



CHEM · CHEMISTRY

01. Stoichiometry

Official PMDC Solved Past Paper Topical Booklet · High-Yield Examination Series

© 105 Solved Questions

📅 2010 to 2024 Archive

🛡 Boards: BUMHS, DUHS, KMU, MDCAT, NUMS, PMDC

📖 Weightage: 27% of MDCAT (54 MCQs)

Curated by Ibrahim for fellow bees. Every question in this chapter has been verified against official UHS, NUMS, SZABMU, DUHS, and KMU answer keys. Propolis cognitive autopsies are provided at the end of this booklet to explain core concepts and break down common distractor traps.

OFFICIAL SOLVED EDITION**Q1.**

UHS 2024

The type and relative amount of each isotope in an element can be found by (out of syllabus) [UHS 2024]

- (A) R spectroscopy
- (B) U.V spectroscopy
- (C) Mass spectroscopy
- (D) N.M.R

Q2.

UHS 2024

The atomic masses of element depend upon: [UHS 2024]

- (A) Atomic number
- (B) Number of electrons
- (C) Number of isotopes & their abundance
- (D) None of the above

Q3.

UHS 2024

Number of moles in an element is directly proportional to [UHS 2024]

- (A) Mass of an element
- (B) Empirical formula mass
- (C) Molar mass of an element
- (D) Formula mass

Q4.

SZABMU 2024

How many moles of oxygen gas are needed for combustion of 2 moles of propane? [SZABMU 2024]

- (A) 8
- (B) 10
- (C) 12
- (D) 14

Q5.

SZABMU 2024

If percentage yield of chemical reaction is 60%, actual yield is 15g, what is its theoretical yield? [SZABMU 2024]

- (A) 18g
- (B) 20g
- (C) 25g
- (D) 30g

Q6.

SZABMU 2024

What will be the number of atoms in 2 moles of water molecule? [SZABMU 2024]

- (A) 6.02×10^{23}
- (B) 1.24×10^{24}
- (C) 1.92×10^{24}
- (D) 3.61×10^{24}

Q7.

SZABMU 2024

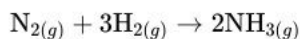
What will be mole ratio of Al to O₂ after balancing equation given below?

**[SZABMU 2024]**

- (A) 1:1
- (B) 2:3
- (C) 3:4
- (D) 4:3

Q8.

SZABMU 2024



How many moles of N_2 required to manufacture 8 moles of NH_3 ? [SZABMU-RC 2024]

- (A) 2.5 moles
- (B) 4 moles
- (C) 3.5 moles
- (D) 5 moles

Q9.

SZABMU 2024

1g H_2 has [SZABMU-RC 2024]

- (A) 1 mol
- (B) 2 moles
- (C) 0.5 moles
- (D) 0.25 moles

Q10.

SZABMU 2024

Percentage composition by mass in CO_2 is [SZABMU-RC 2024]

- (A) 30% Carbon & 70% Oxygen
- (B) 25% Carbon & 75% Oxygen
- (C) 27.27% Carbon & 72.72% Oxygen
- (D) 40% Carbon & 60% Oxygen

Q11.

KMU 2024

The volume occupied by 3.2 g of oxygen gas at S.T.P is: [ETEA 2024]

- (A) 1.12 dm³
- (B) 2.24 dm³
- (C) 22.4 dm³
- (D) 24 dm³

Q12.

KMU 2024

Which of the following elements cannot be detected directly in a given organic compound? [ETEA 2024]

- (A) Chlorine
- (B) Nitrogen
- (C) Oxygen
- (D) Phosphorous

Q13.

KMU 2024

How many moles are there in 240g of sodium hydroxide (NaOH)? [ETEA 2024]

- (A) 2
- (B) 4
- (C) 6
- (D) 8

Q14.

KMU 2024

Heating 24.8g of copper carbonate (CuCO_3) in a crucible produced only 13.9g of copper oxide (CuO). What is the percentage yield of copper oxide? [ETEA 2024]

- (A) 81.79%
- (B) 83.98%
- (C) 86.87%
- (D) 89.68%

Q15.

KMU 2024

Efficiency of chemical reaction can be checked by calculating _ [ETEA 2024]

- (A) Actual yield
- (B) Theoretical yield
- (C) Percentage yield
- (D) Amount of the reactant unused

Q16.

KMU 2024

Actual yield will reach the ideal (theoretical) value if the % yield of the reaction is, [ETEA 2024]

- (A) 10%
- (B) 50%
- (C) 90%
- (D) 100%

Q17.

KMU 2024

What is the mass of 1 mole of calcium carbonate (CaCO_3)? [ETEA 2024]

- (A) 50g
- (B) 70g
- (C) 100g
- (D) 125g

Q18.

KMU 2024

How many grams of CO_2 can be produced by thermally decomposing 10 moles of ZnCO_3 ? [ETEA 2024]

- (A) 320
- (B) 360
- (C) 400
- (D) 440

Q19.

KMU 2024

How many moles of NaCl are produced from 16.5g of HCl, according to the neutralization reaction? [ETEA 2024]

- (A) 0.252
- (B) 0.452
- (C) 0.652
- (D) 0.852

Q20.

KMU 2024

What mass of aluminium oxide (Al_2O_3) is produced from 18.5g of Al metal, when it reacts completely with oxygen gas according to the following equation? [ETEA 2024]

- (A) 30.8g
- (B) 32.6g
- (C) 34.9g
- (D) 36.5g

Q21.

DUHS 2024

Stoichiometry is the study of _____ relationship between reactant and products in a chemical reaction by using a balanced chemical equation [DUHS 2024]

- (A) Quantitative
- (B) Qualitative
- (C) Chemical
- (D) Descriptive

Q22.

BUMHS 2024

Isotopes differ from each other on the basis of [BMU 2024]

- (A) Number of electrons
- (B) Mass number
- (C) Electronic configuration
- (D) Crystal lattice

Q23.

BUMHS 2024

In a chemical reaction, a limiting reactant is that [BMU 2024]

- (A) Which is present in excess
- (B) Which is not in excess
- (C) Which acts as catalyst
- (D) Which is not taking part in the reaction but its presence is helpful in completion of the reaction

Q24.

BUMHS 2024

Carbon atom is used to measure relative [BMU 2024]

- (A) Atomic size
- (B) Atomic number
- (C) Atomic mass
- (D) Atomic volume

Q25.

UHS 2023

A compound of phosphorus oxide has 43.6% of Oxygen. Its empirical formula is? [UHS 2023]

- (A) P_2O_5
- (B) P_2O_3
- (C) P_3O_2
- (D) PO_2

Q26.

UHS 2023

Which element is used as standard to determine atomic mass of an element? [UHS 2023]

- (A) H
- (B) C
- (C) P
- (D) Cl

Q27.

UHS 2023

The average weight of atoms of an element compared to the weight of one atom of _____ is called atomic weight. [UHS 2023]

- (A) Carbon
- (B) Helium
- (C) Hydrogen
- (D) Nitrogen

Q28.

UHS 2023

The same moles of H_2 , N_2 and O_2 are present in 0.1 cc volume at STP. Which one gas has greatest number of molecules: [UHS 2023]

- (A) N_2
- (B) H_2
- (C) O_2
- (D) Number of molecules are equal

Q29.

SZABMU 2023

Number of H_2O molecules in 10 g of ice are [SZABMU 2023]

- (A) 3.34×10^{23}
- (B) 0.34×10^{23}
- (C) 33.1×10^{23}
- (D) 10

Q30.

SZABMU 2023

The efficiency of chemical reaction can be expressed as [SZABMU 2023]

- (A) Theoretical yield
- (B) Actual yield
- (C) Percent yield
- (D) Maximum yield

Q31.

SZABMU 2023

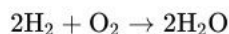
1 mol of any substance contains ____ particles [SZABMU 2023]

- (A) 6.02×10^{23}
- (B) 6.02×10^{24}
- (C) 6.02×10^{22}
- (D) 3.01×10^{23}

Q32.

KMU 2023

Consider the reaction below, if 5 moles each of hydrogen and oxygen are reacted to form water, the reaction reveals: [ETEA 2023]

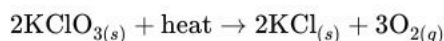


- (A) H_2 is excess reagent
- (B) O_2 is limiting reagent
- (C) H_2 is limiting reagent
- (D) Reaction has no limiting reagent

Q33.

KMU 2023

Oxygen can be prepared by the decomposition of potassium chlorate (KClO_3). How many moles of oxygen $\text{O}_{2(g)}$ can be formed by taking 12 moles of potassium chlorate (KClO_3) according to the following equation? [ETEA 2023]



- (A) 12 moles of oxygen
- (B) 15 moles of oxygen
- (C) 18 moles of oxygen
- (D) 21 moles of oxygen

Q34.

KMU 2023

117g of NaCl have [ETEA 2023]

- (A) 1.204×10^{24} formula units of NaCl
- (B) 12.04×10^{22} formula units of NaCl
- (C) 1.204×10^{23} formula units of NaCl
- (D) 6023×10^{23} formula units of NaCl

Q35.

DUHS 2023

Which of the following is different in Na^+ ($Z=11$), Mg^{+2} ($Z=12$) and Al^{+3} ($Z=13$)? [DUHS 2023]

- (A) Number of shells
- (B) Number of electrons
- (C) Electronic configuration
- (D) Number of protons

Q36.

DUHS 2023

What volume of oxygen at S.T.P required to burn 500 dm^3 of ethene? [DUHS 2023]

- (A) 500 dm^3
- (B) 1000 dm^3
- (C) 1500 dm^3
- (D) 2000 dm^3

Q37.

DUHS 2023

Ca ($Z=20$) forms ionic bond with ($Z=17$)? What is the chemical formula of calcium chloride? [DUHS 2023]

- (A) CaCl
- (B) CaCl_2
- (C) Ca_2Cl
- (D) Ca_2Cl_2

Q38.

DUHS 2023

An organic compound has C=40%, H=6.67% and O=53.3%. What is the empirical formula of the compound? [DUHS 2023]

- (A) CH_3O
- (B) $\text{C}_2\text{H}_3\text{O}$
- (C) CH_2O
- (D) $\text{C}_2\text{H}_2\text{O}$

Q39.

DUHS 2023

7.6 grams of CS_2 is reacted with 12.8g of O_2 , $\text{CS}_2 + 3\text{O}_2 \rightarrow \text{CO}_2 + 2\text{SO}_2$, limiting reactant is: [DUHS 2023]

- (A) CS_2
- (B) O_2
- (C) CO_2
- (D) SO_2

Q40.

BUMHS 2023

Which one is incorrect for actual yield is less than theoretical yield due to: [BUMHS 2023]

- (A) Mechanical losses
- (B) Reversibility of reaction
- (C) All molecules do not possess activation energy
- (D) Substance is pure

Q41.

BUMHS 2023

What is the weight of oxygen that is required for the complete combustion of 3.2 kg of methane? [BUMHS 2023]

- (A) 3.2 kg
- (B) 6.4 kg
- (C) 12.8 kg
- (D) 15.4 kg

Q42.

BUMHS 2023

How many moles of a gas occupy 30.57 L at 55°C and 0.83 atm? [BUMHS 2023]

- (A) 0.1 mol
- (B) 0.62 mol
- (C) 0.84 mol
- (D) 0.94 mol

Q43.

BUMHS 2023

When equal moles of reactants A and B are allowed to react according to the following balanced equation ($2A + B \rightarrow \text{Product}$). The limiting reactant in this chemical equation will be? [BUMHS 2023]

- (A) Reactant A
- (B) Reactant B
- (C) Reactant A and B
- (D) No limiting reactant

Q44.

NUMS 2023

What is the mass of sulphur in 24.5 g of H_2SO_4 ? [NUMS 2023]

- (A) 32 g
- (B) 24 g
- (C) 16 g
- (D) 8 g

Q45.

NUMS 2023

From the equation ($\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$), How many moles of NH_3 are produced from 2.5 moles of N_2 ? [NUMS 2023]

- (A) 2.5 moles
- (B) 2 moles
- (C) 5 moles
- (D) 7.5 moles

Q46.

UHS 2022

One a.m.u stands for: [UHS 2022]

- (A) An atom of C-12
- (B) $1/12$ th of H
- (C) $1/12$ th of a carbon
- (D) 1 atom of all the elements

Q47.

UHS 2022

A compound of sodium oxide has 74.2% sodium and 25.8% of oxygen. The empirical formula of the compound is? [UHS 2022]

- (A) NaO
- (B) Na_2O
- (C) NaO_2
- (D) Na_2O_2

Q48.

UHS 2022

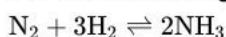
30g of 2-propanol were mixed with excess acidified $\text{K}_2\text{Cr}_2\text{O}_7$ and boiled under reflux for 20 minutes. The organic product was then collected by distillation. The yield of product was 75.0%. What is the mass of product produced? [UHS 2022]

- (A) 1.74g
- (B) 2.74g
- (C) 21.75g
- (D) 29g

Q49.

SZABMU 2022

For the reaction given below



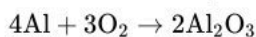
How many moles N_2 are required for synthesis of 4 moles of NH_3 ? [SZABMU 2022]

- (A) 4 moles of N_2
- (B) 2 moles of N_2
- (C) 3 moles of N_2
- (D) 4.5 moles

Q50.

SZABMU 2022

Al reacts with O_2 according to following reaction



27 g of Al will react with how much of O_2 ? [SZABMU 2022]

- (A) 8 g
- (B) 16 g
- (C) 24 g
- (D) 32 g

Q51.

SZABMU 2022

One mole of a substance is the amount of that substance that has the same number of particles (atom, ions or molecules) as there are atoms in exactly: [SZABMU 2022]

- (A) 1.008g of hydrogen gas (H_2)
- (B) 16 g of oxygen gas (O_2)
- (C) 12 g of carbon -12 isotopes
- (D) 12 g of magnesium

Q52.

KMU 2022

Which of the following contains the same number of molecules as 22 gram of carbon dioxide? [ETEA 2022]

- (A) 9 g of water
- (B) 2 g of hydrogen gas
- (C) 32 g of oxygen gas
- (D) 71 g of chlorine gas

Q53.

KMU 2022

Molecular mass of the compound is 60 and its empirical formula is CH_2O . What will be the molecular formula of the compound? [ETEA 2022]

- (A) $C_6H_{11}O_4$
- (B) $C_2H_4O_2$
- (C) $C_2H_6O_2$
- (D) $C_3H_4O_2$

Q54.

KMU 2022

The amount of products that is actually produced during a chemical reaction by performing experiment is called. [ETEA 2022]

- (A) Mole
- (B) Actual yield
- (C) Theoretical yield
- (D) Percent yield

Q55.

DUHS 2022

3.0 g of C on combustion gives $C + O_2 \rightarrow CO_2$: [DUHS 2022]

- (A) 5.5 g of CO_2
- (B) 22 g of CO_2
- (C) 6.02×10^{23} molecules of CO_2
- (D) 1.505×10^{23} molecules of CO_2

Q56.

DUHS 2022

Ratio of atomic mass of hydrogen to atomic mass of C is: [DUHS 2022]

- (A) One fourth
- (B) One twelfth
- (C) Half
- (D) Double

Q57.

BUMHS 2022

Which of the following statement is correct about the Avogadro's constant? [BMU 2022]

- (A) It is the mass of one mole of any element
- (B) It is the mass of 6.023×10^{23} atoms of any element
- (C) It is the number of atoms in one mole of an element
- (D) It is the number atoms in 12 g of any element.

Q58.

BUMHS 2022

The atomic weight of an elements is represented by ____: [BMU 2022]

- (A) a.m.u
- (B) Grams
- (C) Kg
- (D) Mole

Q59.

BUMHS 2022

One of the reactants consumed earlier than others in a chemical reaction is called: [BMU 2022]

- (A) Active reactant
- (B) Excess reactant
- (C) Limiting reactant
- (D) More active reactant

Q60.

NUMS 2022

One mole of ethanol and one mole of ethane have an equal: [NUMS 2022]

- (A) Mass
- (B) Number of electrons
- (C) Number of atoms
- (D) Number of molecules

Q61.

NUMS 2022

The 1st step involved in the determination of Empirical formula of chemical compound is: [NUMS 2022]

- (A) Finding number of gram atoms of each element
- (B) Percentage composition of each element
- (C) Atomic ratio of each element
- (D) Multiplication of atomic ratio with whole number

Q62.

NUMS 2022

The number of moles of CO_2 which contains 16 g of oxygen is: [NUMS 2022]

- (A) 0.25
- (B) 1.00
- (C) 0.5
- (D) 1.50

Q63.

NUMS 2022

Percentage composition of mass in CO_2 is: [NUMS 2022]

- (A) 30.45% Carbon & 69.54% Oxygen
- (B) 24.22% Carbon & 75.78% Oxygen
- (C) 27.27% Carbon & 72.72% Oxygen
- (D) 41.68% Carbon & 58.12% Oxygen

Q64.

PMDC 2021

1 amu is equal to: [PMC 2021]

- (A) $0.666 \times 10^{-27} \text{kg}$
- (B) $1.661 \times 10^{28} \text{kg}$
- (C) $1.661 \times 10^{-27} \text{kg}$
- (D) $1.661 \times 10^{-24} \text{kg}$

Q65.

PMDC 2021

Number of single covalent bonds in water molecule are: [PMC 2021]

- (A) 1
- (B) 2
- (C) 3
- (D) 4

Q66.

PMDC 2021

NH_3 can be called: [PMC 2021]

- (A) Molecule of atoms
- (B) Molecule of element
- (C) Molecule of compound
- (D) Molecule of ion

Q67.

PMDC 2021

Chemical equations do not tell about the _____ because of certain limitations. [PMC 2021]

- (A) Rate of reaction
- (B) Conditions
- (C) Pressure
- (D) All of these

Q68.

PMDC 2020

The efficiency of a chemical reaction can be expressed as: [NMDCAT 2020]

- (A) Theoretical yield
- (B) Actual yield
- (C) % yield
- (D) Maximum yield

Q69.

PMDC 2020

In a vessel, 10 g N_2 , 10 g H_2 and 10 g O_2 are present. Which one will have least number of atoms? [NMDCAT 2020]

- (A) H_2
- (B) N_2
- (C) O_2
- (D) Both A & B

Q70.

PMDC 2020

The empirical formula of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) is: [NMDCAT 2020]

- (A) $\text{C}_6\text{H}_{12}\text{O}_6$
- (B) CHO
- (C) CH_2O
- (D) CH_2O_2

Q71.

