CHEMISTRY ONLINE
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CHEMISTRY

PHYSICAL CHEMISTRY

Level & Board	AQA (A-LEVEL)
TOPIC:	AMOUNT OF SUBSTANCE
PAPER TYPE:	QUESTION PAPER - 2
TOTAL QUESTIONS	10
TOTAL MARKS	/38

Amount of Substance - 2

1. Calcium sulfide reacts with calcium sulfate as shown.

$CaS + 3CaSO_4 \rightarrow 4CaO + 4SO_2$

2.50 g of calcium sulfide are heated with 9.85 g of calcium sulfate until there is no further reaction.

Show that calcium sulfate is the limiting reagent in this reaction.

Calculate the mass, in g, of sulfur dioxide formed.

Mr (CaS) = 72.2
Mr ($CaSO_4$) = 136.2

(5)

2. A compound contains 40.0% carbon, 6.7% hydrogen and 53.3% oxygen by mass. Which could be the molecular formula of this compound?

A. $C_2H_2O_2$
B. C_2H_2O
C. $C_2H_4O_2$
D. C_2HO_2

(1)

3. A student is provided with a 5.60 g sample of ethanoic acid (CH_3COOH) contaminated with sodium ethanoate (CH_3COONa).

The student dissolves the sample in deionised water and makes the volume up to 200 cm^3

The student removes 25.0 cm^3 samples of the solution and titrates them with 0.350 mol dm^{-3} sodium hydroxide solution.

The table below shows the results of these titrations.

	Rough	1	2	3
Final volume / cm^3	20.85	41.10	20.50	40.80
Initial volume / cm^3	0.00	20.85	0.00	20.50
Titre / cm^3	20.85	20.25	20.50	20.30

(a) Use the results in the table above to calculate the mean titre value.

Use the mean titre to calculate the percentage by mass of sodium ethanoate in the original sample.

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(6)

(b) The student rinses the burette with deionised water before filling with sodium hydroxide solution.

State and explain the effect, if any, that this rinsing will have on the value of the titre.

(2)

4. When driving a car, a legal limit for ethanol (Mr = 46.0) is 80 mg per 100 cm^3 of blood.

What is this concentration in mol dm^{-3}?

A. 1.74×10^{-1}
B. 1.74×10^{-2}
C. 1.74×10^{-3}
D. 1.74×10^{-4}

(1)

5. This question is about two experiments on gases.

(a) In the first experiment, liquid Y is injected into a sealed flask under vacuum.

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The liquid vaporises in the flask.

The table below shows data for this experiment.

Mass of Y	717 mg
Temperature	297 K
Volume of flask	482 cm^3
Pressure inside flask	51.0 kPa

Calculate the relative molecular mass of Y.
Show your working.

The gas constant, R = 8.31 J K^{-1} mol^{-1}

(5)

(b) In the second experiment, another flask is used for a combustion reaction.

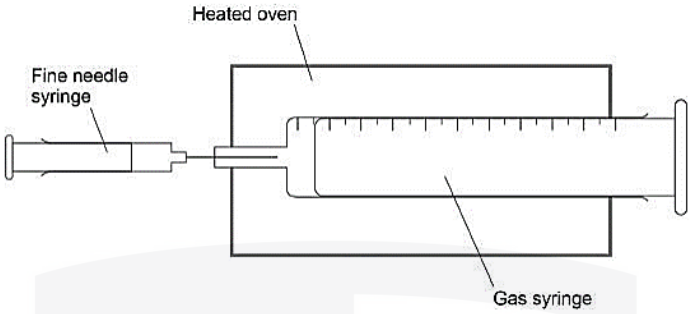
Method

- Remove all the air from the flask.
- Add 0.0010 mol of 2,2,4-trimethylpentane (C_8H_{18}) to the flask.
- Add 0.0200 mol of oxygen to the flask.
- Spark the mixture to ensure complete combustion.
- Cool the mixture to the original temperature.

The equation is

$C_8H_{18}(g) + 1/2\ O_2(g) \rightarrow 8\ CO_2(g) + 9\ H_2O(l)$

Calculate the amount, in moles, of gas in the flask after the reaction.



