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VCE Chemistry ½
Moles & Stoichiometry Revision [2.4]
Homework

Admin Info & Homework Outline:

Student Name	
Questions You Need Help For	
[2.1] – Moles & Molar Mass	Pg 2 — Pg 13
[2.2] – Relative Atomic Mass & Percentage Composition	Pg 14 — Pg 29
[2.3] – Stoichiometry	Pg 30 — Pg 43
[2.1-2.3] Overall (VCAA Qs)	Pg 44 — Pg 54

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Section A: [2.1] – Moles & Molar Mass (61 Marks)

Sub-Section [2.1.1]: Apply Avogadro's Number to Mole Calculations using $n = N/N_a$

Question 1 (4 marks)

For the following questions, calculate the amount required.

a. The moles of magnesium atoms in 1.204×10^{24} particles. (1 mark)

_____

_____

b. The particles of argon atoms in 19 moles. (1 mark)

_____

_____

c. The moles of francium atoms in 3.913×10^{24} particles. (1 mark)

_____

_____

d. The particles of copper atoms in 9.654 moles. (1 mark)

_____

_____

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Question 2 (4 marks)

Find the number of particles in the following.

a. In 2 moles of O_2, find the particles of oxygen atoms. (1 mark)

_____

_____

b. In 4 moles of $CaCl_2$, find the particles of calcium ions. (1 mark)

_____

_____

c. If we knew that a sample of CO_2 contained 1.20×10^{24} particles of oxygen, how many moles of CO_2 were there? (2 marks)

_____

_____

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Question 3 (6 marks)

Consider the compound of ammonia, NH_3.

a. If there are 6.02×10^{24} molecules of ammonia, how many moles of ammonia are present? (1 mark)

_____

b. How many nitrogen atoms are there in this amount of ammonia? (1 mark)

_____

_____

c. How many hydrogen atoms are there in this amount of ammonia? (1 mark)

_____

_____

d. Given that we have 4.518×10^{24} atoms of hydrogen in a sample of ammonia, calculate the moles of ammonia we have in total. (3 marks)

_____

_____

_____

_____

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Question 4 (6 marks)

Consider the compound of $KMnO_4$, commonly referred to as potassium permanganate.

a. Given that we have 6.41×10^{29} particles of oxygen, what number of particles of manganese and potassium do we have? (2 marks)

_____

_____

b. Hence, what number of moles of potassium permanganate do we have? (1 mark)

_____

_____

c. A student says that 100 molecules of O_2 versus 100 molecules of Se_2, because Se is a much bigger molecule than O, their amount in moles will be different. Evaluate this statement. (3 marks)

_____

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Sub-Section [2.1.2]: Apply Molar Mass to Mole Calculations Using $n = m/M$

Question 5 (4 marks)

For the following substances, find their molar mass.

a. CO_2. (1 mark)

_____

b. KCl. (1 mark)

_____

c. $CaCO_3$. (1 mark)

_____

d. $C_6H_{12}O_6$. (1 mark)

_____

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Question 6 (4 marks)

For the following samples, calculate the amount required.

a. Given that there is 5.0 g of CO_2, calculate the moles present. (1 mark)

_____

_____

b. Given that there is 10.0 g of NaOH, calculate the moles of sodium hydroxide. (1 mark)

_____

_____

c. Given that there are 3.00 moles of $MgCl_2$, calculate the mass present. (1 mark)

_____

_____

d. Given that there are 2.50 moles of KNO_3, calculate the mass present. (1 mark)

_____

_____

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Question 7 (5 marks)

a. Given that a sample contains 12.50 moles and weighs 778.75 g, what is its molar mass? (2 marks)

_____

b. Based on your understanding of molar mass, is it reasonable to assume that 10 g of $NaNO_3$ will be similar in amount to 10 g of $CsNO_3$? Explain. (3 marks)

_____

_____

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Question 8 (7 marks)

Consider an unknown chemical X_2O. We know that there are 7.89×10^{25} atoms of oxygen in this sample.

a. What is the number of individual atoms in our sample? (2 marks)

_____

_____

b. Find the moles of X_2O. (2 marks)

_____

_____

c. If the compound is 12345 grams, find its molar mass. (2 marks)