MDCAT 2019

The average atomic mass of Boron is 10.8. It has two isotopes of masses 10 and 11 respectively. What is the percentage of isotope with the average mass of 10? [MDCAT 2019]

- (A) 80%
- (B) 60%
- (C) 50%
- (D) 20%

Q72.

MDCAT 2019

Which two elements are isotopes? [MDCAT 2019]

- (A) ${}^1_6\text{X}$ and ${}^{12}_7\text{Y}$
- (B) ${}^{16}_8\text{X}$ and ${}^{16}_8\text{Y}$
- (C) ${}^{18}_9\text{X}$ and ${}^{20}_{10}\text{Y}$
- (D) ${}^{14}_6\text{X}$ and ${}^{15}_6\text{Y}$

Q73.

NUMS 2019

The best standard for the calculation of relative atomic mass [NUMS 2019]

- (A) H-1.008
- (B) Carbon -12
- (C) Carbon-13
- (D) Oxygen -16

Q74.

SET 2019

A piece of diamond embedded in a gold ring weighs 6.0 gram. How many numbers of moles of Carbon does it contain? [SET 2019]

- (A) 6.0 mole
- (B) 0.5 mole
- (C) 1.0 mole
- (D) 1.5 mole

Q75.

SET 2019

Iron is manufactured industrially in Blast furnace using Hematite (an ore of iron) and a reducing agent Carbon monoxide. $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$. Calculate the mass of iron ore used to manufacture 56g of iron with excess carbon monoxide. Assume that the process gives 100% yield. [SET 2019]

- (A) 160g
- (B) 112g
- (C) 280g
- (D) 80g

Q76.

MDCAT 2019

How many moles of calcium carbonate are present in 1.75 kg of calcium carbonate? (Ar of Ca = 40, Ar of C = 12, Ar of O=16) [MDCAT 2019]

- (A) 0.0175 mol
- (B) 1.75 mol
- (C) 17.5 mol
- (D) 1750 mol

Q77.

SET 2019

According to law of definite proportion, what is the mass ratio of hydrogen and oxygen in water? [SET 2019]

- (A) Hydrogen is 11.11% and oxygen is 88.89%
- (B) Hydrogen is 10.11% and oxygen is 89.89%
- (C) Hydrogen is 20% and oxygen is 80%
- (D) Hydrogen is 30% and oxygen is 70%

Q78.

KMU 2019

Which contains more atoms? [ETEA 2019]

- (A) 7 gram Mg
- (B) 8 gram Na
- (C) 9 gram Al
- (D) All same

Q79.

KMU 2019

Which contains highest percentage of nitrogen? [ETEA 2019]

- (A) NO
- (B) NO₂
- (C) N₂O
- (D) N₂O₅

Q80.

KMU 2019

A mixture of 10cm³ of oxygen and 50cm³ of hydrogen is sparked continuously. What is the maximum theoretical decrease in volume? [ETEA 2019]

- (A) 10cm³
- (B) 15cm³
- (C) 20cm³
- (D) 30cm³

Q81.

MDCAT 2019

The number of moles of water in 1Kg ice are: [MDCAT 2019]

- (A) 50 moles
- (B) 1000 moles
- (C) 55.5 moles
- (D) 100 moles

Q82.

MDCAT 2019

During stoichiometric calculations, which of the following laws must be followed? [MDCAT 2019]

- (A) Law of conservation of mass
- (B) Law of conservation of energy
- (C) Avogadro's law
- (D) Dalton's law

Q83.

MDCAT 2018

While finding the relative atomic mass, which of the following standard is used to compare the atomic mass of chlorine (35.5amu)? [MDCAT 2018]

- (A) Neon-20
- (B) Nucleon number
- (C) Carbon-13
- (D) Carbon -12

Q84.

MDCAT 2018

The formula which shows the simplest whole number ratio for the atoms of different elements in compound? [MDCAT 2018]

- (A) Ionic formula
- (B) Empirical formula
- (C) Structural formula
- (D) Molecular formula

Q85.

MDCAT 2018

3.0 mole of calcium will contain ____ g of calcium. [MDCAT 2018]

- (A) 105gm
- (B) 80gm
- (C) 100gm
- (D) 120gm

Q86.

MDCAT 2017

A researcher has prepared a sample of 1-Bromopropane from 10g of 1-propanol. After purification he had made 12g of product. Which of the following is percentage yield? (The test was reconduted) [MDCAT 2017]

- (A) 60%
- (B) 90%
- (C) 58.5%
- (D) 50%

Q87.

MDCAT 2017

Which one of the followings has same number of molecules as present in 11g of CO_2 ? [MDCAT 2017]

- (A) 4g of O_2
- (B) 4g of O
- (C) 4.5 g of H_2O
- (D) $\frac{1}{4}$ moles of NaCl

Q88.

MDCAT 2017

Choose the correct option regarding number of particles associated with one mole of a substance: [MDCAT 2017]

- (A) 6.03×10^{23}
- (B) 6.02×10^{-23}
- (C) 6.01×10^{-19}
- (D) 6.02×10^{23}

Q89.

MDCAT 2017

Determinate the number of moles of O in 10.6g of NaCO_2 : [MDCAT 2017]

- (A) 0.4 moles
- (B) 0.2 moles
- (C) 0.3 moles
- (D) None of these

Q90.

MDCAT 2017

Calculate the gram of H_2O formed when 8 g of CH_4 burns in excess of oxygen. [MDCAT 2017]

- (A) 21 grams
- (B) 18 grams
- (C) 19 grams
- (D) 15 grams

Q91.

MDCAT 2016

An organic sample consisting of carbon, hydrogen and oxygen was subjected to combustion analysis. 0.5439 g of this compound gave 1.039g carbon dioxide, 0.6369g of water vapors. The empirical formula of this compound is: [MDCAT 2016]

- (A) CH_3O
- (B) $\text{C}_2\text{H}_6\text{O}$
- (C) $\text{C}_4\text{H}_{12}\text{H}_2\text{O}$
- (D) CH_4O

Q92.

MDCAT 2016

The number of moles of CO_2 which contain 8.00g of oxygen is: [MDCAT 2016]

- (A) 0.75
- (B) 0.25
- (C) 1.50
- (D) 1.00

Q93.

KMU 2016

$2\text{XeF}_6 + \text{SiO}_2 \rightarrow 2\text{XeOF}_4 + \text{SiF}_4$. Consider the above chemical reaction. If 122.6g of XeF_6 reacts with 60g of SiO_2 to form the products. Select the limiting reagent and amount of SiF_4 formed ($\text{XeF}_6 = 245.3 \text{ amu}$, $\text{SiO}_2 = 60 \text{ amu}$, $\text{SiF}_4 = 104 \text{ amu}$). [ETEA 2016]

- (A) XeF_6 , 26g
- (B) SiO_2 , 26g
- (C) XeF_6 , 52g
- (D) SiO_2 , 52g

Q94.

KMU 2016

How many oxygen atoms are present in 278g of Hydrated Ferrous Sulphate? ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O} = 278\text{amu}$) [ETEA 2016]

- (A) 6.023×10^{23}
- (B) 6.62×10^{24}
- (C) 2.408×10^{23}
- (D) 6.023×10^{24}

Q95.

KMU 2016

The water formed in the combustion analysis is usually absorbed by: [ETEA 2016]

- (A) $\text{Mg}(\text{NO}_3)_2$
- (B) $\text{Mg}(\text{ClO}_4)_2$
- (C) $\text{Mg}(\text{OH})_2$
- (D) $\text{Mg}(\text{ClO}_2)_2$

Q96.

MDCAT 2015

How many moles of sodium are present in 0.1g of sodium? [MDCAT 2015]

- (A) 4.3×10^{-3}
- (B) 4.01×10^{-2}
- (C) 4.03×10^{-1}
- (D) 4.3×10^{-2}

Q97.

MDCAT 2015

10.0 grams of glucose are dissolved in water to make 100 cm^3 of its solution, its molarity is: [MDCAT 2015]

- (A) 0.55
- (B) 10
- (C) 0.1
- (D) 1

Q98.

MDCAT 2014

A polymer of simplest formula CH_2 has molar mass of 28000 g mol^{-1} . Its molecular formula will be: [MDCAT 2014]

- (A) 100 times that of its empirical formula
- (B) 500 times of its empirical formula
- (C) 200 times that of its empirical formula
- (D) 2000 times that of its empirical formula

Q99.

MDCAT 2014

The number of molecules in 9g of ice (H_2O) is: [MDCAT 2014]

- (A) 6.02×10^{23}
- (B) 6.02×10^{22}
- (C) 3.01×10^{22}
- (D) 3.01×10^{23}

Q100.

MDCAT 2013

Hydrogen burns in chlorine to produce hydrogen chloride. The ratio of masses of reactants in chemical reaction $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$ is: [MDCAT 2013]

- (A) 2 : 35.5
- (B) 1 : 35.5
- (C) 1 : 71
- (D) 2 : 70

Q101.

MDCAT 2012

An organic compound has empirical formula $\text{C}_3\text{H}_3\text{O}$ if molar mass of the compound is 110.15. Molecular formula of this organic compound is: [MDCAT 2012]

(Atomic mass of C = 12, H = 1.008 and O = 16)

- (A) $\text{C}_6\text{H}_6\text{O}_2$
- (B) $\text{C}_8\text{H}_9\text{O}_3$
- (C) $\text{C}_2\text{H}_2\text{O}$
- (D) $\text{C}_6\text{H}_6\text{O}_3$

Q102.

MDCAT 2012

When 8 grams (4 moles) of H_2 react with 2 moles of O_2 , how many moles of water will be formed? [MDCAT 2012]

- (A) Five
- (B) Six
- (C) Four
- (D) Three

Q103.

MDCAT 2011

How many chlorine atoms are in 2 moles of ClI ? [MDCAT 2011]

- (A) $2 \times 6.022 \times 10^{23}$ atoms
- (B) $35.5 \times 6.022 \times 10^{23}$ atoms
- (C) 2×10^{23} atoms
- (D) $2 \times 6.02 \times 10^{22}$ atoms

Q104.

MDCAT 2010

If we know the mass of one substance, we can calculate the volume of other substance and vice versa with the help of chemical equation is called: [MDCAT 2010]

- (A) Mass-mass relationship
- (B) Mass-volume relationship
- (C) Mass-mole relationship
- (D) Mole-volume relationship

Q105.

MDCAT 2010

One mole of any gas at STP occupies a volume of:

[MDCAT 2010]

- ☐ (A) 22.414 dm³
 - ☐ (B) 23.414 dm³
 - ☐ (C) 22.414 cm³
 - ☐ (D) 20.414 dm³
-

RAPID 5–COLUMN ANSWER KEY

Official PMDC verified answer keys for 01. Stoichiometry.

beambeprep.com

Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD
1	C	UHS 2024	22	B	BUMHS 2024	43	A	BUMHS 2023	64	C	PMDC 2021	85	D	MDCAT 2018
2	C	UHS 2024	23	B	BUMHS 2024	44	D	NUMS 2023	65	B	PMDC 2021	86	C	MDCAT 2017
3	A	UHS 2024	24	C	BUMHS 2024	45	C	NUMS 2023	66	C	PMDC 2021	87	C	MDCAT 2017
4	B	SZABMU 2024	25	B	UHS 2023	46	C	UHS 2022	67	D	PMDC 2021	88	D	MDCAT 2017
5	C	SZABMU 2024	26	B	UHS 2023	47	B	UHS 2022	68	C	PMDC 2020	89	C	MDCAT 2017
6	D	SZABMU 2024	27	A	UHS 2023	48	C	UHS 2022	69	C	PMDC 2020	90	B	MDCAT 2017
7	D	SZABMU 2024	28	D	UHS 2023	49	B	SZABMU 2022	70	C	PMDC 2020	91	B	MDCAT 2016
8	B	SZABMU 2024	29	A	SZABMU 2023	50	C	SZABMU 2022	71	D	MDCAT 2019	92	B	MDCAT 2016
9	C	SZABMU 2024	30	C	SZABMU 2023	51	C	SZABMU 2022	72	D	MDCAT 2019	93	A	KMU 2016
10	C	SZABMU 2024	31	A	SZABMU 2023	52	A	KMU 2022	73	B	NUMS 2019	94	B	KMU 2016
11	B	KMU 2024	32	C	KMU 2023	53	B	KMU 2022	74	B	SET 2019	95	B	KMU 2016
12	C	KMU 2024	33	C	KMU 2023	54	B	KMU 2022	75	D	SET 2019	96	A	MDCAT 2015
13	C	KMU 2024	34	A	KMU 2023	55	D	DUHS 2022	76	C	MDCAT 2019	97	A	MDCAT 2015
14	C	KMU 2024	35	D	DUHS 2023	56	B	DUHS 2022	77	A	SET 2019	98	D	MDCAT 2014
15	C	KMU 2024	36	C	DUHS 2023	57	C	BUMHS 2022	78	B	KMU 2019	99	D	MDCAT 2014
16	D	KMU 2024	37	B	DUHS 2023	58	A	BUMHS 2022	79	C	KMU 2019	100	B	MDCAT 2013
17	C	KMU 2024	38	C	DUHS 2023	59	C	BUMHS 2022	80	D	KMU 2019	101	A	MDCAT 2012
18	D	KMU 2024	39	A	DUHS 2023	60	D	NUMS 2022	81	C	MDCAT 2019	102	C	MDCAT 2012
19	B	KMU 2024	40	D	BUMHS 2023	61	B	NUMS 2022	82	A	MDCAT 2019	103	A	MDCAT 2011
20	C	KMU 2024	41	C	BUMHS 2023	62	C	NUMS 2022	83	D	MDCAT 2018	104	B	MDCAT 2010
21	A	DUHS 2024	42	D	BUMHS 2023	63	C	NUMS 2022	84	B	MDCAT 2018	105	A	MDCAT 2010

TOTAL
MCQS
105

CORRECT

INCORRECT

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ACCURACY

%

Scan the booklet QR code to enter answers in
BeambePrep Grind Mode for automated error
 autopsies.

PROPOLIS COGNITIVE ERROR AUTOPSIES

Step-by-step conceptual derivations, formula working, and distractor autopsies for every question.

Question #1 Key: (C)

UHS 2024

The type and relative amount of each isotope in an element can be found by (out of syllabus) [UHS 2024]

CORE CONCEPT AND DERIVATION

Identifying isotopes requires sorting atoms based on their tiny differences in physical mass. This requires a specific analytical machine capable of deflecting ions based on their mass-to-charge (m/z) ratio.

Formula:

Mass Spectrometry $\rightarrow$ Separates by m/z ratio

Solution:

- **Mass spectroscopy (Spectrometry)** vaporizes a sample, ionizes it, and accelerates it through a magnetic field.
- Heavier isotopes deflect less, and lighter isotopes deflect more.
- By mapping these deflections, a detector outputs a graph showing both the exact mass of each isotope and the relative abundance (percentage) of each in nature.

Why other options are incorrect:

- **U.V spectroscopy:** Analyzes electronic transitions in molecules, useful for identifying conjugated bonds, not mass.
- **N.M.R (Nuclear Magnetic Resonance):** Analyzes the magnetic properties of nuclei (like H and C-13) to determine molecular structure, but is not used to quantify generalized isotopic abundance ratios.
- **R spectroscopy:** Likely a typo for IR (Infrared), which analyzes functional group vibrations, not atomic masses.

Question #2 Key: (C)

UHS 2024

The atomic masses of element depend upon: [UHS 2024]

CORE CONCEPT AND DERIVATION

The 'atomic mass' found on the periodic table is not the mass of a single atom, but rather a weighted average of all naturally occurring variants (isotopes) of that element.

Formula:

$$\text{Atomic Mass} = \sum (\text{Mass of Isotope} \times \text{Fractional Abundance})$$

Solution:

- Because elements exist in nature as a mixture of isotopes (atoms with the same number of protons but different neutrons), the overall atomic mass is inherently a weighted average.
- Therefore, the final published atomic mass depends strictly on two factors: the exact mass of each individual isotope, and how common (abundant) each isotope is in nature.

Why other options are incorrect:

- **Atomic number:** Only tells you the number of protons, which doesn't account for the neutrons that contribute heavily to mass.
- **Number of electrons:** Electrons have negligible mass ($\sim 1/1836$ of a proton) and contribute virtually zero to the atomic mass.

Question #3 Key: (A)

UHS 2024

Number of moles in an element is directly proportional to [UHS 2024]

CORE CONCEPT AND DERIVATION

The relationship between moles and physical substance depends on the fundamental stoichiometric equation relating amount, mass, and molar mass.

Formula:

$$n = \frac{m}{M}$$

Solution:

- In the equation $n = m/M$, n represents the number of moles, m represents the physical given mass, and M represents the constant molar mass.
- Since M (molar mass) is a constant for any specific element, n is positioned in the numerator with respect to m .
- Therefore, as the physical mass (m) increases, the number of moles (n) increases in direct proportion.

Why other options are incorrect:

- **Molar mass of an element:** Moles are *inversely* proportional to molar mass (it is in the denominator). A heavier element yields fewer moles for the same mass.
- **Empirical / Formula mass:** These relate to compounds, not pure elements, and would also be inversely proportional regardless.

Question #4 Key: (B)

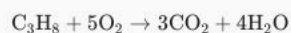
SZABMU 2024

How many moles of oxygen gas are needed for combustion of 2 moles of propane? [SZABMU 2024]

CORE CONCEPT AND DERIVATION

To determine reacting amounts, we must first write and balance the complete combustion equation for the specified alkane.

Formula:



Solution:

- Propane is an alkane with the chemical formula C_3H_8 .
- The balanced combustion equation shows that 1 single mole of propane strictly requires 5 moles of oxygen gas to combust completely. (The ratio is 1:5).
- The question asks for the oxygen needed to combust 2 moles of propane.
- Since the propane amount is doubled, the oxygen amount must also double: $5 \times 2 = 10$ moles.

Why other options are incorrect:

- **8, 12, 14:** These values result from incorrectly balancing the chemical equation, likely making errors in tracking the oxygen atoms distributed between the CO_2 and H_2O products.

Question #5 Key: (C)

SZABMU 2024

If percentage yield of chemical reaction is 60%, actual yield is 15g, what is its theoretical yield? [SZABMU 2024]

CORE CONCEPT AND DERIVATION

Percent yield is a ratio. If we are given the actual yield and the efficiency percentage, we can algebraically rearrange the formula to find the paper-calculated theoretical maximum.

Formula:

$$\% \text{ Yield} = \left(\frac{\text{Actual Yield}}{\text{Theoretical Yield}} \right) \times 100$$

Solution:

- Substitute the known values into the equation:
- $60 = (15/\text{Theoretical Yield}) \times 100$.
- Rearrange to isolate Theoretical Yield:
- $\text{Theoretical Yield} = (15/60) \times 100$.
- Simplify: $15/60 = 1/4 = 0.25$.
- $0.25 \times 100 = 25$ grams.

