ENHANCING THE LEARNING AND TEACHING OF MOLE CALCULATIONS

In-Class Concept Test

Difficulties Students encounter in Mole Calculations

Scheme

Month	Task
December	✓Worksheet to students for revision of the Half-yearly Examination
January	Half-yearly Examination
	✓Guidelines given to students to set questions on Reacting Mass in groups of two to three
February	Students hand in questions in groups ✓
	Choose at least one question from each group to set the **Test**
	Students explain to classmates about the questions chosen from their group, after the **Test**

Worksheet

Reacting Mass

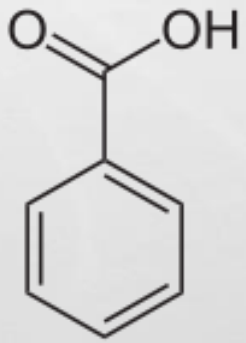
Section A MC (show your calculations)

1. Which of the following substances contains the same number of ions as 9.53 g of magnesium chloride?
   (Relative atomic masses: O = 16.0, Na = 23.0, Mg = 24.3, S = 32.1, Cl = 35.5, K = 39.1, Ca = 40.1, Zn = 65.4)

   A. 5.46 g of potassium chloride
   B. 6.82 g of zinc chloride
   C. 3.60 g of calcium sulphate
   D. 7.81 g of sodium sulph

4. Calculate the relative molecular mass of benzoic acid (苯甲酸) , with the structure shown below.

   A. 122
   B. 128
   C. 122 g mol^{-1}
   D. 128 g mol^{-1}



9 MCs

Worksheet

Section B Conventional Questions

1. The iodide of a metal *X* has the formula of XI_2 and contains 8.7 % by mass of *X*.

   (a) Determine the relative atomic mass of *X*.

2. 2.9 g of a dry gaseous compound *X* (containing carbon and hydrogen only) were completely burnt in excess dry oxygen. The products were passed through a drying agent, and it was found that 4.5 g of water had formed. Determine the empirical formula of *X*.

4. (d)The student finally obtained 9.9 g of copper. Calculate the percentage yield of the reaction.

to Students
in Google Classroom

Guidelines on Designing Questions to test Classmates' Proficiencies in tackling problems in Reacting Mass

1. You are to work in Groups of 2-3 to design questions on the topic Reacting Mass for your classmates, which will be set out as a revision test. Groupings to be handed in by 20 Jan, 2017.

2. Question Types to be included:
   (a) MC (at least 5 questions to be set)
   (b) Conventional Questions (at least 4 questions to be set)

to Students
in Google Classroom

3. Topics to be included:
   (i) The mole, Avogadro constant and molar mass
   (ii) Percentage by mass of an element in a compound
   (iii) Chemical formulae of compounds
   (iv) Empirical formulae and molecular formulae derived from experimental data
   (v) Reacting masses from chemical equation

4. All the questions set must be accompanied by fully work-out solutions. For MCs, think about the common mistakes and design the options with distractors, i.e., with options that involve common mistakes in calculations. Explain each distractor.

to Students
in Google Classroom

5. Hints on setting the questions:

(I) *You may refer to the worksheet given to you on Reacting Mass.*

(II) *Common mistakes of classmates in this topic include:*
In considering which reactant is the limiting reagent, classmates may consider the one with the lowest number of moles as the limiting reagent, without considering the stoichiometry of the reactants in the equation.

(III) *Include some daily compounds to test classmates' ability in counting the number of atoms and in calculating percentage by mass. For example, you may search for the structures of Vitamin D, lycopene (番茄紅素) etc. to set questions.*

to Students
in Google Classroom

6. You will be asked to explain to classmates how to tackle the problems set by you after the test and may be video recorded for educational purpose.

7. Format to be handed in: Wordfile email to at@hmtgss.edu.hk
(File name: Class and Class No., for example, if the questions were set by *Cathy* and *Michelle*, the file name will be "4H 4 and 4T 26")
You may start preparing Powerpoint for future explanation to classmates.

8. Deadline to submit this assignment : 6 Feb, 2017.

Sample of Students' Work - Questions

4H (15), (29), 4T (16)

HOMANTIN GOVERNMENT SECONDARY SCHOOL F.4 CHEMISTRY QUESTIONS

Multiple-choice Questions

1. How many grams of O_2 are needed to produce 45.8 grams of Fe_2O_3 in the following reaction?

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$$

A. 38.4g of O_2
B. 13.8g of O_2
C. 20.6g of O_2
D. 1.25g of O_2

2. 0.1 mole ammonia reacts with 0.1 mole oxygen according to the following question:

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$$

Which of the following is the limiting agent?

A. Ammonia
B. Oxygen
C. Nitrogen monoxide
D. Water

3. Under a certain condition, 70% ozone (O_3) is converted to oxygen (O_2) via the following reaction pathway:

$$2O_3(g) \rightarrow 3O_2(g)$$

If the original number of ozone molecules is x moles, calculate the number of moles of oxygen formed.

