Amount of Substance (MCQ)

1. 0.24 g of an element, **X**, is reacted with 0.0100 mol Cl_2 to form a chloride with the formula $\mathbf{X}Cl_2$. What is element **X**?

A carbon
B magnesium
C molybdenum
D titanium

Your answer ☐ **[1]**

2. Which chemical process is the most sustainable in terms of the atom economy of the organic product?

A $CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$
B $CH_3CH_2OH + NaCl + H_2SO_4 \rightarrow CH_3CH_2Cl + NaHSO_4 + H_2O$
C $CH_3CH_2Br + NaOH \rightarrow CH_3CH_2OH + NaBr$
D $CH_3CH_2CH_2CH_2OH \rightarrow CH_3CH_2CH{=}CH_2 + H_2O$

Your answer ☐ **[1]**

3. 8.0 dm^3 of NO is mixed with 6.0 dm^3 of O_2 at room temperature and pressure (RTP). The reaction below takes place until one of the reactants is used up.

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

What is the volume of the mixture at RTP after the reaction has taken place?

A 8.0 dm^3
B 10.0 dm^3
C 12.0 dm^3
D 14.0 dm^3

Your answer ☐ **[1]**

4. What is the volume of 0.0100 mol of N_2 at 350 ºC and 200 kPa?

A 145 cm^3
B 259 cm^3
C 145 dm^3
D 259 dm^3

Your answer ☐ **[1]**

5. What is the percentage composition by mass of nitrogen in $(NH_4)_2CO_3$?

A 14.58%
B 17.95%
C 29.17%
D 37.50%

Your answer ☐ **[1]**

6. 1 mol of a compound reacts with 8 mol O_2 for complete combustion.

What is the formula of the compound?

A C_4H_8
B C_4H_9OH
C $C_5H_{11}OH$
D C_5H_{12}

Your answer ☐ **[1]**

7. What is the number of oxygen atoms in 88.0 g of CO_2?

A 3.01×10^{23}
B 1.20×10^{24}
C 2.41×10^{24}
D 4.82×10^{24}

Your answer ☐ **[1]**

8. A compound has the composition by mass:

H, 5.00%; N, 35.00%; O, 60.00%.

Which compound has this composition?

A HNO_3
B NH_4NO_3
C HNO_2
D NH_2OH

Your answer ☐ **[1]**

9. Sodium reacts with water as shown below.

$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$

Which mass of sodium reacts with water to produce 960 cm^3 of hydrogen gas at RTP?

A 0.46 g
B 0.92 g
C 1.84 g
D 3.68 g

Your answer ☐ **[1]**

10. Samples of four hydrocarbons are completely burnt under the same conditions of temperature and pressure.

Which sample produces the greatest volume of CO_2?

A 0.4 mol C_2H_6
B 0.3 mol C_3H_8
C 0.2 mol C_4H_{10}
D 0.1 mol C_5H_{12}

Your answer ☐ **[1]**

11. Which reaction produces the smallest atom economy of $BaCl_2$?

A $BaCl_2 \cdot 2H_2O \rightarrow BaCl_2 + 2H_2O$
B $BaO + 2HCl \rightarrow BaCl_2 + H_2O$
C $BaCO_3 + 2HCl \rightarrow BaCl_2 + CO_2 + H_2O$
D $Ba + 2HCl \rightarrow BaCl_2 + H_2$

Your answer ☐ **[1]**

12. An organic compound has the composition by mass:

C, 53.33 %; H, 11.11%; O, 35.56%.

What is the empirical formula of the organic compound?

A $C_4H_8O_2$
B $C_4H_{10}O_2$
C C_2H_4O
D C_2H_5O

Your answer ☐ **[1]**

13. Calcium nitrate, $Ca(NO_3)_2$, decomposes when heated, as shown below.

$$Ca(NO_3)_2(s) \rightarrow CaO(s) + 2NO_2(g) + \tfrac{1}{2}O_2(g)$$

A student decomposes 0.00500 mol of $Ca(NO_3)_2$ and collects the gas that is produced.

Calculate the volume of gas that the student should expect to collect, measured at room temperature and pressure.

A 60 cm^3
B 120 cm^3
C 240 cm^3
D 300 cm^3

Your answer ☐

[1]

14. A chemist collects 1.00×10^{-6} m^3 of a gaseous compound at 295 K and 1.01×10^5 Pa.

What is the correct expression for the amount, in mol, of the gaseous compound

A $\frac{8.314 \times 295}{(1.01 \times 10^5) \times (1.00 \times 10^{-6})}$

B $\frac{(1.00 \times 10^{-6}) \times 295}{8.314 \times (1.01 \times 10^5)}$

C $\frac{8.314 \times (1.00 \times 10^{-6})}{(1.01 \times 10^5) \times 295}$

D $\frac{(1.01 \times 10^5) \times (1.00 \times 10^{-6})}{8.314 \times 295}$

Your answer ☐

[1]

15. 0.010 mol of barium is added to 500 cm^3 of water. The equation is shown below:

$$Ba(s) + 2H_2O(l) \rightarrow Ba(OH)_2(aq) + H_2(g)$$

The volume of water does not change during the reaction.

Which statement is correct?