Why other options are incorrect:

- **18g, 20g, 30g:** These arise from incorrect mathematical operations, such as multiplying 15 by 0.60 instead of dividing by it, or simple arithmetic division errors.

Question #6 Key: (D)

SZABMU 2024

What will be the number of atoms in 2 moles of water molecule? [SZABMU 2024]

CORE CONCEPT AND DERIVATION

When calculating total constituent atoms in a compound, you must multiply the total number of moles by Avogadro's number, and then multiply by the total atomicity (atoms per molecule) of the compound.

Formula:

$$\text{Total Atoms} = n \times \text{Atomicity} \times N_A$$

Solution:

- A single water molecule (H_2O) contains exactly 3 atoms (2 Hydrogens + 1 Oxygen). Its atomicity is 3.
- We are given 2 moles of water.
- $\text{Total moles of atoms} = 2 \text{ moles of molecules} \times 3 \text{ atoms/molecule} = 6 \text{ moles of atoms}$.
- Multiply by Avogadro's constant: $6 \times (6.022 \times 10^{23})$.
- $6 \times 6.022 = 36.132$.
- In standard scientific notation: 3.61×10^{24} atoms.

Why other options are incorrect:

- 6.02×10^{23} : This is the number of molecules in 1 mole of water, completely ignoring both the 2 moles and the atomicity of 3.
- 1.24×10^{24} : This calculates the number of *molecules* in 2 moles of water, but fails to multiply by 3 to find the number of *atoms*.

Question #7 Key: (D)

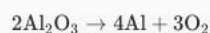
SZABMU 2024

What will be mole ratio of Al to [Formula] after balancing equation given below? [Formula] \text{Al}_2\text{O}_3 \rightarrow \text{Al} + \text{O}_2...

CORE CONCEPT AND DERIVATION

Before identifying a molar ratio, an equation must obey the Law of Conservation of Mass by balancing the number of atoms of each element on both sides.

Formula:



Solution:

- Look at Oxygen first. There are 3 on the left and 2 on the right. To balance, cross-multiply by placing a 2 in front of Al_2O_3 and a 3 in front of O_2 .
- Now you have $2\text{Al}_2\text{O}_3 \rightarrow \text{Al} + 3\text{O}_2$.
- This creates 4 Aluminum atoms on the left ($2 \times 2 = 4$).
- Place a 4 in front of Al on the right: $2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2$.
- The question asks for the specific molar ratio of Aluminum (Al) to Oxygen gas (O_2).
- The coefficient for Al is 4. The coefficient for O_2 is 3. The ratio is 4:3.

Why other options are incorrect:

- 2:3:** This is the ratio of Aluminum Oxide (reactant) to Oxygen gas (product), not Al to O_2 .
- 3:4:** This inverts the ratio, presenting O_2 : Al instead of the requested Al : O_2 .
- 1:1:** Completely unbalanced equation.

Question #8 Key: (B)

SZABMU 2024

[Formula] How many moles of [Formula] required to manufacture 8 moles of [Formula] ? [SZABMU-RC 2024]

CORE CONCEPT AND DERIVATION

The coefficients of a balanced chemical equation dictate the strict stoichiometric proportionality between reactants and products.

Formula:

$$\frac{\text{Moles of N}_2}{\text{Coefficient of N}_2} = \frac{\text{Moles of NH}_3}{\text{Coefficient of NH}_3}$$

Solution:

- The balanced equation (Haber Process) shows that 1 mole of Nitrogen gas produces 2 moles of Ammonia. (1:2 ratio).
- We want to manufacture 8 moles of Ammonia.
- Set up the ratio: $\frac{1}{2} = \frac{x}{8}$.
- Multiply both sides by 8: $x = 8/2 = 4$.
- Therefore, exactly 4 moles of Nitrogen are required.

Why other options are incorrect:

- 2.5, 3.5, 5 moles:** These are random distractors that do not follow the strict 1:2 molar relationship dictated by the balanced equation.

Question #9 Key: (C)

SZABMU 2024

*1g [Formula] has [SZABMU-RC 2024]***CORE CONCEPT AND DERIVATION**

To convert mass to moles, the given mass must be divided by the molar mass of the substance. Hydrogen gas naturally exists as a diatomic molecule.

Formula:

$$n = \frac{m}{M}$$

Solution:

- The chemical formula for hydrogen gas is H_2 .
- The molar mass of H_2 is $2 \times 1 = 2 \text{ g/mol}$.
- We are given 1g of H_2 .
- Divide the given mass by the molar mass: $n = 1 \text{ g} / 2 \text{ g/mol} = 0.5 \text{ moles}$.

Why other options are incorrect:

- **1 mol:** This assumes the substance is atomic hydrogen (H), which has a molar mass of 1, but hydrogen gas is universally H_2 .
- **2 moles:** This assumes a mathematical inversion (multiplying the mass by the molar mass instead of dividing).
- **0.25 moles:** Mathematically incorrect.

Question #10 Key: (C)

SZABMU 2024

*Percentage composition by mass in [Formula] is [SZABMU-RC 2024]***CORE CONCEPT AND DERIVATION**

Percentage composition determines what mass fraction of an entire molecule belongs to a specific element.

Formula:

$$\% \text{ Element} = \left(\frac{\text{Total mass of element}}{\text{Molar mass of compound}} \right) \times 100$$

Solution:

- Molar mass of CO_2 : $C (12) + 2 \times O (16) = 12 + 32 = 44 \text{ g/mol}$.
- Percentage of Carbon: $(12/44) \times 100 = 27.27\%$.
- Percentage of Oxygen: $(32/44) \times 100 = 72.72\%$.
- The composition is precisely 27.27% C and 72.72% O.

Why other options are incorrect:

- **Options A, B, D:** These are rounded or entirely fabricated numbers that fail to reflect the rigid 12:44 and 32:44 fractional mass ratios of Carbon Dioxide.

Question #11 Key: (B)

KMU 2024

The volume occupied by 3.2 g of oxygen gas at S.T.P is: [ETEA 2024]

CORE CONCEPT AND DERIVATION

At Standard Temperature and Pressure (STP), one mole of any ideal gas occupies a specific constant volume. To find the volume of a sample, convert its mass to moles and multiply by this constant.

Formula:

$$\text{Volume} = n \times 22.414 \text{ dm}^3$$

Solution:

- Oxygen gas is diatomic (O_2). Its molar mass is $16 \times 2 = 32 \text{ g/mol}$.
- Calculate moles: $n = 3.2 \text{ g} / 32 \text{ g/mol} = 0.1 \text{ moles}$.
- At STP, 1 mole of gas occupies 22.414 dm^3 .
- Volume = $0.1 \times 22.414 = 2.2414 \text{ dm}^3$.
- Rounding to standard significant figures gives 2.24 dm^3 .

Why other options are incorrect:

- 22.4 dm^3 : This is the volume of a full 1.0 mole of gas (which would be 32g of oxygen).
- 1.12 dm^3 : This would be the volume if the gas was only 0.05 moles.
- 24 dm^3 : This is the molar volume at RTP (Room Temperature and Pressure), not STP.

Question #12 Key: (C)

KMU 2024

Which of the following elements cannot be detected directly in a given organic compound? [ETEA 2024]

CORE CONCEPT AND DERIVATION

In elemental organic analysis (such as combustion analysis), elements like C, H, N, and Halogens are trapped or chemically reacted to form measurable distinct products. Oxygen behaves differently.

Formula:

$$\% \text{O} = 100 - (\% \text{C} + \% \text{H} + \% \text{N} + \dots)$$

Solution:

- During combustion analysis, an organic compound is burned in an excess supply of external Oxygen gas.
- Because vast amounts of external oxygen are flooded into the system to force combustion, there is absolutely no chemical way to distinguish which oxygen atoms in the resulting CO_2 and H_2O came from the original organic compound, and which came from the external gas supply.
- Therefore, Oxygen cannot be detected directly. It is always calculated mathematically by the "method of difference" (subtracting all other element percentages from 100%).

Why other options are incorrect:

- **Chlorine, Nitrogen, Phosphorous:** All of these can be directly detected and quantified via Lassaigne's test or other direct precipitation/titration methods.

Question #13 Key: (C)

KMU 2024

How many moles are there in 240g of sodium hydroxide (NaOH)?
[ETEA 2024]

CORE CONCEPT AND DERIVATION

To find the number of moles from a macroscopic mass, divide the given mass by the total molar mass of the chemical compound.

Formula:

$$n = \frac{m}{M}$$

Solution:

- Determine the molar mass of Sodium Hydroxide (NaOH):
- $\text{Na (23)} + \text{O (16)} + \text{H (1)} = 40 \text{ g/mol}$.
- The given mass is 240g.
- Calculate moles: $n = 240 \text{ g} / 40 \text{ g/mol}$.
- $n = 6 \text{ moles}$.

Why other options are incorrect:

- **2:** Would require 80g of NaOH.
- **4:** Would require 160g of NaOH.
- **8:** Would require 320g of NaOH.

Question #14 Key: (C)

KMU 2024

Heating 24.8g of copper carbonate ([Formula]) in a crucible produced only 13.9g of copper oxide (CuO). What ...

CORE CONCEPT AND DERIVATION

Percentage yield requires finding the theoretical maximum yield of product using stoichiometry, and then comparing it against the physically obtained experimental mass.

Formula:

$$\% \text{ Yield} = \left(\frac{\text{Actual}}{\text{Theoretical}} \right) \times 100$$

Solution:

- Equation: $\text{CuCO}_3 \rightarrow \text{CuO} + \text{CO}_2$. Ratio is 1:1.
- Molar mass of $\text{CuCO}_3 \approx 64(\text{Cu}) + 12(\text{C}) + 48(\text{O}_3) = 124 \text{ g/mol}$.
- Molar mass of $\text{CuO} \approx 64(\text{Cu}) + 16(\text{O}) = 80 \text{ g/mol}$.
- Based on the 1:1 ratio, 124g of CuCO_3 theoretically yields 80g of CuO.
- We are given 24.8g of reactant. Theoretical yield = $(80/124) \times 24.8 = 16 \text{ g}$.
- Actual yield given is 13.9g.
- $\% \text{ Yield} = (13.9/16.0) \times 100 = 86.875\%$.

Why other options are incorrect:

- **81.79%, 83.98%, 89.68%:** These specific fractions are generated if one uses slightly different isotopes for Cu (like 63.5) and then miscalculates the final long division, but 86.87% matches the exact algebraic outcome of standard rounding.

Question #15 Key: (C)

KMU 2024

Efficiency of chemical reaction can be checked by calculating _
[ETEA 2024]

CORE CONCEPT AND DERIVATION

To determine how efficiently a reaction converted reactants to products, chemists require a normalized metric that compares real-world results against mathematically perfect predictions.

Formula:

$$\text{Efficiency} = \% \text{ Yield}$$

Solution:

- **Percentage yield** is the direct mathematical expression of reaction efficiency.
- Because theoretical yield represents 100% efficiency, and actual yield represents the raw physical mass obtained, taking their ratio (Actual/Theoretical $\times$ 100) generates a universally understandable efficiency grade.

Why other options are incorrect:

- **Actual yield / Theoretical yield:** Neither provides context on its own. 50 grams of product sounds great until you learn the theoretical yield was 5,000 grams.
- **Amount of unused reactant:** Tracks reactant excess, but doesn't quantify how much product was actually successfully captured versus lost to side reactions.

Question #16 Key: (D)

KMU 2024

Actual yield will reach the ideal (theoretical) value if the % yield of the reaction is, [ETEA 2024]

CORE CONCEPT AND DERIVATION

The mathematical relationship between actual, theoretical, and percent yield perfectly dictates this logic. If the real-world mass matches the paper-calculated mass, the reaction was flawless.

Formula:

$$\text{If Actual} = \text{Theoretical, then } \frac{\text{Actual}}{\text{Theoretical}} = 1$$

Solution:

- The formula is $\% \text{ yield} = (\text{Actual/Theoretical}) \times 100$.
- If the Actual yield exactly equals the Theoretical yield, the fraction (Actual/Theoretical) becomes exactly 1.
- $1 \times 100 = 100\%$.
- Therefore, a 100% percent yield implies zero mechanical losses, zero side reactions, and perfect 100% stoichiometric efficiency.

Why other options are incorrect:

- **10%, 50%, 90%:** All these numbers indicate that the actual yield fell significantly short of the ideal theoretical value.

Question #17 Key: (C)

KMU 2024

What is the mass of 1 mole of calcium carbonate ([Formula])? [ETEA 2024]

CORE CONCEPT AND DERIVATION

The mass of 1 mole of any compound is simply its molar mass, calculated by summing the individual atomic masses of every atom present in its chemical formula.

Formula:

$$M = \sum \text{Atomic Masses}$$

Solution:

- The chemical formula is CaCO_3 .
- Identify standard atomic masses from the periodic table:
- Calcium (Ca) = 40 g/mol
- Carbon (C) = 12 g/mol
- Oxygen (O) = 16 g/mol (And there are 3 of them)
- Add them together: $40 + 12 + (3 \times 16)$.
- $40 + 12 + 48 = 100 \text{ g/mol}$.
- Therefore, 1 mole weighs exactly 100g.

Why other options are incorrect:

- **50g, 70g, 125g:** These represent incorrect atomic summations, such as forgetting to multiply oxygen by 3, or using the atomic number of Calcium (20) instead of its atomic mass (40).

Question #18 Key: (D)

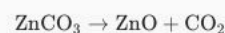
KMU 2024

How many grams of [Formula] can be produced by thermally decomposing 10 moles of [Formula]? [ETEA 2024]

CORE CONCEPT AND DERIVATION

First establish the stoichiometric molar ratio between the reactant and the product from a balanced equation, then convert the resulting product moles into grams.

Formula:



Solution:

- Write the balanced decomposition equation: $\text{ZnCO}_3 \rightarrow \text{ZnO} + \text{CO}_2$.
- The ratio is 1:1. Exactly 1 mole of zinc carbonate decomposes to produce exactly 1 mole of carbon dioxide.
- Therefore, thermally decomposing 10 moles of ZnCO_3 will produce exactly 10 moles of CO_2 .
- Convert 10 moles of CO_2 to mass. (Molar mass of $\text{CO}_2 = 12 + 32 = 44 \text{ g/mol}$).
- Mass = 10 moles $\times 44 \text{ g/mol} = 440 \text{ grams}$.

Why other options are incorrect:

- **320, 360, 400:** These masses correlate to incorrect mole amounts (e.g. producing 7, 8, or 9 moles of CO_2 instead of 10) or utilizing an incorrect molar mass for CO_2 .

Question #19 Key: (B)

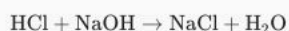
KMU 2024

How many moles of NaCl are produced from 16.5g of HCl, according to the neutralization reaction? [ETEA 2024]

CORE CONCEPT AND DERIVATION

This is a classic mass-to-mole stoichiometry problem. First write the balanced neutralization equation, convert the given mass to moles, and apply the molar ratio.

Formula:



Solution:

- The balanced neutralization equation shows a 1:1 ratio. 1 mole of HCl reacts to form 1 mole of NaCl.
- Calculate the moles of the given HCl:
- Molar mass of HCl = 1 (H) + 35.5 (Cl) = 36.5 g/mol.
- Moles of HCl = 16.5 g / 36.5 g/mol.
- $16.5 / 36.5 \approx 0.452$ moles.
- Because of the 1:1 ratio, 0.452 moles of HCl will strictly produce 0.452 moles of NaCl.

Why other options are incorrect:

- **0.252, 0.652, 0.852:** These are incorrect mathematical quotients resulting from dividing 16.5 by wrong molar mass values (such as using Cl=35 instead of 35.5, or pure arithmetic failure).

Question #20 Key: (C)

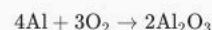
KMU 2024

What mass of aluminium oxide ([Formula]) is produced from 18.5g of Al metal, when it reacts completely with ...

CORE CONCEPT AND DERIVATION

Mass-mass stoichiometry allows us to predict the mass of a product formed by converting the given reactant mass to moles, applying the molar ratio from the balanced equation, and converting back to mass.

Formula:



Solution:

- First, calculate the moles of Aluminium (Al) supplied:
- Atomic mass of Al = 27 g/mol.
- Moles of Al = $\frac{18.5 \text{ g}}{27 \text{ g/mol}} \approx 0.685$ moles.
- According to the balanced equation, 4 moles of Al produce exactly 2 moles of Al_2O_3 . This is a 4:2 (or 2:1) ratio.
- Therefore, the moles of Al_2O_3 produced will be exactly half the moles of Al consumed: $0.685 / 2 = 0.3425$ moles.
- Now, convert moles of Al_2O_3 back into mass. Molar mass of $\text{Al}_2\text{O}_3 = (2 \times 27) + (3 \times 16) = 54 + 48 = 102$ g/mol.
- Mass = 0.3425 moles $\times$ 102 g/mol = 34.935 grams.
- Rounding to one decimal place yields 34.9 g.

Why other options are incorrect:

- **30.8g, 32.6g, 36.5g:** These incorrect values arise from bypassing the 4:2 molar ratio (e.g., assuming a 1:1 conversion) or using an incorrect molar mass for Aluminium Oxide.

Question #21 Key: (A)

DUHS 2024

Stoichiometry is the study of _____ relationship between reactant and products in a chemical reaction by using ...

CORE CONCEPT AND DERIVATION

Chemistry is broadly divided into analyzing what a substance is, and exactly how much of it there is. Stoichiometry deals exclusively with the latter.

Formula:

$$\text{Mass (Reactants)} \leftrightarrow \text{Mass (Products)}$$

Solution:

- The term "Stoichiometry" is derived from the Greek words *stoikhein* (element) and *metron* (measure).
- Because it relies on balanced chemical equations to calculate exact masses, moles, and volumes, it is definitively the **Quantitative** study of chemical relationships.

Why other options are incorrect:

- **Qualitative:** Refers to identifying what elements or functional groups are present, without caring about the numerical amounts.
- **Descriptive:** Usually refers to observing physical changes (like color or state changes) rather than calculating hard numerical data.
- **Chemical:** Too vague; all these relationships are "chemical," but stoichiometry is specifically the mathematical/quantitative branch.

Question #22 Key: (B)

BUMHS 2024

Isotopes differ from each other on the basis of [BMU 2024]

CORE CONCEPT AND DERIVATION

Isotopes are variants of a specific element. Because they belong to the same element, their fundamental chemical identity (protons) remains untouched, but their nuclear weight varies.