_____

_____

d. What is X's identity? (1 mark)

_____

_____

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Sub-Section [2.1.3]: Apply Unit Conversions to Calculation Questions

Question 9 (4 marks)

For the following, convert the current units to the units required.

a. Convert 5.50 kg to grams. (1 mark)

_____

b. Convert 3 hours to seconds. (1 mark)

_____

c. Convert 7500 milligrams to kilograms. (1 mark)

_____

d. Convert 25 micrometres to metres. (1 mark)

_____

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Question 10 (4 marks)

Find the missing value for the following scenarios.

a. Given that a sample of K_2SO_4 weighed 2.50 kg, what is the number of moles present? (1 mark)

_____

_____

b. Given that another sample of $CaCl_2$ weighed 980 mg, what is the number of atoms of chlorine present? (3 marks)

_____

_____

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Question 11 (5 marks)

Consider the compound of calcium bromide.

a. What is its molar mass? (1 mark)

_____

b. Given that, a sample contains 9.7412×10^{-4} megagrams, what is the number of moles present? (2 marks)

_____

_____

_____

c. Now, given that is the case, find the mass of bromine in the sample, expressed in milligrams. (2 marks)

_____

_____

_____

_____

Space for Personal Notes

Question 12 (8 marks)

Consider a molecule of $K_2Cr_2O_7$, commonly referred to as potassium dichromate.

a. What is the molar mass of this molecule? (1 mark)

_____

b. What type of intramolecular bonding holds this molecule together? (1 mark)

_____

c. If there was 20.3 mg of potassium dichromate present, how many moles of it are present? (1 mark)

_____

_____

d. From your previous answer, calculate the number of molecules of potassium dichromate present. (2 marks)

_____

_____

e. Now, state how many kilograms of oxygen was present in the sample. (3 marks)

_____

_____

_____

_____

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Section B: [2.2] – Relative Atomic Mass & Percentage Composition (83 Marks)

Sub-Section [2.2.1]: Calculate The Percentage Composition By Mass Of An Element In A Compound

Question 13 (4 marks)

For the following, find the percentage composition of the required element in the substance.

a. Oxygen in H_2O_2. (1 mark)

_____

_____

_____

b. Carbon in CO_2. (1 mark)

_____

_____

_____

c. Hydrogen in NH_3. (1 mark)

_____

_____

_____

d. Sulphur in SO_3. (1 mark)

_____

_____

_____

Question 14 (2 marks)

For the following, find the percentage composition of the required element in the substance.

a. Phosphorus in H_2PO_4. (1 mark)

_____

_____

_____

b. Magnesium in $Mg_3(PO_4)_2$. (1 mark)

_____

_____

_____

Question 15 (4 marks)

For the following, find the percentage composition of all the elements in the compound.

a. $Ca(ClO_4)_2$. (2 marks)

_____

_____

_____

_____

_____

b. $KHSO_3$. (2 marks)

_____

_____

_____

_____

_____

Question 16 (8 marks)

Consider the molecule of C_3H_7OH.

a. What is the percentage composition by mass of carbon? (2 marks)

_____

_____

_____

b. What is the percentage composition by mass of hydrogen? (2 marks)

_____

_____

c. Explain why the value you obtained for carbon is higher than hydrogen when the individual number of hydrogens is more than carbon. (2 marks)

_____

_____

_____

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d. Can the percentage composition be 100% for an element in a compound? (2 marks)

_____

_____

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Sub-Section [2.2.2]: Find The Empirical Formula & Amp; Molecular Formula Of A Compound

Question 17 (3 marks)

A 3.66 g sample of iron combines with oxygen to give 5.232 g of the final product, which contains only iron and oxygen. Determine the empirical formula.

_____

_____

_____

_____

Question 18 (4 marks)

Find the empirical formulae given the below information.

a. A compound contains 26.2% nitrogen, 7.5% hydrogen, and 66.3% chlorine. (2 marks)

_____

_____

_____

_____

b. A compound contains 19.4% carbon, 3.2% hydrogen, 77.4% oxygen. (2 marks)

_____

_____

_____

_____

Question 19 (3 marks)

A sample of an unknown compound is found to contain 0.825 g of carbon, 0.138 g of hydrogen and 1.037 g of oxygen. If the molar mass of the compound is 120 $g\ mol^{-1}$, determine its molecular formula.

