Exam Papers Practice

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	Hard

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

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The correct answer is **A** because:

- First, you need to identify the changes in the state of matter:

subliming	solid to gas
vaporizing	liquid to gas
melting	solid to liquid
condensing	gas to liquid

- Where the particles are moving faster, they gain energy and become further apart

B is incorrect as the particles are moving further apart

C is incorrect as the particles are gaining energy

D is incorrect as the particles are losing energy

2

The correct answer is **D** because:

- A homogeneous mixture has uniform composition
- Concrete is a mixture of cement, sand and stones (aggregate). The mixture varies, so it is classified as heterogeneous

A is incorrect as in salt solution the salt and water are completely mixed and the concentration is the same throughout the solution. The salt cannot be seen as separate from the water

B is incorrect as brass is an alloy of copper and zinc. The composition is uniform through the alloy

C is incorrect as orange juice would be heterogeneous until it is filtered, as it will contain small pieces of solids. However, once filtered it would become homogeneous, as the composition becomes uniform

3

The correct answer is **C** because:

- When the equation is balanced the coefficient for oxygen is 7½

$$C_5H_{11}OH(g) + 7½O_2(g) \rightarrow 5CO_2(g) + 6H_2O(g)$$

- Double the coefficients to remove the half and achieve a whole number

$$2C_5H_{11}OH(g) + 15O_2(g) \rightarrow 10CO_2(g) + 12H_2O(g)$$

- The coefficients for oxygen is 15

Careful: when balancing combustion reactions of alcohols; it's easy to forget the oxygen in the hydroxyl group

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The correct answer is **D** because:

- The speed of diffusion of gases is proportional to their relative molecular mass

$O_2 = (2 \times 16 =) 32$; $N_2 = (2 \times 14 =) 28$; $Ar = 40$; $CH_4 = (12 + (4 \times 1) =) 16$

- The order by molecular mass from lightest to heaviest is $CH_4 < N_2 < O_2 < Ar$
- Therefore, from slowest to fastest will be the opposite order $Ar < O_2 < N_2 < CH_4$

A, **B** and **C** are incorrect as they do not given the correct order by speed

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The correct answer is **D** because:

- Hydrogen gas consists of H_2 molecules (H-H)
- Each hydrogen atom has one proton and one electron
- So, each hydrogen molecule has
  2 protons and 2 electrons = a total of 4 (protons + electrons)
- 1 mole of hydrogen molecules = 4 (protons + electrons)
- Therefore, the total number of protons and electrons in two moles must be

$$2 \times 4 \times \text{Avogadro's Constant}$$

$$2 \times 4 \times 6 \times 10^{23} = 48 \times 10^{23} = 4.8 \times 10^{24}$$

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The correct answer is **B** because:

- To find the number of moles of atoms, you need to count the number of atoms in the formula
- The number moles of atoms is then multiplied by the number of moles

P_2O_5 = 2 + 5 atoms = 7 atoms x 0.3 mol = **2.1 mol**

$CuSO_4.5H_2O$ = 1+1+4+10+5 = 21 atoms x 0.4 = **8.4 mol**

CH_3COOH = 1 + 3 + 1+ 1 + 1 + 1 = 8 atoms x 0.5 = **4.0 mol**

H_2O = 2 + 1 = 3 x 0.9 = **2.7 mol**

- The 5 in $CuSO_4.5H_2O$ is a coefficient and represents 5 moles of water (10 H atoms and 5 O atoms)

Water of crystallization means water molecules that are loosely attached to a salt or other species

The loose attachment is represented by placing a dot followed by the number in front of the water

It is treated the same as brackets in relative formula mass calculations

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The correct answer is **C** because:

- The coefficient in front of Cu and $Cu(NO_3)_2$ must be the same
- By trial and error, start with 1, 2, 3 for the Cu and adjust the other coefficients
- Balance the NO last; it will fall into place when you have balanced HNO_3
- The coefficient of H_2O has to be half of HNO_3, so the HNO_3 is an even number
- When you get to a coefficient of 3 for Cu:

$$3Cu + \_HNO_3 \rightarrow 3Cu(NO_3)_2 + \_NO + \_H_2O$$

the number of oxygens must be more than 18, so the coefficient of HNO_3 must be 8 or higher, but an even number

- with an 8 in front of HNO_3 you can balance the water

$$3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + \_NO + 4H_2O$$

- That just leaves the NO

$$3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$$

Balancing equations is a trial and error process which takes practise

8

The correct answer is **B** because:

- When a liquid evaporates it takes in energy from its surroundings - think of alcohol cooling your skin
- If the pressure is low, the liquid can more easily evaporate

Extra info:

At lower pressures molecules can more easily escape from the surface of the liquid, so evaporation is easier. Refrigerants have to be substances that evaporate easily and can be liquefied easily. CFCs are ideal for this use and are also non-toxic and non-flammable. CFCs can be very damaging to the ozone layer and have been replaced by hydrofluorocarbons (HFCs) since the Montreal Protocol in 1987

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The correct answer is **C** because:

- The acid is in excess so the amount of metal determines the volume of hydrogen given off
- The metal which gives the largest volume of hydrogen gas will be the sample that contains the largest number of moles of metal
- Suppose the sample weighs 10g, then the number of moles is = $\frac{10g}{Ar}$
- From this relationship you should see that the metal with the smallest molar mass will have the largest number of moles
- The molar masses are Ca= 40.08 g mol^{-1}, Zn= 65.38 g mol^{-1}, Mg=24.31 g mol^{-1} and Sr= 87.62 gmol^{-1}
- From this we can tell that magnesium has the smallest molar mass and will give the largest volume of hydrogen gas

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The correct answer is **C** because:

- The compound $(NH_4)_3PO_4$ contains two types of ions NH_4^+ and PO_4^{3-}
- From the formula you can see that a total of four ions are present in 1 unit of $(NH_4)_3PO_4$
  - $(NH_4)_3PO_4 \rightarrow 3NH_4^+ + PO_4^{3-}$
- So 0.02 mol of $(NH_4)_3PO_4$ would give 0.08 mol of ions
- However, the question asks for the **number** of ions, not the number of moles of ions, so we need to multiply by the **Avogadro constant**
  - $0.08 \times 6.02 \times 10^{23} = 0.48 \times 10^{23} = \mathbf{4.8 \times 10^{22}}$