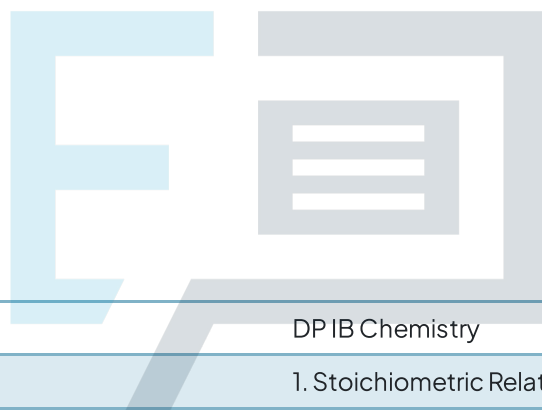




1.1 Matter, Chemical Change & the Mole Concept

Mark Schemes



Course	DP IB Chemistry
Section	1. Stoichiometric Relationships
Topic	1.1 Matter, Chemical Change & the Mole Concept
Difficulty	Medium

To be used by all students preparing for DP IB Chemistry HL
Students of other boards may also find this useful



1

The correct answer is **D** because:

- Divide the masses present by the relative atomic masses of the elements to get the empirical formula

$$\begin{array}{ccc} \text{C} & \text{H} & \text{O} \\ \frac{12}{12.01} \cong 1 & \frac{2}{1.01} \cong 2 & \frac{32}{16.00} = 2 \end{array}$$

- Calculate the approximate empirical mass
 - $12 + 2 + 32 = 46 \text{ gmol}^{-1}$
- The empirical mass will be a multiple of the molar mass
- Divide the molar mass by the empirical mass to get the multiple
$$\frac{92}{46} = 2$$
- Use the multiple to find the molecular formula $2 \times \text{CH}_2\text{O}_2 = \text{C}_2\text{H}_4\text{O}_4$

2

The correct answer is **D** because:

- First balance the equation



- Double everything in order to remove a $\frac{1}{2}$ in the equation



- The sum of the coefficients comes to $2 + 3 + 2 + 2 = 9$

Remember: always balance elements last

When you change a coefficient immediately adjust your equation by changing the other coefficients so you don't lose track of your changes
It's OK to have fractions in equations, but sometimes it is easier to balance equations by removing them



3

The correct answer is **C** because:

- To find the empirical formula, divide the mass by the RAM of each element

S	O
$3.2 \div 32.0$	$4.8 \div 16.0$
0.1	0.3

- Find the nearest whole number ratio, dividing each by the smallest number (by 0.1)

$$1 : 3$$

- The empirical formula is SO_3

4

The correct answer is **C** because:

- Endothermic changes correspond to the breaking of bonds
- Condensing occurs when a gas changes to a liquid, so bonds are formed
- Subliming occurs when a solid changes to a gas, so bonds are broken
- Melting occurs when a solid turns to a liquid, so bonds are broken

State changes in this direction are endothermic as bonds are broken





5

The correct answer is **B** because:

- In one molecule of ethanoic acid, CH_3COOH , there are 2 carbon atoms
- In 0.1 mole of ethanoic acid there would be 0.2 moles of carbon atoms
- In 0.2 moles of carbon would be $0.2 \times$ the Avogadro Constant atoms

$$0.2 \times 6.0 \times 10^{23} = 1.2 \times 10^{23}$$

Be careful to note whether the question asks for the number of moles or the number of atoms. You are expected to be able to manipulate scientific notation to arrive at answers.

6

The correct answer is **A** because:

- You need to find the exact molar mass of each species and multiply by the number of moles

$$\text{NH}_4^+ \quad 14.01 + (1.01 \times 4) = 18.05 \times 2 \text{ mol} = \mathbf{36.10 \text{ g mol}^{-1}}$$

Answer **B** is incorrect as the mass of H_2S is $32.07 + (1.01 \times 2) = \mathbf{34.09 \text{ g mol}^{-1}}$

Answer **C** is incorrect as H_2O_2 $(1.01 \times 2) + (16.00 \times 2) = \mathbf{34.02 \text{ g mol}^{-1}}$

Answer **D** is incorrect as OH^- $16.00 + 1.01 = 17.01 \times 2 \text{ mol} = \mathbf{34.02 \text{ g mol}^{-1}}$

Remember that ions count the same as molecules

The mass of electrons is so small you can ignore them in these calculations

7

The correct answer is **C** because:

To find the empirical formula of a compound you need to divide the percentage by the RAM of each element

- To find the empirical formula, divide the % by the RAM of each element

	C	H
$\frac{80}{12}$	$\frac{20}{1}$	
$= 6.66$	$= 20$	

- Divide by the lowest number

$\frac{6.66}{6.66}$	$\frac{20}{6.66}$
$= 1$	$= 3$

- The empirical formula is CH_3

Don't worry too much about decimal places - rounding will give you the nearest whole numbers and help you identify the correct answer

8

The correct answer is **C** because:

	Steps	Calculation
1	Create an equation that links the atomic masses of each atom present to the overall relative formula mass	$2X + 12.01 + (3 \times 16.00) + (10 \times 2.02) + (10 \times 16.00) = 286.19$
2	Rearrange to find X	$2X + 240.21 = 286.19$ $2X (= 286.19 - 240.21) = 45.98$ $X = 45.98 \div 2 = 22.99$
3	Find the element that has an atomic mass of 22.99	Sodium (Na)

9

The correct answer is **C** because:

- The **empirical formula** is the simplest whole number ratio of atoms in a compound
- The formula of phenazine is $(C_6H_4)_2N_2$
- The simplest ratio of the atoms would be C_6H_4N

A is incorrect as the number of hydrogen atoms is incorrect

B is incorrect as this is the **molecular formula**

D is incorrect as it is the molecular formula with the wrong number of hydrogen atoms



10

The correct answer is **D** because:

	Steps	Calculation
1	Find the mass of the Nickel in the coin	$10.00\text{g} \times 5.869\% = 0.5869\text{g}$
2	Find the moles of Nickel in the coin $\text{Moles} = \frac{\text{mass}}{\text{Mr}}$	$\frac{0.5869}{58.69} = 0.01 \text{ mol}$
3	Find the number of atoms in the coin 6.02×10^{23} atoms per mole (mol^{-1}) - this is known as the Avogadro constant , this has the symbol L	$0.01 \times (6.02 \times 10^{23}) = 6.02 \times 10^{21}$

Exam Papers Practice