_____

_____

_____

_____

_____

Question 20 (7 marks)

a. A sample of an unknown compound contains 0.200 g of carbon, 0.05 g of hydrogen and 0.300 g of oxygen. Find the empirical formula. (3 marks)

_____

_____

_____

_____

b. Given that the molar mass of the compound is 90 $g\ mol^{-1}$, how many of the empirical formula is required? (1 mark)

_____

_____

c. As such, what is the molecular formula? (1 mark)

_____

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d. Is it possible to have two molecular formulae with the same empirical formula? Give an example. (2 marks)

_____

_____

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Sub-Section [2.2.3]: Calculate the Relative Atomic Mass of a Compound From its Relative Isotopic Abundance

Question 21 (4 marks)

a. Boron exists in two isotopes, B-10 and B-11, with relative abundances of 19.9% and 80.1% respectively. Calculate the relative atomic mass of boron. (2 marks)

_____

_____

_____

b. Silver has two isotopes, Ag-107 and Ag-109, with relative abundances of 51.82% and 48.18% respectively. Calculate its relative atomic mass. (2 marks)

_____

_____

_____

Question 22 (2 marks)

Neon has three isotopes: Ne-20, Ne-21, and Ne-22. Their relative abundances are 90.48%, 0.27% and 9.25% respectively. Find the relative atomic mass of neon.

_____

_____

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Question 23 (4 marks)

Gallium exists as two isotopes, Ga-69 and Ga-71 with relative abundances of 60.11% and 39.89% respectively.

a. Calculate its relative atomic mass. (2 marks)

_____

_____

_____

b. Since Gallium has two isotopes exactly, why aren't their abundances not 50% each? (2 marks)

_____

_____

_____

_____

Question 24 (7 marks)

Carbon exists in two isotopes mainly, C-12 and C-13 with relative atomic abundances of 98.93% and 1.07% respectively.

a. Determine the relative atomic mass of carbon. (2 marks)

_____

_____

b. Do you think that when we obtain a sample of carbon at random, the atomic mass of that sample is equivalent to the relative atomic mass? (2 marks)

_____

_____

_____

_____

c. Suppose we collected a sample of carbon-13 exclusively, should the atomic mass be the same as the relative atomic mass? Justify your answer. (3 marks)

_____

_____

_____

_____

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Sub-Section [2.2.4]: Find the Relative Isotopic Abundance from a Compound's RAM / Molar Mass

Question 25 (2 marks)

The relative atomic mass of an element Y is 63.55. If the element consists of two isotopes with masses 63 and 65, determine the percentage abundance of each isotope.

_____

_____

Question 26 (3 marks)

An element Z has a relative atomic mass of 20.18 and consists of two isotopes: Z-20 and Z-22. Find the percentage abundance of each isotope and identify the element.

_____

_____

_____

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Question 27 (4 marks)

Iron has two main isotopes we are interested in, Fe-54 and Fe-56.

a. Determine the percentage abundance of each isotope. (2 marks)

_____

_____

_____

b. Would this change if we were looking at Fe^{2+} or Fe^{3+}? Explain. (2 marks)

_____

_____

Question 28 (8 marks)

The relative atomic mass of an element Q is 10.81. It has two isotopes, Q-10 and Q-11.

a. Calculate the percentage abundances of each isotope. (2 marks)

_____

_____

_____

b. Identify the element identity of element Q. (1 mark)

_____

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c. In the case of two isotopes that exist for the element Q, explain why we only need the abundance of one of the isotopes and not the other. (2 marks)

_____

_____

_____

d. What would you need to calculate the abundances of a compound with three main isotopes? (2 marks)

_____

_____

_____

_____

e. What is the isotopic symbol for the less abundant isotope? (1 mark)

_____

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Sub-Section [2.2.5]: Apply Mass Spectrum Readings To RAM & Amp; Relative Isotopic Abundance Calculations

Question 29 (2 marks)