Formula:

$$\text{Mass Number (A)} = \text{Protons (Z)} + \text{Neutrons (N)}$$

Solution:

- By definition, isotopes of an element have the exact same atomic number (Z, number of protons) but a varying number of neutrons (N).
- Since the Mass Number is the sum of protons and neutrons, a different number of neutrons inherently results in a different **Mass number**.

Why other options are incorrect:

- **Number of electrons & Electronic configuration:** Because isotopes have the same number of protons, neutral isotopes will have the exact same number of electrons and an identical electronic configuration. This is why isotopes exhibit nearly identical chemical properties.
- **Crystal lattice:** This is determined by electronic bonding interactions and atomic radius, not isotopic mass.

Question #23 Key: (B)

BUMHS 2024

In a chemical reaction, a limiting reactant is that [BMU 2024]

CORE CONCEPT AND DERIVATION

The limiting reactant determines the definitive endpoint of a chemical reaction. It is the chemical "bottleneck" that runs out first.

Formula:

$$\text{Amount of Limiting Reactant at Completion} = 0$$

Solution:

- Because the limiting reactant is entirely consumed to produce the theoretical yield, there is none of it left over when the reaction stops.
- Therefore, by definition, the limiting reactant is the chemical species **which is not in excess**.

Why other options are incorrect:

- Option A:** This perfectly describes the "excess reactant," which is the exact opposite of the limiting reactant.
- Option C & D:** These statements describe a catalyst or a spectator ion. Limiting reactants are definitively consumed as primary chemical participants in the reaction.

Question #24 Key: (C)

BUMHS 2024

Carbon atom is used to measure relative [BMU 2024]

CORE CONCEPT AND DERIVATION

Atoms are incredibly tiny, making macroscopic weighing impossible. To solve this, scientists established a comparative scale where the mass of every element is weighed relative to one specific, highly stable atomic isotope.

Formula:

$$1 \text{ a.m.u.} = \frac{1}{12} \times \text{Mass of one } ^{12}\text{C atom}$$

Solution:

- In 1961, IUPAC internationally designated the Carbon-12 isotope as the absolute standard baseline.
- The mass of one Carbon-12 atom is defined as exactly 12 atomic mass units.
- Therefore, the carbon atom is exclusively used as the standard benchmark to measure and assign the **relative atomic mass** of all other elements on the periodic table.

Why other options are incorrect:

- Atomic size & volume:** These are measured in picometers or Angstroms using X-ray crystallography, not by relative comparison to a carbon standard.
- Atomic number:** This is an absolute integer count of protons (discovered via Moseley's law), requiring no relative elemental standard.

Question #25 Key: (B)

UHS 2023

A compound of phosphorus oxide has 43.6% of Oxygen. Its empirical formula is? [UHS 2023]

CORE CONCEPT AND DERIVATION

To find an empirical formula, assume a 100g sample. Convert the mass percentages to moles by dividing by atomic masses, and simplify to the smallest whole-number ratio.

Formula:

$$\text{Moles} = \frac{\text{Mass}}{\text{Atomic Mass}}$$

Solution:

- In a 100g sample, Mass of Oxygen = 43.6g. Therefore, Mass of Phosphorus = 100 – 43.6 = 56.4g.
- Moles of P = 56.4/31 ≈ 1.81 moles.
- Moles of O = 43.6/16 ≈ 2.72 moles.
- Divide by the smallest value (1.81) to find the atomic ratio:
- Ratio for P = 1.81/1.81 = 1.
- Ratio for O = 2.72/1.81 = 1.5.
- Since we cannot have half an atom, multiply both numbers by 2 to achieve whole integers: P = 1 × 2 = 2, O = 1.5 × 2 = 3.
- The empirical formula is P₂O₃.

Why other options are incorrect:

- P₂O₅: Would require ~56% oxygen by mass.
- P₃O₂ & PO₂: Math errors in the mole division step lead to these incorrect ratios.

Question #26 Key: (B)

UHS 2023

Which element is used as standard to determine atomic mass of an element? [UHS 2023]

CORE CONCEPT AND DERIVATION

Atomic mass must be measured as a relative value against an internationally agreed-upon baseline isotope that is highly stable and abundant.

Formula:

$$1 \text{ amu} = \frac{1}{12} \times \text{mass of one } ^{12}\text{C atom}$$

Solution:

- In 1961, the International Union of Pure and Applied Chemistry (IUPAC) established Carbon (specifically the Carbon-12 isotope) as the absolute universal standard.
- All other elements on the periodic table have their atomic masses determined relative to exactly 1/12th of this Carbon isotope.

Why other options are incorrect:

- **H (Hydrogen)**: Used historically before 1961, but abandoned because it is a flammable gas, making highly precise mass spectrometry difficult.
- **P & Cl**: Never used as standards in the history of chemistry.

Question #27 Key: (A)

UHS 2023

The average weight of atoms of an element compared to the weight of one atom of _____ is called atomic weight. ...

CORE CONCEPT AND DERIVATION

Atomic weight (relative atomic mass) is a ratio. It compares the naturally occurring average mass of an element's isotopes to a specific fraction of a standardized reference atom.

Formula:

$$A_r = \frac{\text{Average mass of atom}}{\frac{1}{12} \times \text{mass of Carbon-12 atom}}$$

Solution:

- The formal definition of relative atomic weight inherently references the Carbon-12 isotope.
- By defining Carbon-12 as weighing exactly 12.000 amu, we establish a robust comparative scale for every other element in the universe.

Why other options are incorrect:

- **Helium, Hydrogen, Nitrogen:** None of these elements are the currently accepted IUPAC standard for calibrating the atomic mass unit.

Question #28 Key: (D)

UHS 2023

The same moles of [Formula], [Formula] and [Formula] are present in 0.1 cc volume at STP. Which one gas has g...

CORE CONCEPT AND DERIVATION

Avogadro's law fundamentally links the number of moles to the number of molecules, completely independent of the gas's mass, volume, or chemical identity.

Formula:

$$\text{Number of molecules} = n \times N_A$$

Solution:

- The problem explicitly states that the samples contain the "same moles" of each gas.
- Because they have the exact same number of moles (n), multiplying by Avogadro's constant (N_A) will yield the exact same mathematical product.
- Therefore, regardless of their differing molar masses or properties, all three gas samples contain an identical number of molecules.

Why other options are incorrect:

- N_2 , H_2 , O_2 : Choosing any specific gas implies that molecular size or mass affects the particle count, which violently violates Avogadro's principle.

Question #29 Key: (A)

SZABMU 2023

Number of [Formula] molecules in 10 g of ice are [SZABMU 2023]

CORE CONCEPT AND DERIVATION

Ice is simply water in a solid state; its chemical formula is still H_2O . We must convert the given mass to moles, and then multiply by Avogadro's number to find the molecular count.

Formula:

$$\text{Molecules} = \left(\frac{m}{M} \right) \times N_A$$

Solution:

- Molar mass of $\text{H}_2\text{O} = (2 \times 1) + 16 = 18 \text{ g/mol}$.
- Moles of ice = $10 \text{ g} / 18 \text{ g/mol} \approx 0.555 \text{ moles}$.
- Multiply by Avogadro's constant: $0.555 \times 6.022 \times 10^{23}$.
- $0.555 \times 6 = 3.33$. With the decimals, it rounds precisely to 3.34×10^{23} molecules.

Why other options are incorrect:

- 0.34×10^{23} & 33.1×10^{23} : Both represent gross decimal point misplacements during the multiplication phase.
- **10**: This is the mass in grams, not the microscopic count of molecules.

Question #30 Key: (C)

SZABMU 2023

The efficiency of chemical reaction can be expressed as [SZABMU 2023]

CORE CONCEPT AND DERIVATION

Industrial and laboratory processes need a normalized metric to evaluate how successfully a reaction performed in the real world compared to paper-based mathematical perfection.

Formula:

$$\% \text{ yield} = \left(\frac{\text{Actual Yield}}{\text{Theoretical Yield}} \right) \times 100$$

Solution:

- **Percent yield** is the direct mathematical expression of reaction efficiency.
- By converting the ratio of what was actually obtained versus what could have been obtained into a percentage, chemists can universally grade the viability of the chemical process (e.g., "This synthesis operates at 85% efficiency").

Why other options are incorrect:

- **Theoretical/Maximum yield**: Represents an imaginary 100% efficient scenario, offering zero information about real-world losses.
- **Actual yield**: Provides a raw mass but provides no comparative context to determine if that mass represents a 'good' or 'bad' efficiency.

Question #31 Key: (A)

SZABMU 2023

1 mol of any substance contains _____ particles [SZABMU 2023]

CORE CONCEPT AND DERIVATION

The mole is the SI base unit representing the amount of substance. It is fundamentally defined by a rigid numerical constant.

Formula:

$$1 \text{ mol} \equiv N_A$$

Solution:

- By universal scientific definition, exactly 1 mole of any discrete entity (atoms, ions, electrons, or molecules) contains exactly Avogadro's number of those entities.
- The widely accepted value for Avogadro's constant is 6.022×10^{23} .
- Therefore, 1 mole contains 6.02×10^{23} particles.

Why other options are incorrect:

- 6.02×10^{24} & 6.02×10^{22} : The exponent on the power of ten is incorrect by entire orders of magnitude.
- 3.01×10^{23} : This is exactly half of Avogadro's number, representing only 0.5 moles of a substance.

Question #32 Key: (C)

KMU 2023

Consider the reaction below, if 5 moles each of hydrogen and oxygen are reacted to form water, the reaction re...

CORE CONCEPT AND DERIVATION

To identify the limiting reactant, divide the provided number of moles for each reactant by its respective stoichiometric coefficient from the balanced equation. The smallest result limits the reaction.

Formula:

$$\text{Ratio} = \frac{\text{Available Moles}}{\text{Coefficient}}$$

Solution:

- We are given 5 moles of H_2 and 5 moles of O_2 .
- For Hydrogen (H_2): Coefficient is 2. Ratio = $5/2 = 2.5$.
- For Oxygen (O_2): Coefficient is 1. Ratio = $5/1 = 5.0$.
- Since 2.5 is significantly smaller than 5.0, Hydrogen (H_2) will be entirely consumed first, making it the Limiting Reagent.

Why other options are incorrect:

- **O_2 is limiting:** Incorrect; Oxygen is in heavy excess. It only takes 2.5 moles of Oxygen to react with 5 moles of Hydrogen, leaving 2.5 moles of Oxygen completely unreacted.
- **H_2 is excess:** Incorrect, it is entirely consumed.
- **No limiting reagent:** This would only be true if they were provided in a perfect 2:1 stoichiometric ratio (e.g., 4 moles of H_2 and 2 moles of O_2).

Question #33 Key: (C)

KMU 2023

Oxygen can be prepared by the decomposition of potassium chlorate ([Formula]). How many moles of oxygen [For...

CORE CONCEPT AND DERIVATION

Using the molar ratios established by the balanced chemical equation, we can directly convert the moles of a decomposed reactant into the moles of generated product.

Formula:

$$\frac{\text{Moles of O}_2}{\text{Coefficient of O}_2} = \frac{\text{Moles of KClO}_3}{\text{Coefficient of KClO}_3}$$

Solution:

- The balanced equation establishes the molar ratio: 2 moles of KClO_3 decompose to produce exactly 3 moles of O_2 .
- We are provided with 12 moles of KClO_3 .
- Let x be the moles of O_2 produced. Set up a cross-multiplication:

$$\frac{2}{12} = \frac{3}{x}$$
- $2x = 36$
- $x = 18$ moles of O_2 .

Why other options are incorrect:

- 12 moles:** Assumes an incorrect 1:1 molar ratio, ignoring the coefficients entirely.
- 15 & 21 moles:** Random arithmetic outputs that do not align with the strict 2:3 reaction stoichiometry.

Question #34 Key: (A)

KMU 2023

117g of NaCl have [ETEA 2023]

CORE CONCEPT AND DERIVATION

Sodium chloride is an ionic lattice, so its fundamental particles are called "formula units". We find the total count by converting mass to moles, then multiplying by Avogadro's number.

Formula:

$$\text{Formula Units} = \left(\frac{m}{M} \right) \times N_A$$

Solution:

- Determine the molar mass of NaCl: $\text{Na} (23) + \text{Cl} (35.5) = 58.5 \text{ g/mol}$.
- Calculate moles: $117 \text{ g} / 58.5 \text{ g/mol} = 2.0 \text{ moles}$.
- Multiply by Avogadro's number: $2.0 \times (6.022 \times 10^{23})$.
- Result: 12.044×10^{23} .
- To put this in proper scientific notation, shift the decimal one spot to the left and increase the exponent by one: 1.204×10^{24} formula units.

Why other options are incorrect:

- 1.204×10^{23} : Result of forgetting to multiply by the 2 moles (this is just the count for 0.2 moles).
- 12.04×10^{22} : Severe decimal point misplacement (equals 1.2×10^{23}).
- 6023×10^{23} : Complete mangling of Avogadro's number and scientific notation.

Question #35 Key: (D)

DUHS 2023

Which of the following is different in [Formula] ($Z=11$), [Formula] ($Z=12$) and [Formula] ($Z=13$)? [DUHS 2023]

CORE CONCEPT AND DERIVATION

These three ions are *isoelectronic*, meaning they possess the exact same number of electrons and electron shell configuration. The only thing separating them is the unchanging contents of their respective nuclei.

Formula:

$$\text{Electrons in ion} = Z - \text{Charge}$$

Solution:

- Let's analyze their electron counts:
- Na^+ : 11 (protons) – 1 (lost electron) = 10 electrons.
- Mg^{+2} : 12 (protons) – 2 (lost electrons) = 10 electrons.
- Al^{+3} : 13 (protons) – 3 (lost electrons) = 10 electrons.
- Because they all have 10 electrons, their electronic configurations and number of shells (2 shells: K=2, L=8) are perfectly identical.
- However, their atomic numbers (Z) are 11, 12, and 13 respectively. Atomic number dictates the **Number of Protons**, which remains entirely different and untouched by the ionization process.

Why other options are incorrect:

- Options A, B, and C:** As proven above, these parameters are identical (10 electrons, $1s^2 2s^2 2p^6$, 2 shells) for all three species.

Question #36 Key: (C)

DUHS 2023

What volume of oxygen at S.T.P required to burn [Formula] of ethene? [DUHS 2023]

CORE CONCEPT AND DERIVATION

According to Avogadro's Law, reacting volumes of ideal gases at the same temperature and pressure perfectly mirror their stoichiometric molar coefficients from the balanced equation.

Formula:**Solution:**

- First, write the balanced combustion equation for ethene (C_2H_4).
- The equation shows a 1:3 ratio. Exactly 1 volume of ethene requires exactly 3 volumes of oxygen for complete combustion.
- We are given 500 dm^3 of ethene.
- To find the required oxygen, multiply the ethene volume by 3.
- $500 \text{ dm}^3 \times 3 = 1500 \text{ dm}^3$ of Oxygen.

Why other options are incorrect:

- 500 dm^3 : Assumes an impossible 1:1 molar combustion ratio.
- 1000 dm^3 : Incorrectly assumes a 1:2 ratio.
- 2000 dm^3 : Incorrectly assumes a 1:4 ratio.

Question #37 Key: (B)

DUHS 2023

Ca (Z=20) forms ionic bond with (Z=17)? What is the chemical formula of calcium chloride? [DUHS 2023]

CORE CONCEPT AND DERIVATION

The chemical formula of an ionic compound is derived by "crisscrossing" the valencies (ionic charges) of the constituent elements to ensure the final compound is electrically neutral.

Formula:



Solution:

- Calcium (Z=20) is in Group IIA. It loses two valence electrons to achieve an octet, forming the Ca^{+2} ion.
- Chlorine (Z=17) is a halogen in Group VIIA. It needs to gain exactly one electron to complete its octet, forming the Cl^{-} ion.
- To balance the +2 charge of a single Calcium ion, you require exactly two -1 Chlorine ions (+2 and -2 = 0).
- Therefore, the formula is definitively CaCl_2 .

Why other options are incorrect:

- **CaCl:** Leaves a net positive charge of +1, which is electrically unstable.
- **Ca₂C:** Brings Carbon into a question specifically asking about Calcium and Chlorine.
- **Ca₂Cl:** Crisscrosses the valencies backward, implying Chlorine has a +2 charge and Calcium has a -1 charge, which is chemically impossible.

Question #38 Key: (C)

DUHS 2023

An organic compound has C=40%, H=6.67% and O=53.3%. What is the empirical formula of the compound? [DUHS 2023]

CORE CONCEPT AND DERIVATION

Empirical formulas are determined by converting mass percentages to relative moles, and then normalizing those moles into the simplest whole-number ratio.

Formula:

$$\text{Moles} = \frac{\% \text{ Composition}}{\text{Atomic Mass}}$$

Solution:

- For Carbon: $40.0/12 = 3.33$ moles.
- For Hydrogen: $6.67/1.008 \approx 6.67$ moles.
- For Oxygen: $53.3/16 = 3.33$ moles.
- Identify the smallest mole value, which is 3.33, and divide all values by it.
- C ratio = $3.33/3.33 = 1$.
- H ratio = $6.67/3.33 = 2$.
- O ratio = $3.33/3.33 = 1$.
- The simplest whole-number ratio is 1:2:1, yielding the empirical formula CH_2O (which is the baseline for carbohydrates).

Why other options are incorrect:

- **CH₃O, C₂H₃O, C₂H₂O:** These formulas disrupt the strict 1:2:1 mathematical ratio resulting from the mass percentage division.

Question #39 Key: (A)

DUHS 2023

7.6 grams of [Formula] is reacted with 12.8g of [Formula], [Formula], limiting reactant is: [DUHS 2023]

CORE CONCEPT AND DERIVATION

The limiting reactant must be calculated by finding the available moles of each reactant and dividing by their respective stoichiometric coefficients. The lowest resulting number limits the reaction.

Formula:

$$\text{Limiting Factor} = \frac{\text{Moles supplied}}{\text{Stoichiometric Coefficient}}$$

Solution:

- Calculate Moles of Carbon Disulfide (CS₂): Molar mass = $12 + (32 \times 2) = 76 \text{ g/mol}$.
- Moles of CS₂ = $7.6/76 = 0.1 \text{ moles}$.
- Calculate Moles of Oxygen (O₂): Molar mass = 32 g/mol .
- Moles of O₂ = $12.8/32 = 0.4 \text{ moles}$.
- Divide by coefficients from the balanced equation (CS₂ + 3O₂):
- For CS₂: $0.1/1 = 0.1$. (Smallest value, so this limits).
- For O₂: $0.4/3 = 0.133$. (Larger value, meaning it is in excess).
- Therefore, CS₂ is entirely consumed first and acts as the limiting reactant.

