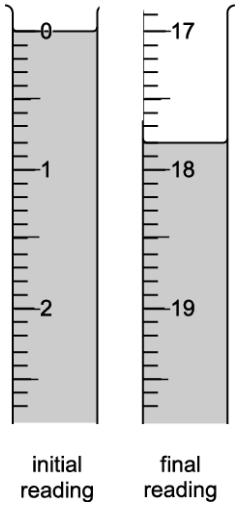
[2]

(c). Look at the diagrams. They show parts of the burette during the first titration.

first titration



Here is Sarah's results table.

Titration number	1	2	3
final reading in cm^3		37.5	32.1
initial reading in cm^3		20.4	15.0
titre (volume of acid added) in cm^3		17.1	17.1

i. **Complete** the table by reading the burette readings from the diagrams.

[2]

ii. Sarah thinks the mean titre is 17.1 cm^3.

Is she correct?

Explain your answer.

---**[1]**

(d). Sarah does a titration to make a fertiliser called potassium nitrate, KNO_3.

Look at the equation for the reaction she uses.

$$KOH + HNO_3 \rightarrow KNO_3 + H_2O$$

The relative formula masses, M_r, of each compound are shown in the table.

compound	formula	relative formula mass
potassium hydroxide	KOH	56.1
nitric acid	HNO_3	63.0
potassium nitrate	KNO_3	101.1
water	H_2O	18.0

What is the atom economy for the reaction to make potassium nitrate?

Assume that water is a waste product.

Atom economy = …… % **[2]**

8. Urea is a fertiliser.

The formula for urea is

$$(NH_2)_2CO$$

A student makes 1 mole of urea from 2 moles of ammonia.

What is the mass of urea that the student makes?

A. 43.0 g
B. 44.0 g
C. 58.0 g
D. 60.0 g

Your answer ☐

[1]

END OF QUESTION PAPER