A. 1.05x
B. 0.47x
C. 0.7x
D. 0.2x

4. An oxide , XO , contains 50.9% by mass of X . What is the relative atomic mass of X ?

A. 19.3
B. 20.3
C. 15.3
D. 0.203

Conventional Questions

1. A student is doing an experiment for the reduction of lead oxide by carbon monoxide. The following results were obtained:
   Mass of combustion tube = 10.20 g
   Mass of combustion tube + lead oxide = 12.43 g
   Mass of combustion tube + lead = 12.27 g
   (a) Calculate the percentage by mass of oxygen and lead in the oxide
   (b) Determine the empirical formula of the oxide

2. 1.6g of CuO was reacted with Methane as shown in the equation below. How much Methane was used up?

$$4CuO + CH4 \rightarrow 4Cu + CO2 + 2H2O$$

3. An oxide of Sulphur contains 59.93% of oxygen by mass. What is the empirical formula of this oxide?

Sample of Students' Work - Answers

ANSWER KEY

Multiple-choice Questions

1. Use molar mass to convert grams of given to moles

   1 mole of Fe_2O_3 = (55.8x2) + (16.0x3) = 159.7 of Fe_2O_3

   Moles of Fe_2O_3 = $\frac{45.8}{159.7}$ = 0.287 mole of Fe_2O_3

   Mole ratio of O_2 = $0.287 \times \frac{3}{2}$ = 3:2

   Mass of O_2 = 0.4305x16x2

   = 13.776

   = 13.8g

B

2. From the equation, mole ratio of $NH_3:O_2$ = 4:5

   Only $\frac{0.1}{5}$ X 4 = 0.08 mole of NH_3 (g) is required to react with 1 mole of oxygen.

   That means, NH_3 (g) is in excess. O_2 is the limiting agent

B

3. Number of moles of O_3 reacted = x X 70% = 0.7x

   From the equation, mole ratio of $O_3 : O_2$ = 2 : 3

   Therefore, Number of moles of O_2 produced

   = $\frac{3}{2}$ x number of moles of O_3 = $\frac{3}{2}$ x 0.7x = 1.05x mol

A

4. 50.9% = a ÷ a + 16.0 X 100%

   50.9% (a + 16) a

   50.95a +8.144 = A

   8.144 = a -0.509a

   8.144 = a0.491

   a = 20.3

B

Conventional Questions

1. (a)Mass of lead in the sample = (12.27 – 10.20) g = 2.07 g

   Mass of lead oxide = (12.43 – 10.20)g = 2.23 g

   Percentage by mass of lead = $\frac{2.07}{2.23}$ X 100% = 92.82%

   Percentage by mass of oxygen = 100 – 92.82 = 7.18%

   (b)Let the mass of lead oxide be 100 g

	Pb	O
Mass (g)	92.82	7.18
Number of moles of atoms (mol)	$\frac{92.82\ g}{207.2\ g\ mol^{-1}}$ = 0.448	$\frac{7.18\ g}{16.0\ g\ mol^{-1}}$ =0.448
Mole ratio (in simplest number)	1	1

Therefore, the empirical formula of the oxide is PbO

2.

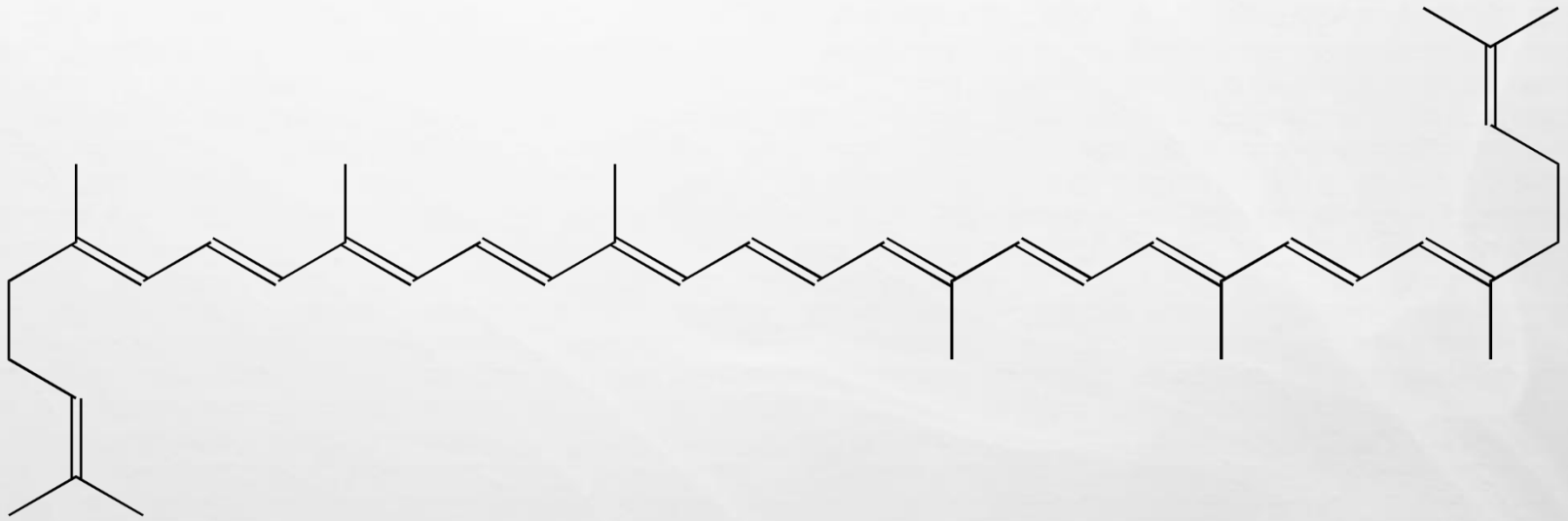
3. Let the mass of sulphur oxide be 100 g