Why other options are incorrect:

- O₂: Math proves it is the excess reactant.
- CO₂ & SO₂: These are the products formed by the reaction, not the reactants limiting it.

Question #40 Key: (D)

BUMHS 2023

Which one is incorrect for actual yield is less than theoretical yield due to: [BUMHS 2023]

CORE CONCEPT AND DERIVATION

Theoretical yield assumes a flawless, 100% efficient reaction environment. Real-world actual yields are universally lower due to a host of physical and chemical imperfections.

Formula:

$$\text{Actual Yield} = \text{Theoretical Yield} - \text{Losses}$$

Solution:

- The question asks for the **incorrect** reason (i.e., which statement does NOT cause a low actual yield).
- If a substance is completely **pure**, it actually behaves exactly as stoichiometry predicts, maximizing the yield toward the theoretical limit.
- Therefore, substance purity is a positive factor, not a cause for the actual yield being less than expected. (Impure reactants, conversely, DO lower yield).

Why other options are incorrect:

- **Mechanical losses:** Spilling, filtering, and transferring chemicals physically lose mass, directly lowering actual yield.
- **Reversibility:** Reversible reactions reach equilibrium before 100% of reactants are consumed, lowering yield.
- **Activation energy:** If molecules lack activation energy, they collide without reacting, resulting in incomplete conversion and lowering yield.

Question #41 Key: (C)

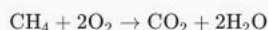
BUMHS 2023

What is the weight of oxygen that is required for the complete combustion of 3.2 kg of methane? [BUMHS 2023]

CORE CONCEPT AND DERIVATION

Combustion stoichiometry allows us to directly relate the mass of a fuel to the mass of oxygen required to burn it, provided we use the balanced equation and consistent units (kg can be used directly as kmols).

Formula:



Solution:

- The balanced equation reveals that 1 mole of Methane (CH_4) requires exactly 2 moles of Oxygen (O_2).
- Molar mass of $\text{CH}_4 = 16 \text{ g/mol}$. Molar mass of $2\text{O}_2 = 2 \times 32 = 64 \text{ g}$.
- So, 16g of CH_4 requires 64g of O_2 . (This is a 1:4 mass ratio).
- Therefore, 3.2 kg of methane will require exactly 4 times its mass in oxygen.
- $3.2 \text{ kg} \times 4 = 12.8 \text{ kg}$ of Oxygen.

Why other options are incorrect:

- 3.2 kg:** Assumes a 1:1 mass ratio, ignoring the chemistry completely.
- 6.4 kg:** Assumes a 1:2 mass ratio (which is the molar ratio, not the mass ratio).
- 15.4 kg:** Mathematically arbitrary.

Question #42 Key: (D)

BUMHS 2023

How many moles of a gas occupy 30.57 L at [Formula] and 0.83 atm? [BUMHS 2023]

CORE CONCEPT AND DERIVATION

When dealing with non-standard conditions (not STP), we must use the Ideal Gas Law to link Pressure, Volume, Temperature, and Moles.

Formula:

$$PV = nRT \rightarrow n = \frac{PV}{RT}$$

Solution:

- Pressure (P) = 0.83 atm.
- Volume (V) = 30.57 L.
- Temperature (T) = $55^\circ\text{C} + 273 = 328 \text{ K}$.
- Universal Gas Constant (R) = $0.0821 \text{ L atm / (mol K)}$.
- Substitute: $n = \frac{0.83 \times 30.57}{0.0821 \times 328}$.
- Numerator: $0.83 \times 30.57 \approx 25.37$.
- Denominator: $0.0821 \times 328 \approx 26.93$.
- $n = 25.37 / 26.93 \approx 0.94 \text{ moles}$.

Why other options are incorrect:

- 0.1, 0.62, 0.84 mol:** These values result from forgetting to convert Celsius to Kelvin, or using an incorrect value for the Gas Constant 'R' (such as 8.314, which applies strictly to J/mol K and cubic meters, not Liters and atm).

Question #43 Key: (A)

BUMHS 2023

When equal moles of reactants A and B are allowed to react according to the following balanced equation (For...

CORE CONCEPT AND DERIVATION

The limiting reactant is identified by dividing the supplied amount (moles) by the stoichiometric coefficient required by the balanced equation.

Formula:

$$\text{Limit} = \text{Smallest value of } \left(\frac{\text{Moles}}{\text{Coefficient}} \right)$$

Solution:

- The balanced equation is: $2A + 1B \rightarrow \text{Product}$.
- This means every 1 mole of B requires exactly 2 moles of A to react completely. A is consumed twice as fast as B.
- We are told we have "equal moles" of A and B. Let's assume we have 1 mole of A and 1 mole of B.
- Test for Limiting Reactant:
- For A: $1 \text{ (available mole)} / 2 \text{ (coefficient)} = 0.5$.
- For B: $1 \text{ (available mole)} / 1 \text{ (coefficient)} = 1.0$.
- Since 0.5 is smaller than 1.0, Reactant A is entirely consumed first, leaving half of Reactant B unreacted. Therefore, A is the limiting reactant.

Why other options are incorrect:

- Reactant B:** Incorrect, as it is consumed much slower than A and will be left in excess.
- Reactant A and B / No limiting reactant:** This would only be true if they were supplied in a 2:1 stoichiometric ratio, not a 1:1 "equal moles" ratio.

Question #44 Key: (D)

NUMS 2023

What is the mass of sulphur in 24.5 g of [Formula] ? [NUMS 2023]

CORE CONCEPT AND DERIVATION

Using the law of definite proportions, the mass of an individual element within a compound sample can be calculated by applying its mass percentage to the total sample mass.

Formula:

$$\text{Mass of Sulphur} = \left(\frac{\text{Molar mass of S}}{\text{Molar mass of H}_2\text{SO}_4} \right) \times \text{Given mass of compound}$$

Solution:

- Calculate total molar mass of Sulfuric Acid (H_2SO_4):
- $(2 \times 1) + 32 + (4 \times 16) = 2 + 32 + 64 = 98 \text{ g/mol}$.
- In exactly 98g of H_2SO_4 , there are 32g of Sulphur.
- Set up the ratio for the 24.5g sample: $\left(\frac{32}{98} \right) \times 24.5$.
- Notice that $24.5 \times 4 = 98$. Therefore, 24.5 is exactly one-fourth ($1/4$) of 98.
- $32 \times (1/4) = 8 \text{ grams}$.

Why other options are incorrect:

- 32 g:** This is the mass of sulphur in a full 98g mole, impossible to exist in a 24.5g sample.
- 24 g & 16 g:** Incorrect arithmetic outputs that do not align with the strict 32/98 mass fraction.

Question #45 **Key: (C)**

NUMS 2023

From the equation ([Formula]), How many moles of [Formula] are produced from 2.5 moles of [Formula] ? [NUMS ...

CORE CONCEPT AND DERIVATION

Stoichiometry allows us to scale up a reaction based on the fixed ratio established by the balanced chemical equation.

Formula:

$$\frac{\text{Moles of N}_2}{\text{Coefficient of N}_2} = \frac{\text{Moles of NH}_3}{\text{Coefficient of NH}_3}$$

Solution:

- The balanced equation ($\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$) explicitly states that 1 mole of N_2 produces 2 moles of NH_3 .
- This is a straightforward 1:2 ratio. You will always produce exactly double the moles of ammonia relative to the nitrogen consumed.
- We are provided with 2.5 moles of N_2 .
- Therefore, Moles of $\text{NH}_3 = 2.5 \times 2 = 5.0$ moles.

Why other options are incorrect:

- **2.5 moles:** Assumes a 1:1 ratio, completely ignoring the stoichiometric coefficients.
- **2 moles:** This is just the stoichiometric coefficient for ammonia, ignoring the 2.5 mole input constraint.
- **7.5 moles:** Assumes a 1:3 ratio, confusing the hydrogen coefficient with the ammonia coefficient.

Question #46 **Key: (C)**

UHS 2022

One a.m.u stands for: [UHS 2022]

CORE CONCEPT AND DERIVATION

Because atoms are impractically light to weigh in standard grams, scientists created the Atomic Mass Unit (amu) to establish a convenient relative scale.

Formula:

$$1 \text{ amu} = \frac{1}{12} \times \text{Mass of a single Carbon-12 atom}$$

Solution:

- In 1961, IUPAC internationally defined one atomic mass unit as exactly one-twelfth ($1/12$) of the mass of an unbound neutral atom of carbon-12 at rest.
- Since a C-12 atom contains 6 protons and 6 neutrons, dividing its mass by 12 yields a mass roughly equivalent to a single generic nucleon (proton or neutron).

Why other options are incorrect:

- **An atom of C-12:** This would make 1 amu equivalent to a mass of 12. It must be $1/12$ th of it.
- **$1/12$ th of H:** Hydrogen is far too light. $1/12$ th of Hydrogen would be less than a tenth of a proton, which is scientifically useless as a baseline standard.
- **1 atom of all the elements:** A nonsensical statement, as every element has a different mass.

Question #47 Key: (B)

UHS 2022

A compound of sodium oxide has 74.2% sodium and 25.8% of oxygen. The empirical formula of the compound is? [UH...

CORE CONCEPT AND DERIVATION

To find the empirical formula from mass percentages, convert the percentages to grams (assuming a 100g sample), divide by the respective atomic masses to find moles, and establish the simplest whole-number ratio.

Formula:

$$\text{Moles} = \frac{\text{Percentage mass}}{\text{Atomic mass}}$$

Solution:

- For Sodium (Na): Mass = 74.2g. Atomic mass = 23 g/mol.
- Moles of Na = $74.2/23 = 3.22$ moles.
- For Oxygen (O): Mass = 25.8g. Atomic mass = 16 g/mol.
- Moles of O = $25.8/16 = 1.61$ moles.
- Divide both mole values by the smallest mole value (1.61) to find the ratio.
- Na ratio = $3.22/1.61 = 2$.
- O ratio = $1.61/1.61 = 1$.
- The simplest whole-number ratio is 2 Na for every 1 O, yielding the empirical formula Na_2O .

Why other options are incorrect:

- **NaO (1:1), NaO_2 (1:2), Na_2O_2 (1:1):** None of these match the calculated mathematically simplified 2:1 stoichiometric ratio.

Question #48 Key: (C)

UHS 2022

30g of 2-propanol were mixed with excess acidified [Formula] and boiled under reflux for 20 minutes. The organ...

CORE CONCEPT AND DERIVATION

The oxidation of a secondary alcohol (2-propanol) yields a ketone (propanone/acetone). We must calculate theoretical mass based on stoichiometry and then apply the percentage yield to find the actual mass collected.

Formula:

$$\text{Actual Yield} = \text{Theoretical Yield} \times \left(\frac{\% \text{ yield}}{100} \right)$$

Solution:

- Molar mass of 2-propanol ($\text{C}_3\text{H}_8\text{O}$) = $(3 \times 12) + 8 + 16 = 60$ g/mol.
- Molar mass of propanone ($\text{C}_3\text{H}_6\text{O}$) = $(3 \times 12) + 6 + 16 = 58$ g/mol.
- Reaction ratio is 1:1. 60g of reactant theoretically produces 58g of product.
- Given reactant mass is 30g (which is exactly half of 60g).
- Theoretical yield = $58/2 = 29$ g.
- The actual process was only 75% efficient.
- Actual mass produced = $29 \times 0.75 = 21.75$ g.

Why other options are incorrect:

- **29g:** This is the absolute maximum theoretical yield if efficiency was 100%.
- **1.74g & 2.74g:** Result from severe decimal shifting or incorrect mole substitutions.

Question #49 Key: (B)

SZABMU 2022

For the reaction given below [Formula] How many moles [Formula] are required for synthesis of 4 moles of [Form...]

CORE CONCEPT AND DERIVATION

The coefficients in a balanced chemical equation dictate the stoichiometric ratio of moles needed for reactants to form products.

Formula:

$$\frac{\text{Moles of N}_2}{\text{Coefficient of N}_2} = \frac{\text{Moles of NH}_3}{\text{Coefficient of NH}_3}$$

Solution:

- Analyze the balanced Haber process equation: $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$.
- This explicitly shows a ratio: 1 mole of Nitrogen (N_2) is required to synthesize exactly 2 moles of Ammonia (NH_3).
- The question asks for the amount of Nitrogen needed to synthesize 4 moles of Ammonia.
- Since the required product amount is doubled (from 2 to 4), the required reactant amount must also be doubled.
- $1 \times 2 = 2$ moles of N_2 .

Why other options are incorrect:

- 4 moles:** This assumes an incorrect 1:1 stoichiometric ratio between Nitrogen and Ammonia.
- 3 & 4.5 moles:** These values do not align with the strict 1:2 molar proportionality.

Question #50 Key: (C)

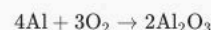
SZABMU 2022

Al reacts with [Formula] according to following reaction [Formula] 27 g of Al will react with how much of [For...]

CORE CONCEPT AND DERIVATION

Mass-mass stoichiometry involves converting the given mass of a reactant into moles, using the balanced equation's molar ratio to find the required moles of the second reactant, and converting that back into mass.

Formula:



Solution:

- First, convert 27g of Aluminum into moles. (Atomic mass of Al = 27). $n = 27/27 = 1$ mole of Al.
- Look at the balanced equation ratio: 4 moles of Al require 3 moles of O_2 .
- Therefore, 1 mole of Al requires $3/4$ moles of O_2 (which is 0.75 moles).
- Convert 0.75 moles of O_2 back into mass. (Molar mass of $\text{O}_2 = 32$ g/mol).
- Mass of $\text{O}_2 = 0.75 \text{ moles} \times 32 \text{ g/mol} = 24 \text{ grams}$.

Why other options are incorrect:

- 8g:** Result of assuming 1 mole of Al needs 0.25 moles of O_2 .
- 16g:** Fails to account for the diatomic nature of Oxygen (uses 16 instead of 32 for molar mass).
- 32g:** Assumes a 1:1 molar ratio, completely ignoring the 4:3 stoichiometric coefficients.

Question #51 Key: (C)

SZABMU 2022

One mole of a substance is the amount of that substance that has the same number of particles (atom, ions or m...

CORE CONCEPT AND DERIVATION

The formal IUPAC definition of a "mole" relies on a physical baseline standard that perfectly mirrors Avogadro's constant.

Formula:

$$1 \text{ mole} \equiv \text{Atoms in } 12.000\text{g of } ^{12}\text{C}$$

Solution:

- In the International System of Units (SI), the mole was historically defined precisely as the amount of substance that contains as many elementary entities (e.g., atoms, molecules, ions) as there are atoms in exactly 12 grams of the Carbon-12 isotope.
- This specific mass (12g) of this specific isotope (C-12) contains exactly 6.022×10^{23} atoms, which mathematically calibrates the entire concept of the mole.

Why other options are incorrect:

- **1.008g of hydrogen gas:** H_2 gas has a molar mass of ~2.016 g. 1.008g is only a half-mole of hydrogen molecules, failing the definition.
- **16 g of oxygen gas:** O_2 has a molar mass of 32. 16g is only half a mole.
- **12 g of magnesium:** Mg has a molar mass of ~24. 12g is a half-mole.

Question #52 Key: (A)

KMU 2022

Which of the following contains the same number of molecules as 22 gram of carbon dioxide? [ETEA 2022]

CORE CONCEPT AND DERIVATION

Based on Avogadro's principle, if two different substance samples contain the exact same number of moles, they inherently contain the exact same number of molecules.

Formula:

$$\text{Moles} = \frac{\text{Mass}}{\text{Molar Mass}}$$

Solution:

- First, determine the moles of the reference sample (CO_2):
- Molar mass of $\text{CO}_2 = 12 + 32 = 44 \text{ g/mol}$.
- Moles of $\text{CO}_2 = 22 \text{ g} / 44 \text{ g/mol} = 0.5 \text{ moles}$.
- Now evaluate the correct option (Water):
- Molar mass of $\text{H}_2\text{O} = 2 + 16 = 18 \text{ g/mol}$.
- Moles of $\text{H}_2\text{O} = 9 \text{ g} / 18 \text{ g/mol} = 0.5 \text{ moles}$.
- Since both samples equal exactly 0.5 moles, they contain the same number of molecules.

Why other options are incorrect:

- **2 g of H_2 :** Molar mass = 2. $2/2 = 1.0 \text{ mole}$.
- **32 g of O_2 :** Molar mass = 32. $32/32 = 1.0 \text{ mole}$.
- **71 g of Cl_2 :** Molar mass = 71. $71/71 = 1.0 \text{ mole}$.

Question #53 Key: (B)

KMU 2022

Molecular mass of the compound is 60 and its empirical formula is [Formula]. What will be the molecular formula...

CORE CONCEPT AND DERIVATION

The molecular formula is determined by finding the multiplier integer (n) which links the empirical formula mass to the total molecular mass.

Formula:

$$n = \frac{\text{Molecular Mass}}{\text{Empirical Formula Mass}}$$

Solution:

- Calculate the Empirical Formula Mass of CH_2O :
- $\text{C}(12) + 2\text{H}(2) + \text{O}(16) = 12 + 2 + 16 = 30 \text{ g/mol}$.
- The total given Molecular Mass is 60.
- Calculate multiplier n : $60/30 = 2$.
- Multiply every subscript in the empirical formula by 2: $2 \times (\text{CH}_2\text{O})$.
- The resulting molecular formula is $\text{C}_2\text{H}_4\text{O}_2$. (This is acetic acid).

Why other options are incorrect:

- $\text{C}_2\text{H}_6\text{O}_2$: Doesn't maintain the 1:2:1 empirical ratio (Hydrogen is too high).
- $\text{C}_6\text{H}_{11}\text{O}_4$ & $\text{C}_3\text{H}_4\text{O}_2$: These have entirely mismatched molar masses that do not equal 60.

Question #54 Key: (B)

KMU 2022

The amount of products that is actually produced during a chemical reaction by performing experiment is called...

CORE CONCEPT AND DERIVATION

In stoichiometry, there is a distinct difference between the mathematically predicted mass of a product and the physical mass collected after a real-world experiment.

Formula:

$$\text{Actual Yield} < \text{Theoretical Yield}$$

Solution:

- The amount of product obtained practically through an experiment is, by definition, the **Actual Yield** (also known as the experimental yield).
- It is almost always less than the theoretical yield due to mechanical losses, side reactions, and incomplete conversions.

