SMART EXAM RESOURCES
SUBJECT: CHEMISTRY
TOPIC:STOICHIOMETRY
SET-3-QP-MS

CALCULATE MOLES

1 The equation for the decomposition of aqueous hydrogen peroxide, $H_2O_2(aq)$, is shown.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

$50.0\,cm^3$ of a $0.200\,mol/dm^3$ solution of $H_2O_2(aq)$ is used.

Calculate the mass of O_2 that forms.
Use the following steps.

- Calculate the number of moles of H_2O_2 used.

..... mol

- Determine the number of moles of O_2 produced.

..... mol

- Calculate the mass of O_2 produced.

..... g
[3]

(e) State the effect on the mass of oxygen produced if the mass of powdered manganese(IV) oxide catalyst is increased.

..... [1]

(f) Oxygen can also be produced by the decomposition of mercury(II) oxide, HgO.
The only products of this decomposition are mercury and oxygen.

Write a symbol equation for this decomposition.

..... [2]

MARK SCHEME:

(a)	**M1** (50.0 × 0.200 ÷ 1000 =) 0.01(1) **M2** 0.005(1) **M3** 0.16(0)(1)	**3**
	no effect (b)	**1**
(b)	$2HgO \rightarrow 2Hg + O_2$ **M1** all formulae correct(1) **M2** equation correct(1)	**2**

2 Calcium nitrate crystals are hydrated and have the formula $Ca(NO_3)_2 \bullet xH_2O$ where x is a whole number of molecules of water.

The student heats the crystals to remove the molecules of water.

$$Ca(NO_3)_2 \bullet xH_2O(s) \rightarrow Ca(NO_3)_2(s) + xH_2O(g)$$

(i) State the term used to describe the calcium nitrate after the molecules of water have been removed.

..... [1]

(ii) The student heats a sample of $Ca(NO_3)_2 \bullet xH_2O$ and forms 2.46 g of $Ca(NO_3)_2$ and 0.0600 moles of H_2O.

Determine the value of x. Use the following steps.

- Calculate the M_r of $Ca(NO_3)_2$.

M_r = ...

- Determine the number of moles of $Ca(NO_3)_2$ formed.

moles of $Ca(NO_3)_2$ formed = ...

- Determine the value of x in $Ca(NO_3)_2 \bullet xH_2O$.

x = ...
[3]

MARK SCHEME:

(i)	anhydrous	**1**
(ii) (a)	**M1** M_r $Ca(NO_3)_2$ = 164 (1) **M2** mol $Ca(NO_3)_2$ = 2.46 / 164 = 0.015(00) (1) **M3** 0.015(00) / 0.015(00) = 1 0.0600 / 0.015(00) = 4 and x = 4 (1)	**3**

3 Magnesium sulfate crystals have the formula, $MgSO_4 \bullet xH_2O$, where x is a whole number of molecules of water.

The student heats the crystals to remove the molecules of water.

$$MgSO_4 \bullet xH_2O(s) \rightarrow MgSO_4(s) + xH_2O(g)$$

(i) Name the term given to crystals containing molecules of water.

..... [1]

(ii) The student heats a sample of $MgSO_4 \bullet xH_2O$ and finds it has lost 0.140 moles of H_2O and has 2.40 g of $MgSO_4$ remaining.

Determine the value of x. Use the following steps.

- Calculate the M_r of $MgSO_4$.

M_r = ...

- Determine the number of moles of $MgSO_4$ formed.

moles of $MgSO_4$ formed = ...

- Determine the value of x in $MgSO_4 \bullet xH_2O$.

x = ...
[3]

MARK SCHEME:

(i)	hydrated	**1**
(ii)	**M1** Mr $MgSO_4$ = 120 (1) **M2** mol $MgSO_4$ = 2.40 / M1 = 2.40 / 120 = 0.02(00) (1) **M3** 0.02(00) / 0.02(00) = 1 0.140 / 0.02(00) = 7 **and** x = 7 (1)	**3**

4 Nickel(II) sulfate crystals contain water of crystallisation.

When nickel(II) sulfate crystals, $NiSO_4 \bullet \mathbf{x}H_2O$, are heated, they give off water.

$$NiSO_4 \bullet \mathbf{x}H_2O(s) \rightarrow NiSO_4(s) + \mathbf{x}H_2O(g)$$

A student carries out an experiment to determine the value of **x** in $NiSO_4 \bullet \mathbf{x}H_2O$.

step 1 Nickel(II) sulfate crystals are weighed.

step 2 Nickel(II) sulfate crystals are heated.

step 3 The remaining solid is allowed to cool and is then weighed.

step 4 The remaining solid is heated again, allowed to cool and is then weighed.

step 5 Step 4 is repeated until there is no change in mass.

