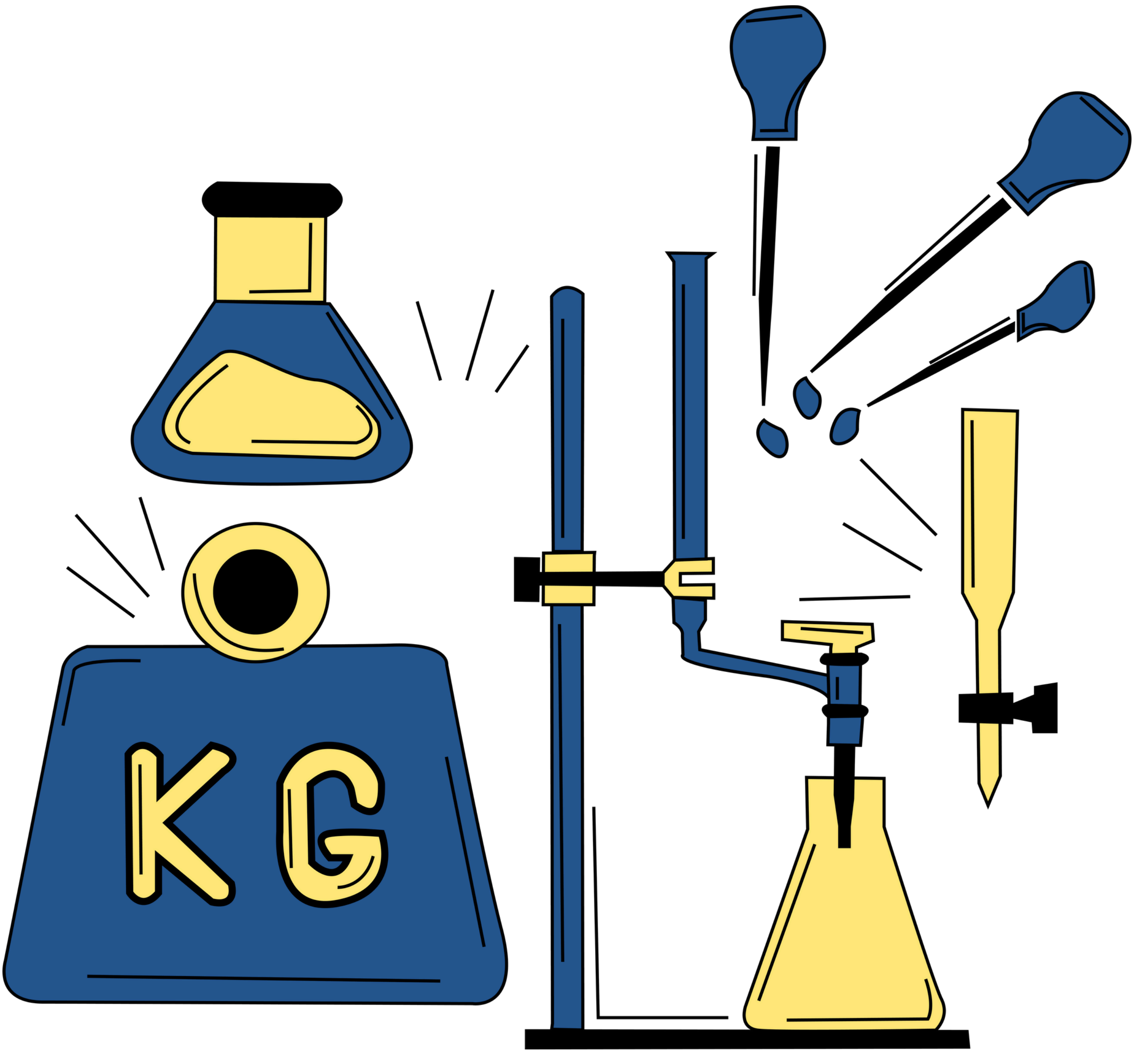
STOICHIOMETRY



KPK BOARD

KPK BOARD TOPPER PERSPECTIVE

INTRODUCTION

- This is one of the most essential chapters for MDCAT preparation. Students must thoroughly go through this chapter, and understand the basic concepts to make their foundation strong enough to ace the competitive exams. This chapter comprises some engaging topics which you'll enjoy studying if you have understood them thoroughly. Also, in this guide, we will be highlighting important topics, tips, and tricks to ace your exam.

1. HOW TO APPROACH THE TEXTBOOK?

1.Identify Learning Objectives:

- Clarify your learning objectives for the session. What specific information or skills do you aim to gain from this chapter?