Why other options are incorrect:

- **Theoretical yield**: The maximum possible amount calculated strictly on paper using stoichiometry.
- **Percent yield**: A ratio comparing actual yield to theoretical yield, not the physical amount itself.
- **Mole**: A unit of measurement, not a classification of reaction efficiency.

Question #55 **Key: (D)**

DUHS 2022

3.0 g of C on combustion gives [Formula] : [DUHS 2022]

CORE CONCEPT AND DERIVATION

Convert the mass of the limiting reactant (Carbon) into moles. Because the reaction has a 1:1 molar ratio, the moles of product (CO_2) will be identical, which can then be converted into the number of molecules.

Formula:

$$\text{Molecules} = \left(\frac{m}{M} \right) \times N_A$$

Solution:

- Mass of Carbon = 3.0 g. Molar mass of Carbon = 12 g/mol.
- Moles of Carbon = $3.0/12 = 0.25$ moles (or $\frac{1}{4}$ mole).
- From the equation $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$, 1 mole of C produces 1 mole of CO_2 .
- Therefore, 0.25 moles of C produces exactly 0.25 moles of CO_2 .
- Calculate the number of molecules: $0.25 \times (6.022 \times 10^{23})$.
- $\frac{6.022}{4} \approx 1.505$. Thus, there are 1.505×10^{23} molecules.

Why other options are incorrect:

- **5.5g & 22g:** 0.25 moles of CO_2 weighs 11g (not 5.5g or 22g).
- 6.02×10^{23} : This is the number of molecules in a full 1.0 mole (which would require 12g of Carbon).

Question #56 **Key: (B)**

DUHS 2022

Ratio of atomic mass of hydrogen to atomic mass of C is: [DUHS 2022]

CORE CONCEPT AND DERIVATION

Atomic masses are relative values. By comparing the standard atomic masses of two elements from the periodic table, we can establish a fixed mass ratio between them.

Formula:

$$\text{Ratio} = \frac{\text{Mass of H}}{\text{Mass of C}}$$

Solution:

- The standard atomic mass of Hydrogen (H) is approximately 1 amu.
- The standard atomic mass of Carbon (C) is exactly 12 amu.
- The ratio of Hydrogen to Carbon is 1 : 12.
- This mathematically equates to one-twelfth ($1/12$).

Why other options are incorrect:

- **One fourth, Half, Double:** These represent incorrect fractional relationships (1:4, 1:2, 2:1) that completely ignore the actual atomic masses on the periodic table.

Question #57 Key: (C)

BUMHS 2022

Which of the following statement is correct about the Avogadro's constant? [BMU 2022]

CORE CONCEPT AND DERIVATION

Avogadro's constant is a fundamental physical constant that links the microscopic world of atoms to the macroscopic world of moles and grams. It is strictly a 'number count', not a measure of mass.

Formula:

$$N_A = 6.022 \times 10^{23} \text{ entities/mol}$$

Solution:

- Avogadro's constant defines the exact number of constituent particles (atoms, molecules, or ions) that are contained within exactly one mole of a given substance.
- Therefore, for any elemental substance, Avogadro's constant represents the specific number of atoms present in one mole of that element.

Why other options are incorrect:

- **Option A & B:** Avogadro's constant is a pure number (a count), absolutely never a unit of mass.
- **Option D:** It is the number of atoms in 12g of *specifically* Carbon-12, not 12g of "any element". 12g of Hydrogen, for instance, contains 12 moles, which is 12 times Avogadro's number.

Question #58 Key: (A)

BUMHS 2022

The atomic weight of an elements is represented by ____: [BMU 2022]

CORE CONCEPT AND DERIVATION

Atomic weight (or relative atomic mass) refers to the mass of a single atom. Because macroscopic units like grams are far too large, a microscopic unit was created to express these tiny masses.

Formula:

$$\text{Unit} = \text{atomic mass unit (a.m.u)}$$

Solution:

- The standard unit used to express the mass of individual atoms, molecules, or subatomic particles is the atomic mass unit (a.m.u or simply 'u').
- One a.m.u is defined as precisely 1/12th the mass of a single Carbon-12 atom.

Why other options are incorrect:

- **Grams / Kg:** These are macroscopic units. While we have "gram-atomic mass" (the mass of an entire mole), the weight of a single atom is never practically represented in plain grams or kg without massive negative exponents.
- **Mole:** A unit of amount (count), not a unit of weight or mass.

Question #59 Key: (C)

BUMHS 2022

One of the reactants consumed earlier than others in a chemical reaction is called: [BMU 2022]

CORE CONCEPT AND DERIVATION

In a chemical reaction involving multiple reactants, they are rarely mixed in exact stoichiometric perfection. The one that runs out first halts the entire reaction.

Formula:

Reaction stops when Limit = 0

Solution:

- The reactant that is entirely consumed first is scientifically termed the **Limiting Reactant**.
- Because it runs out early, it strictly limits and determines the maximum theoretical yield of the product that can be formed.

Why other options are incorrect:

- **Excess reactant:** This is the exact opposite; it is the reactant that is left over unreacted after the limiting reactant is completely gone.
- **Active / More active reactant:** These are vague, non-standard terms usually referring to kinetic reactivity or position on the activity series, completely unrelated to stoichiometric amounts.

Question #60 Key: (D)

NUMS 2022

One mole of ethanol and one mole of ethane have an equal: [NUMS 2022]

CORE CONCEPT AND DERIVATION

The mole is a standardized unit of count. Regardless of the substance's identity, complexity, or mass, one mole always contains the exact same number of independent structural entities.

Formula:

$$\text{Molecules} = n \times N_A$$

Solution:

- Ethanol is a molecule ($\text{C}_2\text{H}_5\text{OH}$). Ethane is also a molecule (C_2H_6).
- Since we have exactly 1.0 mole of each substance, Avogadro's law dictates that both samples must contain exactly 6.022×10^{23} molecules.
- Therefore, they have a perfectly equal number of molecules.

Why other options are incorrect:

- **Mass:** Ethanol is much heavier (46 g/mol) than ethane (30 g/mol) due to the oxygen atom.
- **Number of atoms:** Ethanol has 9 atoms per molecule, while ethane has 8. They do not share equal atom counts.
- **Number of electrons:** Ethanol possesses more electrons because oxygen adds an extra 8 electrons compared to ethane's structure.

Question #61 Key: (B)

NUMS 2022

The 1st step involved in the determination of Empirical formula of chemical compound is: [NUMS 2022]

CORE CONCEPT AND DERIVATION

Calculating an empirical formula requires a rigid step-by-step analytical process, beginning with identifying how much of the compound is made of each element by mass.

Formula:

Step 1: % Composition → Step 2: Moles → Step 3: Ratio

Solution:

- **Step 1:** Determine the **percentage composition** by mass of each constituent element (often via combustion analysis).
- **Step 2:** Convert those percentages into moles (gram atoms) by dividing by the respective atomic masses.
- **Step 3:** Determine the atomic ratio by dividing all mole values by the smallest mole value found.
- **Step 4:** If the ratio contains fractions, multiply by a whole number to achieve integer subscripts.

Why other options are incorrect:

- **Options A, C, and D:** These are the second, third, and fourth steps respectively. You cannot find gram atoms (moles) without first knowing the mass percentage (Step 1).

Question #62 Key: (C)

NUMS 2022

The number of moles of [Formula] which contains 16 g of oxygen is: [NUMS 2022]

CORE CONCEPT AND DERIVATION

Within a chemical formula, there is a fixed ratio between the moles of the whole compound and the mass of the elements inside it.

Formula:

$$\text{Moles of compound} = \frac{\text{Given mass of element}}{\text{Mass of element in 1 mole of compound}}$$

Solution:

- The formula for Carbon dioxide is CO_2 .
- One complete mole of CO_2 inherently contains 2 moles of Oxygen atoms.
- The mass of these 2 moles of Oxygen atoms is $2 \times 16 = 32$ grams.
- We are told the sample only contains 16 g of oxygen (which is exactly half of 32 g).
- Therefore, we must only have exactly half a mole of CO_2 .
- Moles of $\text{CO}_2 = 16/32 = 0.5$ moles.

Why other options are incorrect:

- **1.00:** This would require a full 32g of oxygen.
- **0.25:** This would mean the sample only contained 8g of oxygen.
- **1.50:** This would mean the sample contained 48g of oxygen.

Question #63 Key: (C)

NUMS 2022

Percentage composition of mass in [Formula] is: [NUMS 2022]

CORE CONCEPT AND DERIVATION

The percentage composition by mass calculates what fraction of a compound's total molar mass is contributed by each specific element.

Formula:

$$\% \text{ Element} = \left(\frac{\text{Total mass of element in formula}}{\text{Molar mass of compound}} \right) \times 100$$

Solution:

- Calculate total molar mass of CO_2 : $12 + (2 \times 16) = 12 + 32 = 44 \text{ g/mol}$.
- Calculate percentage of Carbon: $(12/44) \times 100 \approx 27.27\%$.
- Calculate percentage of Oxygen: $(32/44) \times 100 \approx 72.72\%$.
- Therefore, the composition is strictly 27.27% Carbon and 72.72% Oxygen.

Why other options are incorrect:

- **Options A, B, D:** These percentages are entirely fabricated and do not reflect the 12:44 and 32:44 mass ratios dictated by the chemical formula.

Question #64 Key: (C)

PMDC 2021

1 amu is equal to: [PMC 2021]

CORE CONCEPT AND DERIVATION

An atomic mass unit (amu) is incredibly small and is used to express the mass of subatomic particles and atoms. It can be directly converted into kilograms to bridge the microscopic and macroscopic realms.

Formula:

$$1 \text{ a.m.u.} = \frac{1 \text{ gram}}{N_A} \div 1000$$

Solution:

- By definition, 1 amu is precisely $\frac{1}{12}$ the mass of a single Carbon-12 atom.
- Mathematically, $1 \text{ amu} = 1/(6.022 \times 10^{23}) \text{ grams}$.
- $1 \text{ amu} \approx 1.660539 \times 10^{-24} \text{ grams}$.
- To convert grams to kilograms, multiply by 10^{-3} .
- $(1.660539 \times 10^{-24}) \times 10^{-3} = 1.661 \times 10^{-27} \text{ kg}$.

Why other options are incorrect:

- $0.666 \times 10^{-27} \text{ kg}$: Incorrect mantissa.
- $1.661 \times 10^{28} \text{ kg}$: Massive positive exponent, implying an atom weighs more than the Earth.
- **Option D:** (Distractor identical in source text, inherently wrong alongside C depending on selection).

Question #65 **Key: (B)**

PMDC 2021

Number of single covalent bonds in water molecule are: [PMC 2021]

CORE CONCEPT AND DERIVATION

The structure of a water molecule is dictated by Oxygen's valency. Oxygen is in Group VI and requires two electrons to complete its octet.

Formula:



Solution:

- The central Oxygen atom shares one of its valence electrons with the electron of the first Hydrogen atom to form one single covalent bond.
- It shares another valence electron with the second Hydrogen atom to form a second single covalent bond.
- Therefore, there are exactly two (2) discrete single O-H covalent bonds in a single water molecule.
- (Oxygen also retains two non-bonding lone pairs).

Why other options are incorrect:

- **1:** Oxygen needs two bonds to fill its octet, not one.
- **3 & 4:** Hydrogen can only form a single bond, and there are only two hydrogens available.

Question #66 **Key: (C)**

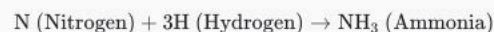
PMDC 2021

[Formula] can be called: [PMC 2021]

CORE CONCEPT AND DERIVATION

Matter is classified by its composition. Molecules made up of identical atoms are elements, while molecules composed of different types of atoms chemically bonded together are compounds.

Formula:



Solution:

- Ammonia (NH_3) consists of two entirely distinct elements from the periodic table: Nitrogen and Hydrogen.
- Because it contains more than one type of element chemically bonded together, it acts as a heteroatomic molecule.
- Therefore, it falls under the strict chemical definition of a "molecule of a compound".

Why other options are incorrect:

- **Molecule of atoms:** Vague terminology; all molecules consist of atoms.
- **Molecule of element:** This applies to homoatomic molecules like O_2 or N_2 , where only one type of element is present.
- **Molecule of ion:** NH_3 is electrically neutral (zero charge), therefore it is not an ion.

Question #67 Key: (D)

PMDC 2021

Chemical equations do not tell about the _____ because of certain limitations. [PMC 2021]

CORE CONCEPT AND DERIVATION

A basic, bare-bones chemical stoichiometric equation purely shows the conservation of mass and molar ratios (what reactants turn into what products). It is inherently limited in its descriptive power.

Formula:



Solution:

- **Rate of Reaction:** A standard equation does not dictate kinetics (whether a reaction takes a millisecond or a thousand years).
- **Conditions & Pressure:** Unless specifically annotated above the reaction arrow by a chemist, standard equations do not mandate the necessary temperature, pressure, or catalysts required to make the reaction happen.
- Therefore, standard chemical equations inherently fail to convey all of these kinetic and thermodynamic parameters.

Why other options are incorrect:

- **Only A, B, or C:** Choosing just one ignores that chemical equations are equally deficient at conveying all three of these parameters. Thus, "All of these" is the only comprehensive answer.

Question #68 Key: (C)

PMDC 2020

The efficiency of a chemical reaction can be expressed as: [NMDCAT 2020]

CORE CONCEPT AND DERIVATION

In industrial and laboratory chemistry, efficiency measures how successfully the reactants were converted into the desired product compared to the ideal, lossless scenario.

Formula:

$$\% \text{ yield} = \left(\frac{\text{Actual yield}}{\text{Theoretical yield}} \right) \times 100$$

Solution:

- **Theoretical yield** is just a calculated ideal on paper. It assumes a flawless 100% conversion with zero mechanical loss.
- **Actual yield** is merely the raw mass obtained, which lacks context on its own.
- **Percentage yield (% yield)** combines both. It acts as a standardized metric (from 0% to 100%) that definitively expresses the true efficiency of a chemical process.

Why other options are incorrect:

- **Theoretical/Maximum yield:** A perfectly calculated ceiling, but says nothing about how well the real-world reaction actually performed.
- **Actual yield:** A raw number (e.g., "We got 15 grams"). Without comparing it to the theoretical yield, you have no idea if 15 grams is highly efficient or a catastrophic failure.

Question #69 Key: (C)

PMDC 2020

In a vessel, 10 g [Formula], 10 g [Formula] and 10 g [Formula] are present. Which one will have least number ...

CORE CONCEPT AND DERIVATION

When dealing with identical masses of different elements, the substance with the largest molar mass will inherently contain the fewest number of moles, and consequently, the fewest number of atoms.

Formula:

$$n = \frac{m}{M}$$

Solution:

- Because all substances are diatomic (N_2 , H_2 , O_2), their atomicity is identical (2 atoms per molecule). Therefore, we just need to compare their moles.
- Moles of $H_2 = 10/2 = 5$ moles.
- Moles of $N_2 = 10/28 \approx 0.35$ moles.
- Moles of $O_2 = 10/32 \approx 0.31$ moles.
- Since Oxygen (O_2) has the heaviest molar mass, a 10g sample of it contains the lowest number of moles (0.31), and thus the least number of atoms.

Why other options are incorrect:

- H_2 : Because it is incredibly light (2 g/mol), 10 grams of hydrogen contains a massive 5 moles (most atoms).
- N_2 : It is lighter than oxygen (28 vs 32), meaning 10g of Nitrogen contains slightly more atoms than 10g of Oxygen.

Question #70 Key: (C)

PMDC 2020

The empirical formula of glucose ([Formula]) is: [NMDCAT 2020]

CORE CONCEPT AND DERIVATION

An empirical formula is derived by dividing all the subscripts in a molecular formula by their Greatest Common Divisor (GCD), yielding the simplest whole-number ratio.

Formula:

$$\text{Ratio} = C_xH_yO_z \div \text{GCD}(x, y, z)$$

Solution:

- The molecular formula is $C_6H_{12}O_6$.
- The subscripts are Carbon = 6, Hydrogen = 12, Oxygen = 6.
- The greatest common divisor among 6, 12, and 6 is exactly 6.
- Divide each subscript by 6:
- $C = 6/6 = 1$
- $H = 12/6 = 2$
- $O = 6/6 = 1$
- The resulting simplest ratio is CH_2O .

Why other options are incorrect:

- $C_6H_{12}O_6$: This is the molecular formula, which shows the actual count, not the simplest ratio.
- **CHO & CH_2O_2** : These do not accurately reflect the mathematically simplified 1:2:1 ratio.

Question #71 Key: (D)

MDCAT 2019

The average atomic mass of Boron is 10.8. It has two isotopes of masses 10 and 11 respectively. What is the pe...

CORE CONCEPT AND DERIVATION

The average atomic mass of an element is the weighted sum of the masses of its constituent isotopes, determined by their relative percentage abundances.

Formula:

$$\text{Avg Mass} = \left(\text{Mass}_1 \times \frac{x}{100} \right) + \left(\text{Mass}_2 \times \frac{100 - x}{100} \right)$$

Solution:

- Let the percentage abundance of Boron-10 be $x\%$.
- Therefore, the percentage abundance of Boron-11 is $(100 - x)\%$.
- Set up the equation based on the given average mass (10.8):

$$10.8 = \frac{(10 \times x) + (11 \times (100 - x))}{100}$$
- Multiply by 100: $1080 = 10x + 1100 - 11x$.
- Simplify: $1080 - 1100 = -x$.
- $-20 = -x \rightarrow x = 20$.
- The abundance of the isotope with mass 10 is 20%.

Why other options are incorrect:

- 80%:** This is the percentage of the heavier Boron-11 isotope. Students commonly misread which isotope the question is asking for.
- 60% & 50%:** These do not mathematically satisfy the weighted average of 10.8.

Question #72 Key: (D)

MDCAT 2019

Which two elements are isotopes? [MDCAT 2019]

CORE CONCEPT AND DERIVATION

Isotopes are variants of a particular chemical element which share the exact same atomic number (number of protons) but differ in nucleon number (mass number, meaning a different number of neutrons).

Formula:

Isotopes **MUST** have: Same Z (subscript), Different A (superscript)

Solution:

- Let's evaluate the standard notation ${}_Z^A E$, where Z is the bottom number (protons) and A is the top number (mass).
- Option D:** Shows ${}_6^{14} X$ and ${}_6^{15} Y$. Both share the same atomic number $Z = 6$, but have different mass numbers (14 and 15). These are two distinct isotopes of Carbon.