Find the relative atomic mass of Copper below.
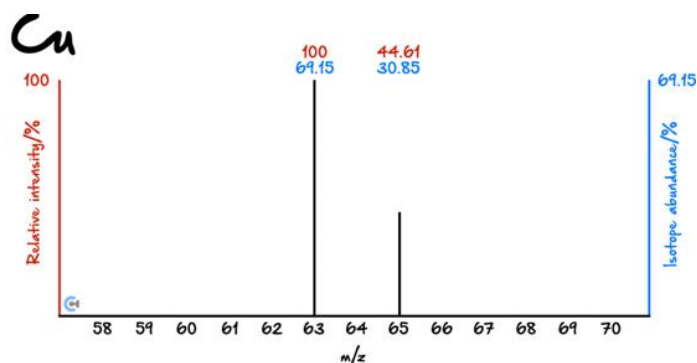
Question 30 (2 marks)

Find the relative atomic mass for Nickel given the following mass.

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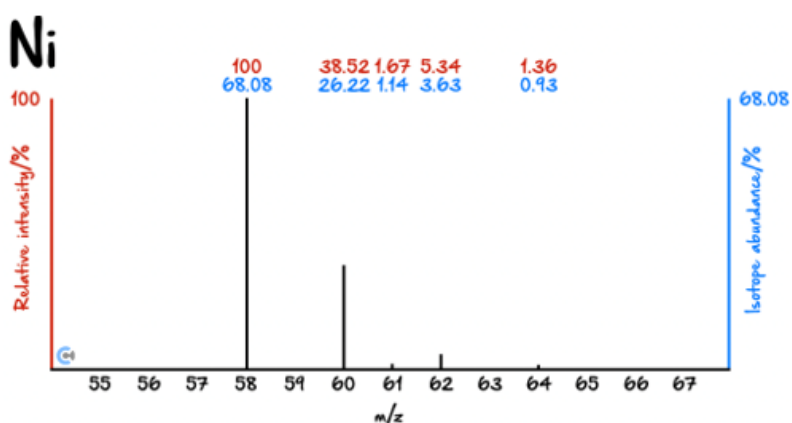
Question 31 (3 marks)

The mass spectrum of Palladium is shown below. Determine the relative atomic mass of Palladium.
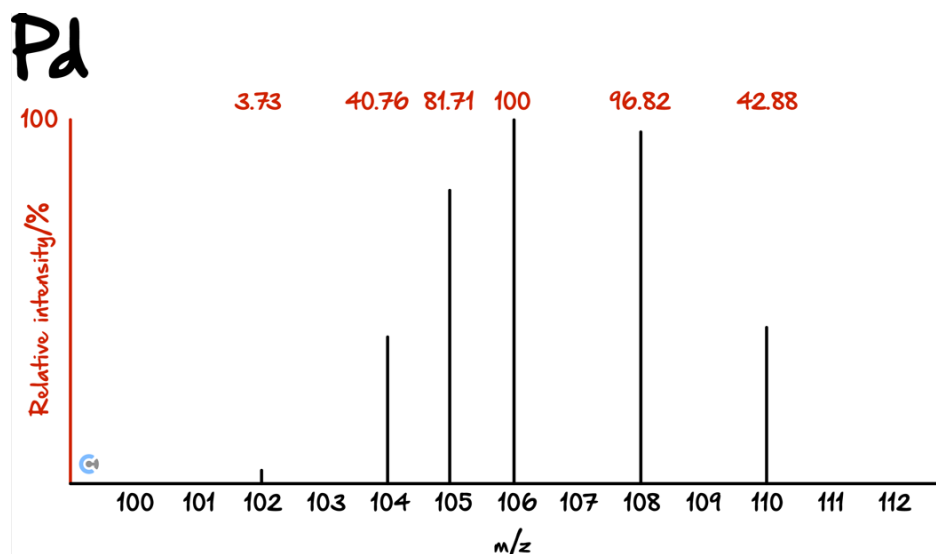
Question 32 (7 marks)

Given the following mass spectrum.