(i) State the term used to describe crystals that contain water of crystallisation.

..... [1]

(ii) State why **step 4** is repeated until there is no change in mass.

..... [1]

(iii) In an experiment, 0.454 g of nickel(II) sulfate crystals, $NiSO_4 \bullet \mathbf{x}H_2O$, is used. The mass of anhydrous nickel(II) sulfate, $NiSO_4$, remaining is 0.310 g.

[M_r: $NiSO_4$, 155; H_2O, 18]

Determine the value of **x** in $NiSO_4 \bullet \mathbf{x}H_2O$.

Use the following steps.

- Calculate the number of moles of $NiSO_4$ remaining.

moles of $NiSO_4$ = ...

- Calculate the mass of H_2O given off.

mass of H_2O = ... g

- Calculate the number of moles of H_2O given off.

moles of H_2O = ...

- Calculate the value of **x**.

x = ...
[4]

MARK SCHEME

(i)	hydrated	**1**
(ii)	to ensure <u>all</u> the water of crystallisation is removed	**1**
(iii)	**M1** 2×10^{-3} / 0.002 (1) **M2** 0.144 (g) (1) **M3** (0.144 ÷ 18 =) 8×10^{-3} / 0.008 (1) **M4** (0.008 ÷ 0.002 =) 4 (1)	**4**

5 Some chlorides are hydrated.

When hydrated barium chloride crystals, $BaCl_2 \cdot \boldsymbol{x}H_2O$, are heated they give off water.

$$BaCl_2 \cdot \boldsymbol{x}H_2O(s) \rightarrow BaCl_2(s) + \boldsymbol{x}H_2O(g)$$

A student carries out an experiment to determine the value of $\boldsymbol{x}$ in $BaCl_2 \cdot \boldsymbol{x}H_2O$.

step 1 Hydrated barium chloride crystals are weighed.

step 2 The hydrated barium chloride crystals are then heated.

step 3 The remaining solid is weighed.

(i) Describe how the student can be sure that all the water is given off.

.....

.....

..... [2]

(ii) In an experiment, 4.88 g of $BaCl_2 \cdot \boldsymbol{x}H_2O$ is heated until all the water is given off. The mass of $BaCl_2$ remaining is 4.16 g.

[M_r: $BaCl_2$, 208; H_2O, 18]

Determine the value of $\boldsymbol{x}$ using the following steps.

- Calculate the number of moles of $BaCl_2$ remaining.

..... mol

- Calculate the mass of H_2O given off.

..... g

- Calculate the number of moles of H_2O given off.

..... mol

- Determine the value of $\boldsymbol{x}$.

$\boldsymbol{x}$ = ...
[4]

MARK SCHEME:

(i)	heat + weigh + repeat (1) until mass is constant (1)	**2**
(ii)	**M1** 0.02 (1) **M2** 0.72 (1) **M3** M2 ÷ 18 = 0.72/18 = 0.04 (1) **M4** M3 ÷ M1 = 0.04 ÷ 0.02 = 2 (1)	**4**

6 **(ii)** In an experiment, 1.61 g of $Na_2SO_4 \cdot \boldsymbol{x}H_2O$ is heated until all the water is given off. The mass of Na_2SO_4 remaining is 0.71 g.

[M_r: Na_2SO_4,142; H_2O,18]

Determine the value of ***x*** using the following steps.

- Calculate the number of moles of Na_2SO_4 remaining.

..... mol

- Calculate the mass of H_2O given off.

..... g

- Calculate the number of moles of H_2O given off.

..... mol

- Determine the value of ***x***.

x = ...
[4]

MARK SCHEME:

	0.005 (1) 0.9 (1) (0.9 ÷ 18 =) 0.05 (1) (0.05 ÷ 0.005 =) 10 (1)	**4**