A. The number of hydroxide ions formed is $0.010 \times 6.02 \times 10^{23}$.
B. The volume of hydrogen gas produced is 0.24 cm^3, measured at room temperature and pressure.
C. The concentration of $Ba(OH)_2(aq)$ formed is 0.020 mol dm^{-3}.
D. 0.0050 mol of water reacts.

Your answer ☐

[1]

16. Which volume of oxygen gas, at room temperature and pressure, is required for complete combustion of 1.25×10^{-3} mol of propan-1-ol?

A. 105 cm^3
B. 120 cm^3
C. 135 cm^3
D. 120 cm^3

Your answer ☐

[1]

17. Which reagent would exactly neutralise 100 cm^3 of 1.00 mol dm^{-3} $H_2SO_4(aq)$?

A. 0.100 mol $Al(OH)_3$
B. 0.100 mol NH_3
C. 0.100 mol $Ba(OH)_2$
D. 0.100 mol NaOH

Your answer ☐

[1]

18. A student mixes 100 cm^3 of 0.200 mol dm^{-3} NaCl(aq) with 100 cm^3 of 0.200 mol dm^{-3} $Na_2CO_3(aq)$.

What is the total concentration of Na^+ ions in the mixture formed?

A. 0.100 mol dm^{-3}
B. 0.200 mol dm^{-3}
C. 0.300 mol dm^{-3}
D. 0.400 mol dm^{-3}

Your answer ☐

[1]

19. Which mass of substance contains the greatest number of atoms?

A. 3.00 g of ammonia, NH_3
B. 3.00 g of chloromethane, $CHCl_3$
C. 4.00 g of hydrogen sulfide, H_2S
D. 4.00 g of hydrogen chloride, HCl

Your answer ☐

[1]

20. A sample of a compound **M** contains 1.46 g of carbon, 0.482 g of hydrogen and 1.69 g of nitrogen.

What is the empirical formula of **M**?

A. CH_2N
B. C_4HN_4
C. CH_4N
D. C_2H_4N

Your answer ☐

[1]

END OF QUESTION PAPER

Mark scheme – Amount of Substance (MCQ)

Question			Answer/Indicative content	Marks	Guidance
1			**B**	1 (AO2.6)	
			Total	**1**	
2			**D**	1 (AO1.2)	**Examiner's Comments** This part discriminated extremely well. Many scripts showed clear working of the atom economy of each process, the usual result being the correct response of D. Candidates choosing an incorrect process (usually A), often showed no working suggesting the response was a guess. The advice here is obviously to work through calculations before choosing the answer.
			Total	**1**	
3			**B**	1 (AO2.6)	**Examiner's Comments** This question proved to be the most difficult of the multiple-choice questions. Candidates clearly did not use the clue in the question: 'until one of the reactants is used up'. Many then responded with C, the volume of NO_2 formed from complete reaction of 6 dm^3 of O_2. D was another common error, which is simply the sum of the volumes of NO and O2 provided in the question. The correct answer of B required candidate to identify that NO is in excess, reacting with 4 dm^3 of the O_2 to form 8 dm^3 NO^2 and leaving behind 2 dm^3 of O_2, and contributing to a total volume of 10 dm^3 of gas.
			Total	**1**	
4			**B**	1 (AO2.2)	**Examiner's Comments** After the difficulties with Question 6, most candidates were able to use the ideal gas equation (annotated on many scripts) to obtain either 259 cm^3 or 259 dm^3. The correct value of B (259 cm^3) revealed the difficulties of unit conversions experienced by many candidates.
			Total	**1**	
5			**C**	1 (AO1.2)	

			Total	**1**	
6			**D**	**1**	**Examiner's Comments** Most candidates selected A or D, with D being the correct option. Presumably, A was chosen by halving the '8' in C_4H_8 without considering that each H_2O molecule contains two H atoms. The successful answer of D usually resulted from the candidate constructing equations.
			Total	**1**	
7			**C**	**1**	**Examiner's Comments** Candidates found this question difficult with comparatively few obtaining the correct response of C. Many candidates selected B instead, the number of CO_2 or O_2 molecules, and not the number of O atoms. Good advice is to read the question carefully and to underline any key features.
			Total	**1**	
8			**B**	**1**	**Examiner's Comments** Nearly all candidates responded with the correct response of B.
			Total	**1**	
9			**C**	**1**	**Examiner's Comments** This part discriminated well, with most able candidates selecting the correct answer of C. A sizeable number selected B, presumably by not considering the 2:1 stoichiometric ratio in the equation.
			Total	**1**	
10			B	**1**	**Examiner's Comments** Able candidates answered this question correctly, with answer option A being a common distractor.
			Total	**1**	
11			C	**1**	**Examiner's Comments** This question was generally answered well. Answer option D was a common distractor.

			Total	**1**	
12			D	**1**	**Examiner's Comments** Most candidates answered this question correctly with only the weakest candidates losing the mark. Some candidates incorrectly identified the answer as B, which has the same ratio but was not the simplest whole number ratio.
			Total	**1**	
13			D	1	**Examiner's Comments** Many candidates were unable to identify the correct molar ratio, with B being a common incorrect answer. Many candidates chose C rather than D, overlooking oxygen in the equation.
			Total	**1**	
14			D	1	
			Total	**1**	
15			C	1	
			Total	**1**	
16			C	1	
			Total	**1**	
17			C	1	
			Total	**1**	
18			C	1	
			Total	**1**	
19			A	1	
			Total	**1**	
20			C	1	
			Total	**1**	