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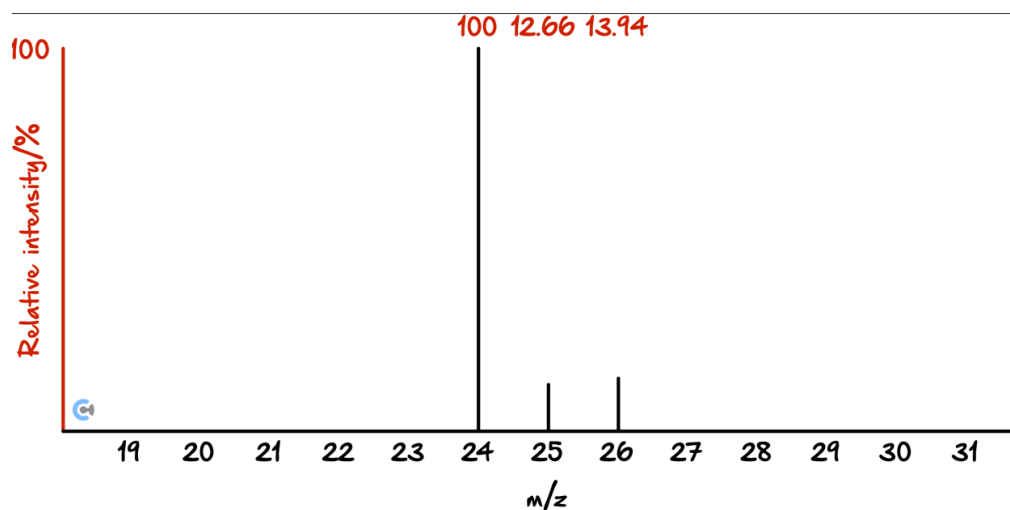
a. Determine the relative atomic mass. (2 marks)

_____

_____

_____

_____

b. What is the compound most likely going to be? (1 mark)

_____

_____

c. Does it matter if the relative intensity of all recorded isotopes is above 100%? (2 marks)

_____

_____

_____

_____

d. Would you expect the result of a mass spectrum from Mg to be different from Mg^{2+}? (2 marks)

_____

_____

_____

_____

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Section C: [2.3] – Stoichiometry (79 Marks)

Sub-Section [2.3.1]: Write Balanced Chemical Equations, Including Combustion

Question 33 (1 mark)

Balance the equation where CH_4 reacts with oxygen gas to form carbon dioxide and water.

_____

Question 34 (4 marks)

Balance the following equations:

a. $KClO_3 \rightarrow KCl + O_2$. (1 mark)

_____

b. $CH_3OH + O_2 \rightarrow H_2O + CO_2$. (1 mark)

_____

c. $Ca(OH)_2 + HCl \rightarrow CaCl_2 + H_2O$. (1 mark)

_____

d. $AgCl + Mg(NO_3)_2 \rightarrow MgCl_2 + AgNO_3$. (1 mark)

_____

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Question 35 (4 marks)

Balance the following combustion equations:

a. Ethanol's complete combustion. (2 marks)

_____

b. Decane's complete combustion. (2 marks)

_____

Question 36 (7 marks)

Consider the combustion equation of butanol.

a. Write the balanced equation, assuming that CO_2 and H_2O is produced. (2 marks)

_____

b. Now, consider when CO and H_2O is produced. (1 mark)

_____

c. Why is it suggested that we balance carbon last in a chemical equation generally? (2 marks)

_____

_____

_____

_____

d. A student argues that we can have more matter at the end of a reaction as we are inputting energy into the reaction system, as a combustion reaction usually results in our fuel disappearing over time. Evaluate this statement. (2 marks)
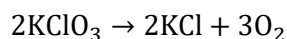
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Sub-Section [2.3.2]: Apply Stoichiometry to Find the Amount of Another Substance Used / Produced

Question 37 (2 marks)

Given the equation:

$$2KClO_3 \rightarrow 2KCl + 3O_2$$

If 5.50 moles of $KClO_3$ reacts, then how much oxygen gas would be produced, in moles?

_____

_____

Question 38 (4 marks)

Given the following equation:

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$
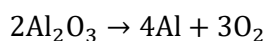
a. If 7.00 g of Al_2O_3 decomposes, how many grams of O_2 gas would be produced? (2 marks)

_____

_____

_____

b. If 3.00 g of oxygen gas was produced how much Al_2O_3 would've been needed, in grams? (2 marks)

_____

_____

_____

Question 39 (4 marks)

Given the combustion of 8.49 g of propanol, C_3H_7OH, calculate the total mass of gases released, assuming the reaction occurred at 120℃.