	S	O
Mass (g)	40.07	59.93
Number of moles of atoms (mol)	$\frac{40.07\ g}{32.1\ g\ mol^{-1}}$ = 1.248	$\frac{59.93\ g}{16.0\ g\ mol^{-1}}$ =3.746
Mole ratio (in simplest number)	1	3

Therefore, the empirical formula of the oxide is SO_3.

3. Calculate the relative molecular mass of lycopene

A: 533
B: 534
C: 535
D: 536



Misconceptions spotted

1. Which of the following chemical has the largest number of molecules?
   A. 1g of helium
   B. 6g of calcium chloride
   C. 7g of calcium carbonate
   D. 10g of magnesium oxide

Misconceptions spotted

LONG QUESTION

1. **Calculate the number of moles of $CuSO_4.5H_2O$ in 100 g of the solid. The Relative Molecular Mass of $CuSO_4.5H_2O$**

ANS
= [63.5 + 32 + (4 x 16) + 5{(2x1) + 16}] = 249.5 g mol–1
number of moles of $CuSO_4.5H_2O$ =

100g of $CuSO_4 . 5H_2O$ / Molar mass of CuSO .5H Oof 249.5gmol –1

= 0.4008 moles of $CuSO_4 . 5H_2O$ molecules

Answers provided by students may be wrong

3. The molecular formula of a element X is X_2 . 278.8g of the gas contain 4 moles of molecules . What is the relative atomic mass of X ?

A. 34.9
B. 65.7
C. 17.4
D. 69.7

The Answer should be A.
This group of students forgot to divide the answer by two for the *relative atomic mass*

Answer: D

The relative atomic mass of X:

278.8/4

= 69.7

Students' Work

- **Broad spectrum,**
  - teachers may have preferences,
    - students learn more through reading other examples

- **The Questions and Answers were typed by students**
  - teachers may use them directly

During the Test.....

Students were curious.

Students were critical.

% of oxygen $= 41.03\%$

Assume having 100 g of the oxide

	Na	O
Mass (g)	58.97	41.03
No. of mole (mol)	$\frac{58.97}{23.0} = 2.56$	$\frac{41.03}{16} = 2.56$
Ratio	$\frac{2.56}{2.56} = 1$	$\frac{2.56}{2.56} = 1$

$\therefore$ the empirical formula of the oxide = NaO

	Strongly Agree(5)	Agree	Neutral	Disagree	Strongly Disagree (1)
1. The Guidelines in setting questions help you set the questions.					
2. The amount of time for you to prepare the questions is enough.					
3. Setting questions in groups is better than individual.					
4. Your groupmates can help you in clarifying concepts when setting the questions.					

Questionnaire on the Lesson Study - Mole Calculations

	Strongly Agree(5)	Agree	Neutral	Disagree	Strongly Disagree (1)
5. You consider your performance in the test on the topic of Reacting Mass set by your classmates is better than that in the Mid-term Examination.					
6. Your presentation to your classmates helps you clarify the concepts.					
7. You can learn from your classmates on the topic Reacting Mass during presentation.					
8. In general, you consider the activity helps you in clarifying concepts on Reacting Mass.					

Questionnaire on the Lesson Study - Mole Calculations

	Strongly Agree(5)	Agree	Neutral	Disagree	Strongly Disagree (1)
1. The Guidelines in setting questions help you set the questions.		✓			
2. The amount of time for you to prepare the questions is enough.			✓		
3. Setting questions in groups is better than individual.	✓				
4. Your groupmates can help you in clarifying concepts when setting the questions.		✓			

Questionnaire on the Lesson Study - Mole Calculations

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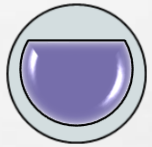
8. In general, you consider the activity helps you in clarifying concepts on Reacting Mass.		✓			

Questionnaire on the Lesson Study - Mole Calculations

Summary

 Worksheet  Guidelines  Test  Explain

Suggestions for Improvements

- ***May video record the explanation by students themselves & Upload to youtube / google classroom***

save lesson time

worksheet for peer evaluation

- ***Use at least one period for the Start-up session***

Occupy students' "free time" constructively,

think more,

read more .....

in Chemistry

Thank You