2.Read Strategically:

- Read the introduction and conclusion to understand the overall theme. Focus on the first and last sentences of paragraphs, as they typically contain key points. Read any bolded or italicized text, as these are typically emphasized concepts.

3.Take Notes:

- As you read, take notes on key concepts, definitions, and significant examples. Use abbreviations and symbols to make your note-taking more efficient.

4.Use Visual Aids:

- Pay attention to charts, graphs, and illustrations. These visual aids can typically simplify complex concepts. Take the time to understand them fully.

2. CHAPTER CONTENT:

1.1	Mole and Avogadro's Number
1.2	Mole Calculation
1.3	Percentage Composition
1.4	Excess and Limiting Reagents
1.5	Theoretical Yield and Actual Yield As Percentage

1.1 Mole and Avogadro's Number:

- The mole is a unit of measurement in chemistry, representing an amount of substance. Avogadro's Number, approximately 6.022 x 10^23, defines the number of entities (atoms, molecules, ions) in one mole.
- This constant is crucial for converting between the mass of a substance and the number of entities it contains, facilitating quantitative chemical calculations.

1.2 Mole Calculation:

- Mole calculations involve using the mole concept to relate the quantity of a substance to its mass, number of particles, or volume.

1.2.1 The Mole and Chemical Equations:

- In chemical equations, coefficients represent mole ratios.
- The coefficients indicate the relative number of moles of reactants and products.
- This relationship allows for the interpretation of chemical equations in terms of quantities, enabling stoichiometric calculations and providing insights into the amounts of substances involved in a reaction.
- Number of moles is equal to mass/molar mass.
- Using the above equation, you can convert any mass of a particular substance into moles or vice versa.
- As one mole of any substance contains 6.023 multiply by 10 to raise power 23 of atoms, molecules or formula units, one can also develop an equation between the number of moles and the number of particles present.
- Following Equation is:
- Number of moles is equal to number of particles/particles per mole.

1.2.2 Calculations Involving Gases:

- When performing calculations involving gases, it's crucial to use the appropriate gas laws and formulas.
- The three main gas laws are Boyle's Law, Charles's Law, and Avogadro's Law.
- Remember to convert temperatures to Kelvin and pressures to atmospheres if needed. Always check units and use the appropriate gas constant (R) based on the units used in the problem.

1.3 Percentage Composition:

- Percentage composition is the relative mass of each element in a compound, expressed as a percentage of the total molecular mass.
- It is calculated by dividing the molar mass of each element by the molar mass of the compound and multiplying by 100.
- This provides insight into the composition of a substance, helping chemists analyze and predict its properties.

1.4 Excess and Limiting Reagents:

- Excess and limiting reagents are key concepts in chemical reactions.
- The limiting reagent is the reactant that determines the maximum amount of product formed, while the excess reagent is present in surplus.
- The actual yield is limited by the limiting reagent, and the reactant ratio is crucial for accurate stoichiometric calculations.
- It's essential to identify and manage limiting and excess reagents for efficient and controlled reactions.

1.5 Theoretical Yield and Actual Yield As Percentage:

- The theoretical yield is the maximum amount of product that can be formed in a chemical reaction based on stoichiometry.
- The actual yield is the amount obtained experimentally.
- The percentage yield is calculated by dividing the actual yield by the theoretical yield and multiplying by 100, providing insight into reaction efficiency.
- Achieving a high percentage yield indicates a successful and efficient reaction.

3a. IMPORTANT NUMERICALS:

Q. What is the mass of 0.5 moles of calcium carbonate ($CaCO_3$)?

Solution:

- The relative formula mass of calcium carbonate ($CaCO_3$)= Ca + C +30
- Molar mass of $CaCO_3$ 40 +12 + (16 x 3) = 100g/mol
- Number of moles(n)= Mass(g)/Molar Massof CaCO,(g/mol)
- 0.5=mass(g)/100g/mol
  or Mass 0.5x100 = 50g

Q. In a certain experiment, 8.50x10 molecules of water were used. Calculate the number of moles of water.

Solution:

- Number of H_2O molecules = 8.50x1025
- Number of moles(n)= Number of H_2O molecules/Avogadro's number
- Number of moles(n)= 8.50×1025/6.023×1023 = 1.41x10'mol
- Thus, 1.41x102 moles of water would have reacted in this particular experiment

Q. How many formula units are present in 125g of hydrated copper sulfate ($CuSO_4.5H_2O$)?

Solution:

- Mass of hydrated copper sulfate ($CuSO_4.5H_2O$) = 125g
- The relative formula mass of hydrated copper sulphate is,
- Formula mass of $CuSO_4.5H_2O$
  64+ 32+ (4x16) + [5x(2x1 + 16)] = 64+32+64+5(18)=250amu
- Thus, Molar mass of $CuSO_4.5H_2O$ = 250g/mol
- So, Number of moles(n)=Mass (g)/Molar Mass of CuSO4.5H,O (g/mol)
- Number of moles(n)= 125g/250g/mol= 0.5mol
- Calculate the number of formula units as, Number of moles(n)= number of formula units of $CuSO_4.5H_2O$/Avogadro's number
- 0.5= number of formula units of CuSO4.5H,O/6.023x1023
- Number of formula units of $CuSO_4.5H_2O$ = 0.5 x 6.023×1023= =3.011×1023 formula units.
- Thus, there are 3.011x1023 formula units of $CuSO_4.5H_2O$ in 125g of the salt.

Q. According to the following equation solid sulphur burns in oxygen produces SO_2.

$$S + O_2 \rightarrow SO_2$$

If 15g of sulphur is burnt, what volume of SO_2 is produced, at STP?

Solution:

- Number of moles of sulphur burnt = mass(in grams)/molar mass (in grams per mol
- Atomic mass of S = 32
- Number of moles of sulphur burnt= 15g/32g per mol
- Number of moles of sulphur = 0.469 mol
- From the equation 1 mol of S = 1 mol of SO_2
- Therefore, 0.469 of S = 0.469 of SO_2
- To calculate the volume of SO_2 produced, we have
  Number of Moles (n) = Volume(dm^3)at STP/molar volume(22.4 dm'/mol)
- 0.469 mol= Volume(dm^3)/22.4 dm^3/mol
- Volume (dm^3) = 0.469-~~mol~~ x 22.4 dm^3/~~mol~~ = 10.51dm^3
- Thus, burning 15g of sulphur wil produce 10.51dm' of SO_2

Q. Calculate the percentage composition of sulphuric acid (H_2SO).

Solution:

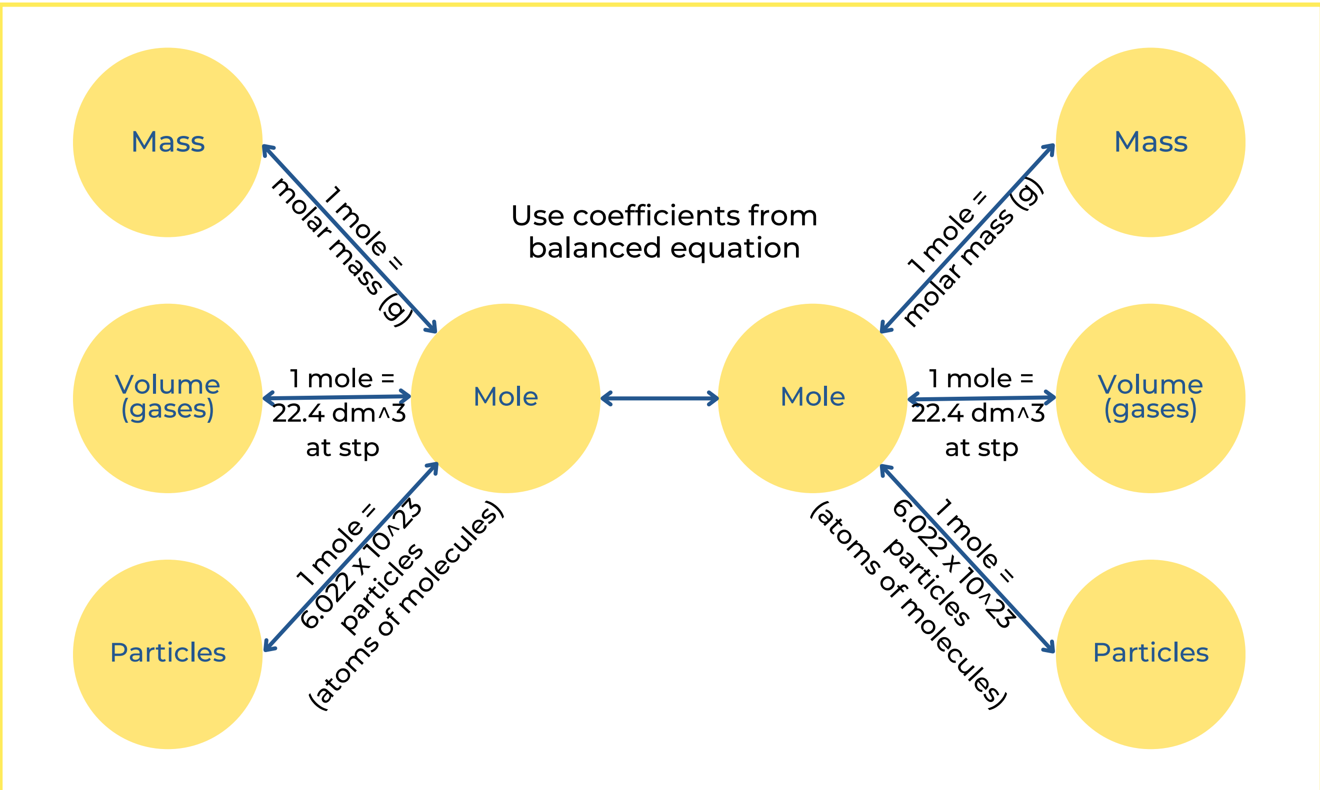
- From the formula, we get:
  Molar mass of H2SO4 = (2x1) + (1x32) + (4x16) =2+32 + 62 98g/mol
- Thus, percentage of each element is calculated as follows,
  (Gram atomic mass of an element x No. of atoms of that element in compound/ Molar mass of the compound) x 100
- Percentage of H= (1 x 2/98) x100=2.041%
- Percentage of S= (32 x 1/98) x100=32.653%
- Percentage of O= (16 x 4/98) x 100=65.306%
- Since, the percentages must add up to 100, we could have found the percentage of the last element (in this case oxygen) by subtracting percentage of the hydrogen and sulphur from 100. i.e. alternatively,
  Percentage of O 100-(% H+ % S) = 100-(2.041 +32.653)=65.306%.