_____

_____

_____

_____

_____

Question 40 (9 marks)

Consider the following chemical equation:

$$H_3PO_4 + KOH \rightarrow K_3PO_4 + H_2O$$
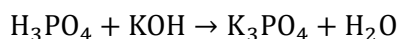
a. Balance the above equation as it is currently unbalanced. (1 mark)

_____

b. If 665.42 g of phosphoric acid (H_3PO_4) reacted, how many moles of water were produced? (2 marks)

_____

_____

_____

c. Consider if 8.15 mol of K_3PO_4 was produced.

   i. How many moles of phosphoric acid were used up? (2 marks)

   _____

   ii. How much water was also produced? (2 marks)

   _____

   iii. What is the mass of KOH required to get this amount of K_3PO_4? (2 marks)
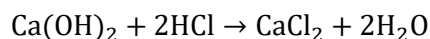
   _____

   _____

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Sub-Section [2.3.3]: Identify the Limiting Reagent When Reactants' Amounts are Known

Question 41 (2 marks)

Consider the reaction:

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

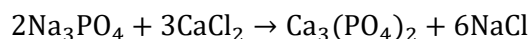There are 13.00 g of $Ca(OH)_2$ and 5.00 g of HCl, determine what the limiting and excess reagents are.

_____

_____

_____

Question 42 (4 marks)

9.55 g of Na_3PO_4 and 7.31 g of $CaCl_2$ are mixed and allowed to react according to this equation:

$$2Na_3PO_4 + 3CaCl_2 \rightarrow Ca_3(PO_4)_2 + 6NaCl$$

a. Which reactant is the limiting reagent? Which reactant is in excess? (2 marks)

_____

_____

_____

_____

b. What is the mass of $Ca_3(PO_4)_2$ that is formed? (2 marks)

_____

_____

_____

Question 43 (6 marks)

Consider the following reaction:

$$N_2 + 3H_2 \rightarrow 2NH_3$$
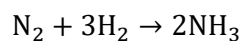
There are $14.00\ g$ of N_2 and $4.00\ g$ of H_2.

a. What are the limiting and excess reagents? (2 marks)

_____

_____

_____

_____

b. Find the mass of NH_3 formed. (2 marks)

_____

_____

_____

c. In another experiment, if $25.5\ g$ of NH_3 was formed, how much H_2 was used initially in grams? (2 marks)

_____

_____

_____

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Question 44 (9 marks)

Consider the combustion reaction of pentane at 200°C.

a. Write the fully balanced reaction. (1 mark)

_____

b. Consider an experiment where we had 44.00 g of pentane and 160.00 g of oxygen gas.

    i. What are the limiting and excess reagents? (2 marks)

_____

_____

_____

    Pentane is the limiting reagent and oxygen gas is the excess.

    ii. What is the mass of gases formed? (2 marks)

_____

_____

_____

_____

    iii. Is this the same as the total mass of gases left over at the end of the reaction? (2 marks)

_____

_____

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c. In another experiment, if 88.00 g of CO_2 was formed, how much O_2 was used initially in grams? (2 marks)
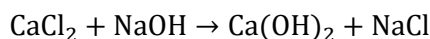
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Sub-Section [2.3.4]: Apply Limiting Reagent to Calculate the Mass of Product(s) Formed, & the Amount of Excess Reagent Leftover

Question 45 (3 marks)

Given the following reaction:

$$CaCl_2 + NaOH \rightarrow Ca(OH)_2 + NaCl$$

a. Balance the equation. (1 mark)

_____

b. A sample of 5.00 moles of $CaCl_2$ and 5.00 moles of NaOH reacts. What is the amount of $CaCl_2$ that would be leftover? (2 marks)

_____

_____

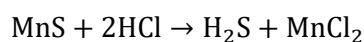**Question 46** (4 marks)

An experiment is conducted according to the following equation:

$$MnS + 2HCl \rightarrow H_2S + MnCl_2$$

If a sample contained 50.00 g of MnS and 26.00 g of HCl, determine the excess and limiting reagent. (2 marks

a. Which is the excess and limiting reagent? (2 marks)

_____

_____

_____

_____

b. What is the amount leftover of the reactants? (2 marks)