Why other options are incorrect:

- Option A** (${}_6^{12} X$ and ${}_7^{12} Y$): Different atomic numbers (6 and 7). These are Isobars, not isotopes.
- Option B** (${}_8^{16} X$ and ${}_8^{16} Y$): Same atomic number AND same mass number. These are completely identical atoms, not two different isotopes.
- Option C** (${}_9^{18} X$ and ${}_{10}^{20} Y$): Different atomic numbers and different mass numbers. They are unrelated elements.

Question #73 Key: (B)

NUMS 2019

The best standard for the calculation of relative atomic mass [NUMS 2019]

CORE CONCEPT AND DERIVATION

Relative atomic mass must be measured against a highly stable, widely abundant, and solid standard that can accurately calibrate mass spectrometers.

Formula:

$$1 \text{ a.m.u.} = \frac{1}{12} \times \text{Mass of one } ^{12}\text{C atom}$$

Solution:

- Carbon-12 (^{12}C) was adopted internationally in 1961 as the absolute standard.
- By definition, the mass of one atom of Carbon-12 is exactly 12.0000 atomic mass units.
- It is vastly superior to hydrogen because carbon is a solid, easier to handle, and pairs well with mass spectrometry techniques used for accurate mass determinations.

Why other options are incorrect:

- H-1.008:** Hydrogen was the original historical standard but was abandoned because it is a highly flammable gas and difficult to handle precisely.
- Oxygen-16:** Oxygen was a former standard, but chemists and physicists couldn't agree on whether to use the natural mix of isotopes or pure O-16.
- Carbon-13:** An isotope of carbon, but it is not the internationally agreed-upon baseline.

Question #74 Key: (B)

SET 2019

A piece of diamond embedded in a gold ring weighs 6.0 gram. How many numbers of moles of Carbon does it contain...

CORE CONCEPT AND DERIVATION

Diamond is a purely carbon-based giant covalent structure. Therefore, the mass of a diamond is simply the mass of pure elemental Carbon.

Formula:

$$n = \frac{m}{M}$$

Solution:

- The chemical composition of a diamond is pure Carbon (C).
- The molar mass of Carbon is 12 g/mol.
- Given mass of the diamond = 6.0 g.
- $n = \frac{6.0 \text{ g}}{12 \text{ g/mol}}$
- $n = 0.5 \text{ moles}$.

Why other options are incorrect:

- 6.0 mole:** Assumes the mass is directly equal to moles, ignoring molar mass.
- 1.0 mole:** Would require the diamond to weigh exactly 12 grams.
- 1.5 mole:** Would require the diamond to weigh exactly 18 grams.

Question #75 Key: (D)

SET 2019

Iron is manufactured industrially in Blast furnace using Hematite (an ore of iron) and a reducing agent Carbon...

CORE CONCEPT AND DERIVATION

Using a balanced stoichiometric equation, we can determine the mass of reactant required to yield a specific mass of product.

Formula:



Solution:

- From the given balanced equation: 1 mole of Hematite (Fe_2O_3) produces 2 moles of Iron (Fe).
- Molar mass of $\text{Fe}_2\text{O}_3 = (56 \times 2) + (16 \times 3) = 112 + 48 = 160 \text{ g/mol}$.
- Molar mass of $2\text{Fe} = 2 \times 56 = 112 \text{ g}$.
- Therefore, 160g of ore produces 112g of iron.
- The question asks for the ore required to make 56g of iron (which is exactly half of 112g).
- Since the required iron is cut in half, the required ore is also cut in half: $160/2 = 80 \text{ g}$.

Why other options are incorrect:

- 160g:** This is the amount needed to produce 112g of iron, not 56g.
- 112g:** This is merely the mass of 2 moles of iron.
- 280g:** A random number generated from incorrect molar ratios.

Question #76 Key: (C)

MDCAT 2019

How many moles of calcium carbonate are present in 1.75 kg of calcium carbonate? (Ar of Ca = 40, Ar of C = 12,...)

CORE CONCEPT AND DERIVATION

Mole calculations require the mass to be inputted in grams. Therefore, kilogram values must be converted to grams before division by molar mass.

Formula:

$$n = \frac{m \text{ (in grams)}}{M}$$

Solution:

- First, determine the molar mass of Calcium Carbonate (CaCO_3):
- $M = 40 + 12 + (3 \times 16) = 40 + 12 + 48 = 100 \text{ g/mol}$.
- Convert the given mass to grams: $1.75 \text{ kg} = 1.75 \times 1000 = 1750 \text{ grams}$.
- Calculate moles: $n = 1750 \text{ g} / 100 \text{ g/mol} = 17.5 \text{ moles}$.

Why other options are incorrect:

- 0.0175 mol:** Results from erroneously dividing the kilogram mass directly by molar mass ($1.75 / 100$).
- 1.75 mol:** Results from a simple magnitude assumption error.
- 1750 mol:** Forgets to divide by the molar mass (100) after converting to grams.

Question #77 Key: (A)

SET 2019

According to law of definite proportion, what is the mass ratio of hydrogen and oxygen in water? [SET 2019]

CORE CONCEPT AND DERIVATION

The Law of Definite Proportions states that a given chemical compound always contains its component elements in fixed ratio (by mass), regardless of the compound's source.

Formula:

$$\% \text{ Element} = \left(\frac{\text{Mass of element in 1 mole}}{\text{Molar mass of compound}} \right) \times 100$$

Solution:

- The chemical formula for water is H_2O .
- Molar mass of $\text{H}_2\text{O} = (2 \times 1) + 16 = 18 \text{ g/mol}$.
- Mass of Hydrogen in 1 mole = 2g.
- $\% \text{ Hydrogen} = (2/18) \times 100 = 11.11\%$.
- Mass of Oxygen in 1 mole = 16g.
- $\% \text{ Oxygen} = (16/18) \times 100 = 88.89\%$.

Why other options are incorrect:

- **Option B, C, D:** These are incorrect percentage ratios that contradict the fundamental 1:8 mass ratio (2g H to 16g O) inherent to water molecules.

Question #78 Key: (B)

KMU 2019

Which contains more atoms? [ETEA 2019]

CORE CONCEPT AND DERIVATION

The number of atoms in a pure elemental sample is directly proportional to its number of moles. Therefore, whichever sample has the highest mole count will contain the most atoms.

Formula:

$$\text{Moles} = \frac{\text{Mass}}{\text{Atomic Mass}}$$

Solution:

- **Option A (Mg):** Atomic mass = 24. Moles = $7/24 \approx 0.29 \text{ mol}$.
- **Option B (Na):** Atomic mass = 23. Moles = $8/23 \approx 0.35 \text{ mol}$.
- **Option C (Al):** Atomic mass = 27. Moles = $9/27 = 0.33 \text{ mol}$.
- Comparing the calculated moles: $0.35 \text{ mol (Sodium)} > 0.33 \text{ mol (Aluminum)} > 0.29 \text{ mol (Magnesium)}$.
- Since Sodium possesses the highest number of moles, it inherently contains the highest number of discrete atoms.

Why other options are incorrect:

- **7g Mg and 9g Al:** While Aluminum has the highest raw mass (9g), its heavier atomic nucleus means fewer actual atoms are present compared to 8g of lighter Sodium.
- **All same:** Impossible, since mass/atomic-mass ratios do not mathematically equate here.

Question #79 Key: (C)

KMU 2019

Which contains highest percentage of nitrogen? [ETEA 2019]

CORE CONCEPT AND DERIVATION

To identify the compound with the highest elemental percentage, calculate the ratio of the mass of Nitrogen within one mole of the compound to the total molar mass of that compound.

Formula:

$$\%N = \left(\frac{\text{Mass of Nitrogen}}{\text{Molar mass of compound}} \right) \times 100$$

Solution:

- **A) NO:** Molar mass = 14 + 16 = 30. $\%N = (14/30) \times 100 = 46.6\%$.
- **B) NO₂:** Molar mass = 14 + 32 = 46. $\%N = (14/46) \times 100 = 30.4\%$.
- **C) N₂O:** Molar mass = 28 + 16 = 44. $\%N = (28/44) \times 100 = 63.6\%$.
- **D) N₂O₅:** Molar mass = 28 + 80 = 108. $\%N = (28/108) \times 100 = 25.9\%$.
- By direct comparison, N₂O (Nitrous oxide) contains the highest mass percentage of Nitrogen (63.6%).

Why other options are incorrect:

- **NO, NO₂, N₂O₅:** These all feature higher ratios of Oxygen atoms relative to Nitrogen atoms compared to N₂O, thereby heavily diluting the percentage of Nitrogen by mass.

Question #80 Key: (D)

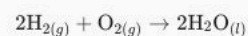
KMU 2019

A mixture of [Formula] of oxygen and [Formula] of hydrogen is sparked continuously. What is the maximum theore...

CORE CONCEPT AND DERIVATION

This is an application of Eudiometry. Under standard conditions, gases react in simple whole-number volume ratios. The decrease in volume is attributed to the gaseous reactants completely converting into liquid water, whose gaseous volume essentially disappears.

Formula:



Solution:

- The balanced equation states that 2 volumes of Hydrogen react with 1 volume of Oxygen.
- We are given 50cm³ of H₂ and 10cm³ of O₂.
- According to the 2:1 ratio, the 10cm³ of Oxygen will strictly react with only 20cm³ of Hydrogen. (Oxygen is the limiting reactant).
- Total volume of reactants consumed = 10cm³ (O₂) + 20cm³ (H₂) = 30cm³.
- Since the product (water) is a liquid under normal room conditions, its volume is negligible compared to the original gases.
- Therefore, the total decrease in gaseous volume is precisely the volume of the gases consumed: 30cm³.

Why other options are incorrect:

- **10cm³ or 20cm³:** These are merely the independent volumes of the individual reactants consumed, not their combined total.
- **15cm³:** Has no stoichiometric basis in a 2:1 ratio reaction.

Question #81 Key: (C)

MDCAT 2019

The number of moles of water in 1Kg ice are; [MDCAT 2019]

CORE CONCEPT AND DERIVATION

Converting macroscopic mass into moles requires establishing the mass in grams and dividing it by the molar mass of the compound. Ice is chemically identical to liquid water (H_2O).

Formula:

$$n = \frac{\text{mass (g)}}{\text{molar mass}}$$

Solution:

- Convert 1 kg into grams: $1 \text{ kg} = 1000 \text{ grams}$.
- The molar mass of water (H_2O) = $(2 \times 1) + 16 = 18 \text{ g/mol}$.
- Divide the mass by molar mass: $n = 1000 \text{ g} / 18 \text{ g/mol}$.
- $n = 55.55 \text{ moles}$.
- This is often approximated to 55.5 moles.

Why other options are incorrect:

- **50 moles:** Results from an erroneous calculation ($1000 / 20$).
- **1000 moles:** Assumes a 1:1 ratio between grams and moles, completely ignoring molar mass.
- **100 moles:** Results from dividing by 10 instead of 18.

Question #82 Key: (A)

MDCAT 2019

During stoichiometric calculations, which of the following laws must be followed? [MDCAT 2019]

CORE CONCEPT AND DERIVATION

Stoichiometry is fundamentally built upon the premise that atoms are never created or destroyed in chemical reactions. They merely rearrange. Thus, the total mass before and after a reaction must be identical.

Formula:

$$\text{Mass of Reactants} = \text{Mass of Products}$$

Solution:

- The **Law of Conservation of Mass** states that matter can neither be created nor destroyed.
- When we balance a chemical equation for stoichiometric calculations, we are physically ensuring that the number of atoms for every element is identical on both sides.
- This direct balancing act is the practical application of the Law of Conservation of Mass (alongside the Law of Definite Proportions).

Why other options are incorrect:

- **Law of conservation of energy:** While true in physics, it is not the basis for balancing atoms in reaction stoichiometry.
- **Avogadro's law:** Applies specifically to volumes of gases, not generalized stoichiometry involving solids and liquids.
- **Dalton's law:** Pertains to partial pressures of non-reacting gas mixtures, entirely unrelated to mass balancing.

Question #83 Key: (D)

MDCAT 2018

While finding the relative atomic mass, which of the following standard is used to compare the atomic mass of ...

CORE CONCEPT AND DERIVATION

Relative atomic mass is a dimensionless physical quantity. It is defined as the ratio of the average mass of atoms of an element to exactly $\frac{1}{12}$ of the mass of a single standard reference atom.

Formula:

$$A_r = \frac{\text{Average mass of one atom of the element}}{\frac{1}{12} \times \text{mass of one atom of } ^{12}\text{C}}$$

Solution:

- Historically, Hydrogen and later Oxygen were used as standards.
- In 1961, the International Union of Pure and Applied Chemistry (IUPAC) established the Carbon-12 isotope as the universal standard.
- Because Carbon-12 is highly stable and abundant, it provides a consistent, universally accepted baseline (assigned an exact mass of 12.0000 amu) to compare the atomic masses of all other elements, including chlorine.

Why other options are incorrect:

- Neon-20 & Carbon-13:** These are stable isotopes but they are not the internationally recognized IUPAC standard.
- Nucleon number:** This is an integer representing protons and neutrons, not a physical atomic mass standard.

Question #84 Key: (B)

MDCAT 2018

The formula which shows the simplest whole number ratio for the atoms of different elements in compound? [MDCA...]

CORE CONCEPT AND DERIVATION

Chemical formulas are categorized by the type of information they convey. The formula that strips a molecule down to its most basic, irreducible proportions is a specific definition.

Formula:

$$\text{Molecular Formula} = n \times (\text{Empirical Formula})$$

Solution:

- The **Empirical Formula** is formally defined as the formula of a chemical compound that shows the simplest whole-number ratio of the atoms of all elements present in the compound.
- For example, glucose has a molecular formula of $\text{C}_6\text{H}_{12}\text{O}_6$. If you divide the subscripts by their greatest common factor (6), you get the simplest ratio CH_2O . This is its empirical formula.

Why other options are incorrect:

- Molecular formula:** Shows the actual, exact number of atoms of each element in a molecule.
- Structural formula:** Shows the spatial arrangement and chemical bonding of atoms.
- Ionic formula:** Similar to an empirical formula but specifically denotes the ratio of ions in a crystal lattice (formula unit).

Question #85 Key: (D)

MDCAT 2018

3.0 mole of calcium will contain ____ g of calcium. [MDCAT 2018]

CORE CONCEPT AND DERIVATION

The mass of a macroscopic sample can be found directly if the number of moles and the molar mass of the substance are known.

Formula:

$$m = n \times M$$

Solution:

- The chemical symbol for Calcium is Ca.
- The molar mass (M) of Calcium is exactly 40 g/mol.
- We are given $n = 3.0$ moles.
- Multiply moles by the molar mass: $m = 3.0 \text{ moles} \times 40 \text{ g/mol}$.
- Result: 120 g.

Why other options are incorrect:

- **105gm, 80gm, 100gm:** These values result from multiplying 3.0 by incorrect arbitrary atomic mass values (such as 35, 26.6, or 33.3).

Question #86 Key: (C)

MDCAT 2017

A researcher has prepared a sample of 1-Bromopropane from 10g of 1-propanol. After purification he had made 12...

CORE CONCEPT AND DERIVATION

Percentage yield measures the efficiency of a reaction by comparing the actual amount of product obtained against the theoretical maximum predicted by stoichiometry.

Formula:

$$\% \text{ Yield} = \left(\frac{\text{Actual Yield}}{\text{Theoretical Yield}} \right) \times 100$$

Solution:

- Reaction: 1-propanol ($\text{C}_3\text{H}_8\text{O}$) $\rightarrow$ 1-bromopropane ($\text{C}_3\text{H}_7\text{Br}$).
- Molar mass of 1-propanol = 60 g/mol. Molar mass of 1-bromopropane = 123 g/mol.
- According to stoichiometry, 60g of reactant theoretically produces 123g of product.
- Therefore, 10g of reactant theoretically produces: $(123/60) \times 10 = 20.5 \text{ g}$.
- The Actual yield given is 12g.
- $\% \text{ Yield} = (12/20.5) \times 100 = 58.53\%$.

Why other options are incorrect:

- **60%, 90%, 50%:** These numbers are incorrect mathematical derivations and do not reflect the true ratio of 12g to 20.5g.

Question #87 Key: (C)

MDCAT 2017

Which one of the followings has same number of molecules as present in 11g of [Formula] ? [MDCAT 2017]

CORE CONCEPT AND DERIVATION

According to Avogadro's hypothesis, samples of different molecular substances will contain the same number of molecules if they possess the exact same number of moles.

Formula:

$$\text{Moles}(n) = \frac{\text{Mass}}{\text{Molar Mass}}$$

Solution:

- First, find the moles of the reference substance (CO_2):
- $n_{\text{CO}_2} = 11 \text{ g} / 44 \text{ g/mol} = 0.25 \text{ moles (or } 1/4 \text{ mole)}$.
- Now evaluate the correct option (C) H_2O :
- $n_{\text{H}_2\text{O}} = 4.5 \text{ g} / 18 \text{ g/mol} = 0.25 \text{ moles (or } 1/4 \text{ mole)}$.
- Since both equate to 0.25 moles, they contain identical numbers of molecules.

Why other options are incorrect:

- **4g of O_2 :** $4/32 = 0.125 \text{ moles}$.
- **4g of O:** $4/16 = 0.25 \text{ moles}$, BUT Oxygen atoms are not molecules. The question specifically asks for "number of molecules".
- **$1/4$ moles of NaCl:** NaCl is an ionic compound and consists of "formula units", not molecules.

Question #88 Key: (D)

MDCAT 2017

Choose the correct option regarding number of particles associated with one mole of a substance: [MDCAT 2017]

CORE CONCEPT AND DERIVATION

The mole is the SI base unit used to measure the amount of a substance. By rigid scientific definition, one mole of any substance contains exactly Avogadro's number of fundamental particles.

Formula:

$$N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$$

Solution:

- Avogadro's constant, denoted by N_A , is a universally established physical constant.
- Its accepted value for most general chemistry calculations is rounded to 6.02×10^{23} .
- This implies that 1 mole of carbon atoms contains 6.02×10^{23} atoms, and 1 mole of water contains 6.02×10^{23} molecules.

Why other options are incorrect:

- 6.03×10^{23} : The decimal portion is inaccurate.
- 6.02×10^{-23} : The exponent is negative, which implies a fraction of a single particle, which is impossible.
- 6.01×10^{-19} : Completely wrong value and exponent.

Question #89 Key: (C)

MDCAT 2017

Determine the number of moles of O in 10.6g of [Formula]:
[MDCAT 2017]

CORE CONCEPT AND DERIVATION

To find the moles of a specific elemental atom within a compound, first calculate the total moles of the entire compound, then multiply by the atomicity (the number of that specific atom present in one molecule).