Q. Heating 24.8g of copper carbonate (CUCO3) in a crucible produced on 13.9g of copper oxide (CuO). What is the percentage yield of copper oxide?

Solution:

- The actual yield of CuO = 13.99
- Theoretical yield is calculated from the balanced chemical equation which is:
  CuCO3 $\xrightarrow{\Delta}$ CuO + O2
  1mol 1mol 1mol
  CuCO3: (64+12+(16x3)=124)
  CuO: (64+16=80)
  Moles of $CuCO_2$= 24.8/124= 0.2
- According to balanced chemical equation,
- 1 mol of CuCO = 1 mol of CuO
- 0.2 mol of CuCO = 0.2 mol of CuO
- So, mass of CuO Theoretical yield=0.2 x 80 = 16.09
- Percentage Yield of Copper oxide= Actual Yield/Theoretical Yield x 100
- Percentage Yield of Copper oxide= 13.9/16.0 x 100
- Percentage Yield of copper oxide = 86.87%

3b. IMPORTANT FORMULAE:



Representation of Different Conversions

- Number of moles (n) = Weight of the substance/At. Wt or Mol. Wt
- Number of moles (n) = Volume of gas in dm^3 at STP/$22.4dm^3$
- Number of moles (n) = Number of particles/6.023 x 1^23
- Weight of one atom of an element = Atomic weight/6.023 × 10^23
- Weight of one molecule of a compound = Molecular weight/6.023 × 10^23

3c. IMPORTANT TABLES:

Names of First 20 Elements			
Element	**Symbol**	**Atomic No.**	**Atomic Mass**
Hydrogen	H	1	1.008
Helium	He	2	4.002
Lithium	Li	3	6.94
Beryllium	Be	4	9.012
Boron	B	5	10.81
Carbon	C	6	12.01
Nitrogen	N	7	14.00
Oxygen	O	8	15.99
Flourine	F	9	18.99
Neon	Ne	10	20.18
Sodium	Na	11	22.99

Names of First 20 Elements			
Element	**Symbol**	**Atomic No.**	**Atomic Mass**
Magnesium	Mg	12	24.30
Aluminium	Al	13	26.98
Silicon	Si	14	28.08
Phosphorous	P	15	30.97
Sulfur	S	16	32.06
Chlorine	Cl	17	35.45
Argon	Ar	18	39.94
Potassium	K	19	39.09
Calcium	Ca	20	40.07

4. SAMPLE MCQS:

Q. 1.2g of Mg was dropped in 100ml of 0.1M HCL solution. caculate the volume of H2 obtain by STP.

- 0.8L
- 0.5L
- ✓ 0.4L
- 0.112L

Explanation:

- The working for the above question is as following:
  Equation: Mg + 2HCl → MgCl2 + H2
  1 mol Mg react with 2 mol HCl to produce 1 mol H2.
  Check for limiting reactant:
  Molar mass Mg=24g/mol
  Mol in 1.2g Mg = 1.2/24 = 0.05 mol Mg
  This will react with 0.05 x 2 = 0.10 mol HCl
  Mol HCl in 100mL of 0.1M HCl solution = 100/1000 x 0.1 0.01 mol HCl.
  Thus HCl is the limiting reactant.
  From the equation: 0.01 mol HCl will produce 0.01/2 = 0.005 mol H_2
  At STP, 1 mol H2 gas has volume of 22.4L
  At STP, 0.005 mol H gas has volume = 0.005 x 22.4 = 0.112LH2 gas.
  The volume of H2 produced is 0.112 L.

Q.If 0.5 mole of BaCl2 is mixed with 0.2 Mole of Na3PO4 the maximum moles of Ba3(PO4)2 obtain will be.

- 0.2
- 0.5
- ✓ 0.3
- 0.1

Explanation:

- Following is the solution to this question: 3BaCl2 +2Na3PO4 → Ba3(PO4)2 + 6NaCl The limiting reactant is Na3PO4 the no. of moles of Ba3(PO4)2 produced=20.1mole

5. SOME HELPFUL RESOURCES:

1.YouTube's videos:

- Physics in Seconds (Chemistry portion)
- WAK Academy
- PhysicsWallah

2.Guidebooks and Notes:

- Wisegot Chemistry notes
- Kips prep book (Chemistry)

6. IMPORTANT TOPICS:

- 1.1 Mole and Avogadro's Number
- 1.2 Mole Calculation
- 1.4 Excess and Limiting Reagents
- 1.5 Theoretical Yield and Actual Yield As Percentage

7. TOPICAL QUESTIONS ON PREMED.PK:

- Studying the chapter is not enough-you need to be able to keep that information stored in your memory for a long time (at least till the MDCAT). The best way to do this is by practicing as many questions as possible. The PreMed.PK question bank was of invaluable help to us during our preparation. Solve the topical sets, learn from the explanations provided, and save the questions that you find challenging. It is extremely important that you familiarize yourself with the types of questions asked, because the goal is to be able to solve the MCQs on the MDCAT. We simply cannot emphasize this enough!
- Link: PreMed.PK Topical

8. STUDY HACKS:

1.Animations:

- Watching animations for this chapter can be very useful as it helps create a visual memory and a better grasp of the concept.

2.Note down values:

- Noting down all values in one place will help you quickly learn and recall them during revision without missing any.

3.Flashcards:

- Make these to help you quickly memorize key terms and definitions.

4.Make these to help you quickly memorize key terms and definitions:

- You can get a better understanding of the subtopics of this chapter through flowcharts and tables, you can make your own tables as well for an exquisite understanding.

9. REVISION TIPS FOR LAST MINUTE:

1.Prioritize Topics:

- Identify the most significant topics or concepts that are likely to appear on the exam. Focus on areas where you feel less confident or where the exam is likely to place more emphasis.

2.Condense Notes:

- Create condensed notes or summaries that capture the key points of each topic. Use bullet points, diagrams, and mnemonics to simplify information.

3.Active Recall:

- Test yourself on the material using flashcards, practice questions, or by recalling key concepts from memory. Actively recalling information enhances retention.

4.Focus on Weak Areas:

- Prioritize your time on the topics or areas where you feel less confident. Reinforce your understanding in these weak areas to improve overall performance.

5.Past Papers and Practice Questions:

- If past exam papers are available, practice with them to familiarize yourself with the format and types of questions. Focus on time management during practice to simulate exam conditions.

10. CONCLUSION:

- In conclusion, mastering the chapter on stoichiometry for the entrance test requires a focused and disciplined approach.
- Start by understanding the fundamental concepts, such as mole ratios, balanced chemical equations, and the relationships between reactants and products in chemical reactions.

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A little about the author

Guidance is what gets us all through tough times right? Exactly, premed is all about this ; guidance, experience and innovation. You will get the most amazing guidance here . Exciting, right? So get ready to ace !! Most of the mdcat aspirants think that mdcat is too tough to crack but I believe that premed.pk has always got your back. Premed has been a life saver during my mdcat journey. Qbank , mocks, flashcards, timed test mode ,daily tests and what not!! I definitely recommend premed.pk to all my juniors and fellows out there. I took every bit of advantage from premed and now it's your time to rock