_____

_____

_____

Question 47 (7 marks)

Given the following reaction:

$$3Na_2CO_3(s) + 2HCl(aq) \rightarrow 6NaCl(aq) + 3CO_2(g) + H_2O(l)$$
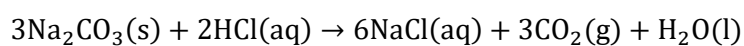
a. Given that there was 9.40 g of sodium carbonate and 8.90 g of hydrogen chloride, find the limiting and excess reagents. (3 marks)

_____

_____

_____

_____

_____

Therefore, the sodium carbonate is limiting, and hydrogen chloride is excess.

b. Find the mass of NaCl and CO_2 that will be produced. (2 marks)

_____

_____

_____

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c. What is the mass of the excess reagent left over? (2 marks)

_____

_____

_____

Question 48 (9 marks)

Given the following reaction:

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$
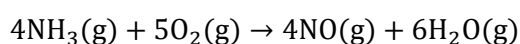
a. Given that there was 5.03 g of NH_3 and 3.45 g of O_2, find the limiting and excess reagents. (2 marks)

_____

_____

_____

_____

b. After the reaction is completed, some of the excess reagent remains.

    i. Find the amount of excess reagent that is left over. (2 marks)

    _____

    _____

    _____

    ii. Find the mass of the excess reagent that is left over. (1 mark)

    _____

    _____

iii. Find the mass of gases produced. (2 marks)

_____

_____

c. What is the amount, in grams, of the current limiting reagent we need to add to turn the reaction into one where the reactants fully react? (2 marks)

_____

_____

_____

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Section D: [2.1-2.3] Overall (VCAA Qs) (60 Marks)

Question 49 (3 marks)

Find the number of particles in the following:

a. In 2 moles of O_2, find the number of oxygen atoms. (1 mark)

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_____

b. In 4 moles of $CaCl_2$, find the number of chloride ions. (1 mark)

_____

_____

c. If there are 9.03×10^{24} particles of fluorine atoms in a sample of F_2 gas, find the number of moles of F_2. (1 mark)

_____

_____

Question 50 (5 marks)

For the following samples, calculate the amount required.

a. Given that there is $5.0\ g$ of CO_2, calculate the moles present. (1 mark)

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_____

_____

b. Given that there is 14.6 g of NH_3, calculate the moles of ammonia. (1 mark)

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_____

_____

c. Given that there are 1.50 moles of $CaCl_2$, calculate the mass present. (1 mark)

_____

_____

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d. Given that there are 3.00 moles of K_2SO_4, calculate the mass present. (1 mark)

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e. Given that there is 4.56×10^{-3} mol Na_2CO_3, calculate the mass present. (1 mark)

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Question 51 (2 marks)

Neon has three naturally occurring isotopes: Ne-20, Ne-21, Ne-22. Their relative abundances are 90.48%, 0.27%, and 9.25% respectively. Calculate the relative atomic mass of neon.

_____

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Question 52 (2 marks)

The relative atomic mass of an element Y is 10.81. It has two isotopes: Y-10 and Y-11. Determine the percentage abundance of each isotope.

_____

_____

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Question 53 (4 marks)

For the following, find the percentage composition of all the elements in the compound.

a. $Mg_3(PO_4)_2$. (2 marks)

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b. $Ca(NO_3)_2$. (2 marks)

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Question 54 (4 marks)

The following reaction occurred in an experiment:

$$FeCl_3 \ + \ 3NaOH \ \rightarrow \ Fe(OH)_3 \ + \ 3NaCl$$
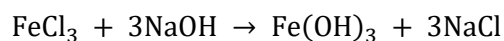
There are 1.80 _grams_ of $FeCl_3$ and 4.20 grams of NaOH.

a. What are the limiting and excess reagents? (2 marks)

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_____

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b. Find the mass of NaCl and $Fe(OH)_3$ formed. (2 marks)

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Question 55 (5 marks)

Consider the compound, ammonium sulphate, $(NH_4)_2SO_4$.

a. What is its molar mass? (1 mark)

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_____

b. Given that a sample contains $4.28 \times 10^{-3}\ kg$, what is the number of moles present in ammonium sulphate? (2 marks)