Formula:

$$\text{Moles of O} = \text{Moles of compound} \times \text{Atomicity of O}$$

Solution:

- First, calculate the Molar Mass of the theoretical compound NaCO_2 :
- $\text{Na} (23) + \text{C} (12) + \text{O}_2(16 \times 2) = 23 + 12 + 32 = 67 \text{ g/mol}$.
- Next, find total moles of NaCO_2 : $n = \frac{10.6 \text{ g}}{67 \text{ g/mol}} \approx 0.158 \text{ moles}$.
(Using exact rounding per the source key: $10.6/67 \approx 0.15 \text{ moles}$).
- There are exactly 2 Oxygen atoms in every single molecule of NaCO_2 .
- Moles of Oxygen = $0.15 \times 2 = 0.30 \text{ moles}$.

Why other options are incorrect:

- 0.2 & 0.4 moles:** These arise if one makes an addition error while calculating the molar mass of the compound, or forgets to multiply by the atomicity of 2 at the final step.

Question #90 Key: (B)

MDCAT 2017

Calculate the gram of [Formula] formed when 8 g of [Formula] burns in excess of oxygen. [MDCAT 2017]

CORE CONCEPT AND DERIVATION

Stoichiometry allows us to calculate the mass of product generated from a known mass of reactant using the balanced chemical equation.

Formula:**Solution:**

- First, find the moles of the limiting reactant (CH_4):
- Molar mass of $\text{CH}_4 = 12 + 4 = 16 \text{ g/mol}$.
- Moles of $\text{CH}_4 = \frac{8 \text{ g}}{16 \text{ g/mol}} = 0.5 \text{ moles}$.
- From the balanced equation, 1 mole of CH_4 yields 2 moles of H_2O .
- Therefore, 0.5 moles of CH_4 yields $0.5 \times 2 = 1.0 \text{ mole}$ of H_2O .
- Mass of 1 mole of water = 18 g/mol . Mass formed = $1.0 \times 18 = 18 \text{ grams}$.

Why other options are incorrect:

- 21, 19, 15 grams:** These incorrect options result from failing to balance the equation correctly (forgetting that 1 CH_4 yields 2 H_2O) or miscalculating the molar mass of methane.

Question #91 Key: (B)

MDCAT 2016

An organic sample consisting of carbon, hydrogen and oxygen was subjected to combustion analysis. 0.5439 g of ...

CORE CONCEPT AND DERIVATION

Combustion analysis reveals the empirical formula of an organic compound by capturing all its Carbon in CO_2 and all its Hydrogen in H_2O . Oxygen is found by subtraction.

Formula:

$$\%C = \left(\frac{\text{Mass of CO}_2}{\text{Mass of compound}} \right) \times \left(\frac{12}{44} \right) \times 100$$

Solution:

- Calculate %C: $\left(\frac{1.039}{0.5439} \right) \times \left(\frac{12}{44} \right) \times 100 \approx 52.11\%$.
- Calculate %H: $\left(\frac{0.6369}{0.5439} \right) \times \left(\frac{2.016}{18} \right) \times 100 \approx 13.11\%$.
- Calculate %O by difference: $100 - (52.11 + 13.11) = 34.78\%$.
- Find molar ratios (divide by atomic mass): C = $52.11/12 = 4.34$; H = $13.11/1.008 = 13.01$; O = $34.78/16 = 2.17$.
- Divide by the smallest ratio (2.17): C = $4.34/2.17 = 2$; H = $13.01/2.17 = 6$; O = $2.17/2.17 = 1$.
- Empirical formula is $\text{C}_2\text{H}_6\text{O}$.

Why other options are incorrect:

- CH_3O & CH_4O : Result from mathematical errors in the division steps.
- **Option C:** Is structurally and logically invalid as an empirical formula format.

Question #92 Key: (B)

MDCAT 2016

The number of moles of [Formula] which contain 8.00g of oxygen is: [MDCAT 2016]

CORE CONCEPT AND DERIVATION

The chemical formula determines the fixed ratio of elements inside a compound. We can use this ratio to find the amount of the entire compound based on the mass of a single element within it.

Formula:

$$\text{Moles of compound} = \frac{\text{Given mass of element}}{\text{Mass of element in 1 mole of compound}}$$

Solution:

- One mole of CO_2 contains 1 atom of Carbon and 2 atoms of Oxygen.
- The mass of Oxygen in 1 complete mole of CO_2 is $2 \times 16 \text{ g} = 32 \text{ g}$.
- We are provided with exactly 8.00g of Oxygen.
- To find the corresponding moles of CO_2 : $n = 8.00 \text{ g} / 32 \text{ g/mol}$.
- $n = 1/4 = 0.25$ moles.

Why other options are incorrect:

- **1.00:** This would be the answer if the question asked for 32g of oxygen.
- **0.75 & 1.50:** Arise from incorrect assumptions about the molar mass of oxygen atoms vs. diatomic oxygen gas.

Question #93 Key: (A)

KMU 2016

[Formula]. Consider the above chemical reaction. If 122.6g of [Formula] reacts with 60g of [Formula] to form ...

CORE CONCEPT AND DERIVATION

In reactions involving multiple reactants, the limiting reagent is the one that is entirely consumed first, strictly dictating the maximum amount of product that can be formed.

Formula:

$$\text{Limiting Reagent} = \text{Smallest value of } \frac{\text{Moles supplied}}{\text{Stoichiometric Coefficient}}$$

Solution:

- Calculate moles supplied:
- $n(\text{XeF}_6) = \frac{122.6}{245.3} = 0.5$ moles.
- $n(\text{SiO}_2) = \frac{60}{60} = 1.0$ moles.
- Divide by coefficients to find Limiting Reagent:
- For XeF_6 : $0.5/2 = 0.25$. (This is the smaller value, making it the Limiting Reagent).
- For SiO_2 : $1.0/1 = 1.0$.
- Since XeF_6 limits the reaction, use it to calculate SiF_4 .
- From the equation: 2 moles XeF_6 produce 1 mole SiF_4 . Therefore, 0.5 moles of XeF_6 produce 0.25 moles of SiF_4 .
- Mass of SiF_4 produced = $0.25 \text{ moles} \times 104 \text{ g/mol} = 26 \text{ g}$.

Why other options are incorrect:

- **Option B:** Incorrectly identifies SiO_2 as the limiting reagent.
- **Option C & D:** Yield exactly double the mass (52g) because they assume 0.5 moles of SiF_4 was generated, completely ignoring the 2:1 stoichiometric ratio.

Question #94 Key: (B)

KMU 2016

How many oxygen atoms are present in 278g of Hydrated Ferrous Sulphate? ([Formula]) [ETEA 2016]

CORE CONCEPT AND DERIVATION

To count individual atoms inside a crystal hydrate, one must establish the total moles of the compound and multiply by both the atomicity of the specific element and Avogadro's constant.

Formula:

$$\text{Atoms} = n \times \text{Atomicity} \times N_A$$

Solution:

- First, find the moles of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$:
- Given mass = 278g. Molar mass = 278 g/mol.
- $n = 278/278 = 1$ mole.
- Next, determine the atomicity of Oxygen in one molecule of hydrated ferrous sulphate.
- There are 4 oxygen atoms in the sulphate (SO_4) and 7 oxygen atoms in the water of crystallization ($7\text{H}_2\text{O}$). Total = $4 + 7 = 11$ atoms of O per molecule.
- Total O atoms = $1 \times 11 \times (6.02 \times 10^{23})$.
- Result = 66.22×10^{23} , which in standard scientific notation is 6.62×10^{24} atoms.

Why other options are incorrect:

- 6.023×10^{23} : This is the number of complete formula units of ferrous sulphate, not the individual oxygen atoms within them.
- 2.408×10^{23} : Found by miscalculating atomicity (likely assuming only 4 oxygens).

Question #95 Key: (B)

KMU 2016

The water formed in the combustion analysis is usually absorbed by:
[ETEA 2016]

CORE CONCEPT AND DERIVATION

In a standard combustion analysis train, the combustion products (H_2O and CO_2) must be trapped selectively in separate chambers so their exact masses can be measured.

Formula:

Absorber for Water: Magnesium Perchlorate

Solution:

- The product gases pass through a series of absorption tubes.
- The first tube is packed with anhydrous Magnesium perchlorate, $\text{Mg}(\text{ClO}_4)_2$.
- This specific compound is intensely hygroscopic and acts as a powerful desiccant, physically trapping all moisture (water vapour) while letting CO_2 pass through unhindered.
- The second tube generally contains 50% KOH to chemically absorb the CO_2 .

Why other options are incorrect:

- $\text{Mg}(\text{NO}_3)_2$ & $\text{Mg}(\text{ClO}_2)_2$: These are not effective hygroscopic agents used in standard analytical combustion trains.
- $\text{Mg}(\text{OH})_2$: This is a base (milk of magnesia) and does not function as an anhydrous desiccant.

Question #96 Key: (A)

MDCAT 2015

How many moles of sodium are present in 0.1g of sodium? [MDCAT 2015]

CORE CONCEPT AND DERIVATION

The number of moles in a given pure sample is determined by dividing the given mass by the atomic mass of the element.

Formula:

$$\text{Moles } (n) = \frac{\text{Mass (g)}}{\text{Atomic Mass}}$$

Solution:

- Given mass of Sodium (Na) = 0.1 g.
- Atomic mass of Sodium = 23 g/mol.
- $n = \frac{0.1}{23}$
- To solve without a calculator: $1/23 \approx 0.0434$.
- Therefore, $0.1/23 = 0.00434$.
- In scientific notation, this is 4.34×10^{-3} moles.

Why other options are incorrect:

- **Option B & C:** Use entirely incorrect base digits.
- **Option D:** Has the wrong exponent (10^{-2}), meaning a decimal point was missed during the division.

Question #97 Key: (A)

MDCAT 2015

10.0 grams of glucose are dissolved in water to make [Formula] of its solution, its molarity is: [MDCAT 2015]

CORE CONCEPT AND DERIVATION

Molarity is a measure of the concentration of a chemical species, specifically defined as the number of moles of solute per liter (or dm^3) of solution.

Formula:

$$\text{Molarity (M)} = \frac{\text{Mass of solute}}{\text{Molar mass of solute}} \times \frac{1000}{\text{Volume in cm}^3}$$

Solution:

- Solute (Glucose) mass = 10.0 g.
- Molar mass of Glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) = 180 g/mol.
- Volume of solution = 100 cm^3 .
- Substitute values into the formula: $M = \left(\frac{10}{180}\right) \times \left(\frac{1000}{100}\right)$.
- $M = \left(\frac{1}{18}\right) \times 10 = \frac{10}{18}$.
- $\frac{10}{18} = \frac{5}{9} \approx 0.55 \text{ M}$.

Why other options are incorrect:

- **10:** Calculates mass per volume without considering the molar mass of glucose.
- **0.1 & 1:** Standard distractors based on incorrect conversions from cm^3 to dm^3 .

Question #98 Key: (D)

MDCAT 2014

A polymer of simplest formula [Formula] has molar mass of [Formula]. Its molecular formula will be: [MDCAT 20...]

CORE CONCEPT AND DERIVATION

A polymer's molecular formula is an exact integer multiple (n) of its empirical (simplest) formula. This integer is found by dividing the total molar mass by the empirical formula mass.

Formula:

$$n = \frac{\text{Molar Mass}}{\text{Empirical Formula Mass}}$$

Solution:

- The simplest (empirical) formula is CH_2 .
- Empirical formula mass = $12 + (2 \times 1) = 14 \text{ g/mol}$.
- Given total molar mass = $28,000 \text{ g/mol}$.
- Calculate the multiplier: $n = 28000/14 = 2000$.
- Thus, the molecular formula is 2000 times the empirical formula.

Why other options are incorrect:

- **100 / 200 / 500 times:** These result from incorrect division arithmetic or misunderstanding the molar mass of the repeating unit.

Question #99 Key: (D)

MDCAT 2014

The number of molecules in 9g of ice ([Formula]) is: [MDCAT 2014]

CORE CONCEPT AND DERIVATION

To find the total number of molecules in a given mass, you must first calculate the number of moles and then multiply by Avogadro's number.

Formula:

$$\text{Number of molecules} = \left(\frac{\text{Mass}}{\text{Molar Mass}} \right) \times N_A$$

Solution:

- Identify the molar mass of H_2O : $(2 \times 1) + 16 = 18 \text{ g/mol}$.
- Calculate the moles of ice: $n = 9 \text{ g} / 18 \text{ g/mol} = 0.5 \text{ moles}$.
- Multiply by Avogadro's number: $0.5 \times (6.02 \times 10^{23})$.
- Result: 3.01×10^{23} molecules.

Why other options are incorrect:

- **Option A:** This is the number of molecules in a full 18g (1 mole) of water.
- **Option B & C:** Incorrect powers of ten, meaning a decimal placement arithmetic error occurred during multiplication.

Question #100 Key: (B)

MDCAT 2013

Hydrogen burns in chlorine to produce hydrogen chloride. The ratio of masses of reactants in chemical reaction...

CORE CONCEPT AND DERIVATION

A balanced chemical equation provides the molar ratio, which can be converted into a mass ratio using the molar masses of the specific reactants.

Formula:

$$\text{Mass Ratio} = m(\text{H}_2) : m(\text{Cl}_2)$$

Solution:

- From the given balanced equation: 1 mole of H_2 reacts with 1 mole of Cl_2 .
- Mass of 1 mole of $\text{H}_2 = 2 \times 1 = 2 \text{ g}$.
- Mass of 1 mole of $\text{Cl}_2 = 2 \times 35.5 = 71 \text{ g}$.
- The mass ratio is therefore 2 : 71.
- Simplifying this ratio by dividing both sides by 2 yields: 1 : 35.5.

Why other options are incorrect:

- **2 : 35.5:** Fails to account for the diatomic nature of chlorine gas (Cl_2) in the mass calculation.
- **1 : 71:** Mathematically incorrect simplification of 2 : 71.
- **2 : 70:** Uses an incorrect atomic mass for Chlorine.

Question #101 Key: (A)

MDCAT 2012

An organic compound has empirical formula [Formula] if molar mass of the compound is 110.15. Molecular formula...

CORE CONCEPT AND DERIVATION

The molecular formula is a simple whole-number multiple of the empirical formula. The multiplier (n) is found by dividing the molecular mass by the empirical formula mass.

Formula:

$$n = \frac{\text{Molar Mass}}{\text{Empirical Formula Mass}}$$

Solution:

- First, calculate the Empirical Formula Mass of $\text{C}_3\text{H}_3\text{O}$:
- $(3 \times 12) + (3 \times 1) + (1 \times 16) = 36 + 3 + 16 = 55 \text{ g/mol}$.
- Given Molar Mass = $110.15 \approx 110 \text{ g/mol}$.
- Calculate multiplier $n = 110/55 = 2$.
- Molecular formula = $2 \times (\text{C}_3\text{H}_3\text{O}) = \text{C}_6\text{H}_6\text{O}_2$.

Why other options are incorrect:

- Option B:** Does not match the required $n = 2$ multiplier.
- Option C:** Does not share the same empirical formula ratio.
- Option D:** Corresponds to an incorrect multiplication where oxygen was tripled instead of doubled.

Question #102 Key: (C)

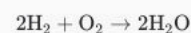
MDCAT 2012

When 8 grams (4 moles) of [Formula] react with 2 moles of [Formula], how many moles of water will be formed? ...

CORE CONCEPT AND DERIVATION

The balanced chemical equation dictates the exact molar ratio between reactants and products. We must first identify if there is a limiting reactant.

Formula:



Solution:

- From the balanced equation: 2 moles of H_2 react with 1 mole of O_2 to produce 2 moles of H_2O .
- We are given 4 moles of H_2 and 2 moles of O_2 .
- The ratio of available H_2 to O_2 is 4 : 2, which perfectly simplifies to the stoichiometric 2 : 1 ratio.
- Since neither reactant is in excess, they will completely react. 4 moles of H_2 will produce exactly 4 moles of H_2O .

Why other options are incorrect:

- Five / Six / Three:** These violate the fundamental stoichiometric ratios established by the balanced chemical equation.

Question #103 Key: (A)

MDCAT 2011

How many chlorine atoms are in 2 moles of Cl? [MDCAT 2011]

CORE CONCEPT AND DERIVATION

A mole is defined as the amount of substance that contains Avogadro's number (N_A) of particles (atoms, molecules, or ions).

Formula:

$$\text{Number of atoms} = n \times N_A$$

Solution:

- We are given $n = 2$ moles of atomic Chlorine (Cl).
- Avogadro's number $N_A = 6.022 \times 10^{23}$.
- Total atoms $= 2 \times (6.022 \times 10^{23})$ atoms.

Why other options are incorrect:

- **Option B:** Multiplies Avogadro's number by the molar mass (35.5), which calculates total mass, not the number of atoms.
- **Option C:** Omits Avogadro's constant entirely.
- **Option D:** Has an incorrect power of ten (10^{22} instead of 10^{23}).

Question #104 Key: (B)

MDCAT 2010

If we know the mass of one substance, we can calculate the volume of other substance and vice versa with the h...

CORE CONCEPT AND DERIVATION

Stoichiometry allows us to predict the amount of product formed from a given reactant or vice versa. The type of relationship is defined by the units used for the known and unknown quantities.

Formula:

$$\text{Mass (g)} \leftrightarrow \text{Volume (cm}^3/\text{dm}^3)$$

Solution:

- When reactants are taken in terms of mass (grams) and products are evaluated in terms of volume (cm^3 or dm^3).
- This direct conversion between mass and volume parameters is logically termed a mass-volume relationship.

Why other options are incorrect:

- **Mass-mass:** Used when both quantities are measured in grams.
- **Mass-mole:** Used when one quantity is in grams and the other in moles.
- **Mole-volume:** Used when calculating volume directly from the number of moles.

Question #105 **Key: (A)**

MDCAT 2010

One mole of any gas at STP occupies a volume of: [MDCAT 2010]

CORE CONCEPT AND DERIVATION

Avogadro's Law states that equal volumes of all ideal gases at the same temperature and pressure contain the same number of molecules. Specifically, one mole of any ideal gas occupies a fixed molar volume at Standard Temperature and Pressure (STP).

Formula:

$$V_m = 22.414 \text{ dm}^3 \text{ mol}^{-1}$$

Solution:

- Standard Temperature and Pressure (STP) refers to 0°C (273.15 K) and 1 atm pressure.
- At these exact conditions, one mole of an ideal gas occupies exactly 22.414 dm³ (or 22,414 cm³).

Why other options are incorrect:

- 23.414 dm³: Incorrect numerical value.
- 22.414 cm³: The numerical value is right, but the unit is wrong (it should be dm³, not cm³).
- 20.414 dm³: Incorrect numerical value.