(2)

6. What is the percentage atom economy for the production of ethanol from glucose?

$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$

A. 25.6%
B. 27.1%
C. 51.1%
D. 54.2%

(1)

7. This question is about a volatile liquid, A.

(a) A student does an experiment to determine the relative molecular mass (Mr) of liquid A using the apparatus shown in the figure below.

The student injects a sample of A into a gas syringe in an oven.

At the temperature of the oven, liquid A vaporises.

The table shows the student's results

Mass of fine needle syringe and contents before injecting	11.295 g
Mass of fine needle syringe and contents after injecting	10.835 g
Volume reading on gas syringe before injecting	0.0 cm^3
Volume reading on gas syringe after injecting	178.0 cm^3
Pressure of gas in syringe 100 kPa Temperature of oven	120 °C

Calculate the Mr of A.

Give your answer to 3 significant figures.

The gas constant, R = 8.31 J K^{-1} mol^{-1}

(4)

(b) The student noticed that some of the liquid injected into the gas syringe did not vaporise.

Explain the effect that this has on the Mr calculated by the student.

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(2)

(c) The table is repeated here.

Mass of fine needle syringe and contents before injecting	11.295 g
Mass of fine needle syringe and contents after injecting	10.835 g
Volume reading on gas syringe before injecting	0.0 cm^3
Volume reading on gas syringe after injecting	178.0 cm^3
Pressure of gas in syringe 100 kPa Temperature of oven	120 °C

Each reading on the balance used to record the mass of the fine needle syringe and contents had an uncertainty of ±0.001 g

Calculate the percentage uncertainty in the mass of liquid A injected in this experiment.

(1)

8. Nitration of 1.70 g of methyl benzoate (Mr = 136.0) produces methyl 3-nitrobenzoate (Mr = 181.0).

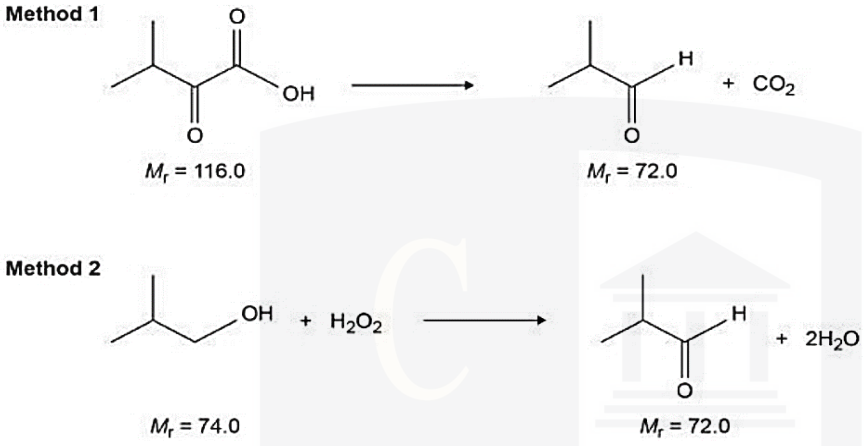
The percentage yield is 65.0% What mass, in g, of methyl 3-nitrobenzoate is produced?

A. 0.830
B. 1.10
C. 1.47
D. 2.26

(1)

9. A student investigates two experimental methods of making methylpropanal.

The equations for these two methods are shown.



In each method, the student uses 1.00 g of organic starting material.

The yield of methylpropanal obtained using each method and other data are included in the table.

	Method 1	Method 2
Yield of methylpropanal / mg	552	778
Percentage yield		80.0%
Percentage atom economy	62.1%	

Calculate the percentage yield for Method 1.
Calculate the percentage atom economy for Method 2.
State the importance of percentage yield and percentage atom economy when choosing the method used to make a compound.

(6)

10. Which compound needs the greatest amount of oxygen for the complete combustion of 1 mol of the compound?

A. Ethanal
B. Ethanol
C. Ethane-1,2-diol
D. Methanol

(1)

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