_____

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c. Now, based on your answer, find the mass of nitrogen in the sample, expressed in micrograms. (2 marks)

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Question 56 (5 marks)

Consider the compound of $Ca(NO_3)_3$.

a. What is the molar mass? (1 mark)

_____

b. Given that a sample contains $6.240 \times 10^{-4} \ kg$, what is the number of moles present in the compound? (2 marks)

_____

_____

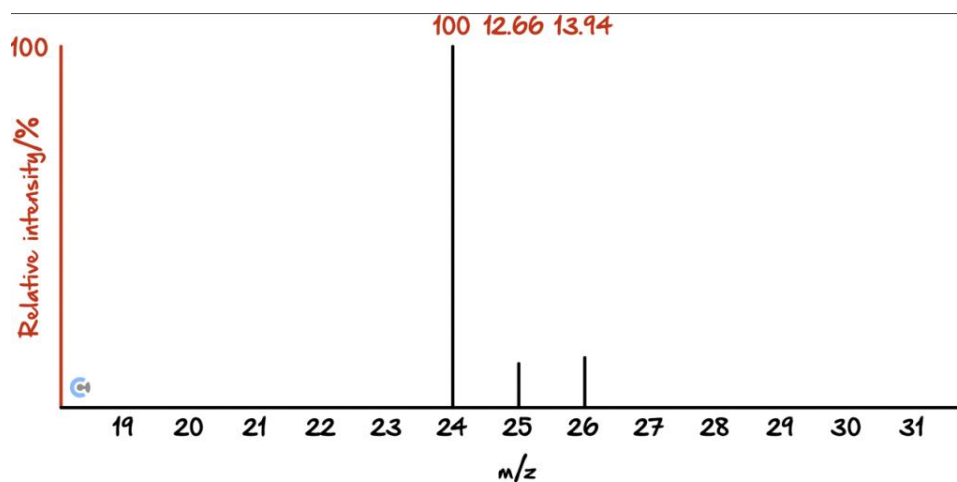**c.** Based on your answer, find the atoms of oxygen in the sample. (2 marks)

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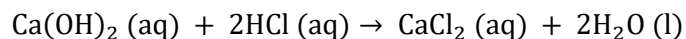
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Question 57 (3 marks)

Find the relative atomic mass given the following mass spectrum and identify the compound.

Question 58 (7 marks)

Consider the reaction:

$$Ca(OH)_2 \text{ (aq)} + 2HCl \text{ (aq)} \rightarrow CaCl_2 \text{ (aq)} + 2H_2O \text{ (l)}$$

a. If there are 2.78 g of $Ca(OH)_2$ and 3.65 g of HCl, find the limiting reagent. (3 marks)

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b. What mass of the excess reagent will be left over? (2 marks)

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c. If 9.88 g of $CaCl_2$ was produced, what is the mass of $Ca(OH)_2$ required to produce this, assuming the reaction is 100% efficient? (2 marks)

_____

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Question 59 (10 marks)

Consider an experiment where the aim is to experimentally determine Avogadro's number using a sample of aluminium sulphate, $Al_2(SO_4)_3$.

a. What is the molar mass of aluminium sulphate? (1 mark)

_____

b. Calculate the number of moles of aluminium sulphate in a 52 mg sample. (2 marks)

_____

_____

_____

c. Given that the sample we know has 2.508×10^{20} atoms of sulphur, calculate the experimental value of Avogadro's number. (3 marks)

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d. Explain whether this experimental value is accurate. (2 marks)

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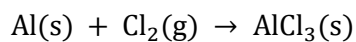e. Briefly explain why Avogadro's number has the units it does. (2 marks)

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Question 60 (10 marks)

Given the following reaction:

$$Al(s) \ + \ Cl_2(g) \ \rightarrow \ AlCl_3(s)$$

a. Balance the reaction. (1 mark)

_____

b. If 5.40 g of aluminium is reacted, how much aluminium chloride would be produced? (2 marks)

_____

_____

_____

c. If there is 5.40 g of Al and 9.48 g of Cl_2, which is the limiting and excess reagent? (3 marks)

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d. Find the mass of $AlCl_3$ produced. (2 marks)

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e. How much of the excess reagent, in kg, is left at the end of the reaction? (2 marks)

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