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Stoichiometry: From Moles to Reactions

Exam — Chemical Reactions & Stoichiometry

A comprehensive beginner-to-advanced progression of stoichiometry questions: mole concept, Avogadro's constant, molar mass, balancing equations, mole ratios, limiting reagent, theoretical vs actual yield, concentrations/dilutions, precipitation reactions, simple titrations, and empirical/molecular formulas.

70 items — Printable Exam

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Generated February 20, 2026

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1 **Which statement best defines 1 mole of a substance?**

A The mass of 1 gram of the substance

B Exactly 6.02×10^{23} particles (atoms, molecules, or formula units) of that substance

C The number of protons in the nucleus

D The volume of 22.4 L of any substance

E The number of neutrons in carbon-12

2 **Avogadro's constant is most directly used to convert between:**

A Mass (g) and volume (L)

B Moles and number of particles

C Temperature (°C) and pressure (atm)

D Electrons and neutrons

E Density and molarity

3 **How many molecules are in 0.50 mol of CO2?**

A 3.01×10^{22}

B 3.01×10^{23}

C 6.02×10^{23}

D 1.20×10^{24}

E 0.50 molecules

4 **How many moles of water are in 18.0 g of H2O? (Mr(H2O) = 18.0)**

A 0.10 mol

B 0.50 mol

C 1.00 mol

D 2.00 mol

E 18.0 mol

5 **What is the mass of 0.250 mol of NaCl? (Mr(NaCl) = 58.5)**

A 7.31 g

B 14.6 g

C 29.3 g

D 58.5 g

E 0.250 g

6 **A student says: "Mr(CO2) = 44, so the molar mass of CO2 is 44 g/mol." Which statement is correct?**

A The student is correct: molar mass in g/mol has the same number as Mr

B The molar mass is 44 kg/mol, not g/mol

C The molar mass is 44 g, not per mole

D Mr cannot be used to get molar mass

E The molar mass depends on temperature, so it cannot be determined

7 How many moles are in 2.0×10^{24} atoms of helium? ($NA = 6.02 \times 10^{23}$ mol−1)

A 0.332 mol

B 3.32 mol

C 6.02 mol

D 12.0 mol

E 1.20 mol

8 How many moles of chloride ions (Cl−) are present in 0.10 mol of CaCl2 (assuming complete dissociation)?

A 0.05 mol

B 0.10 mol

C 0.20 mol

D 0.30 mol

E 0.40 mol

9 Which sample contains the greatest number of atoms?

A 1.0 mol He

B 1.0 mol O2

C 1.0 mol CO2

D 1.0 mol CH4

E 2.0 mol H2

10 **At the same temperature and pressure, which pair contains the same number of molecules?**

A 1.0 L He(g) and 1.0 L N_2(g)

B 1.0 L He(g) and 2.0 L He(g)

C 1.0 L O_2(g) and 1.0 L CO_2(g), but only because both contain oxygen

D 2.0 L H_2(g) and 1.0 L H_2(g)

E 1.0 L He(g) and 1.0 L liquid water

11 **Which chemical equation is correctly balanced?**

A $H_2 + O_2 \rightarrow H_2O$

B $2H_2 + O_2 \rightarrow 2H_2O$

C $N_2 + H_2 \rightarrow NH_3$

D $2Na + Cl_2 \rightarrow NaCl$

E $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

12 **In the balanced equation $2H_2 + O_2 \rightarrow 2H_2O$, which interpretation is correct?**

A 2 g of H_2 reacts with 1 g of O_2 to form 2 g of H_2O

B 2 moles of H_2 react with 1 mole of O_2 to form 2 moles of H_2O

C 2 molecules of H_2 react with 2 molecules of O_2 to form 1 molecule of H_2O

D The coefficients represent volumes of liquids, not gases or moles

E The coefficients must always be the same for all substances

13 **If you multiply every coefficient in a balanced equation by 2, what changes?**

A The equation becomes unbalanced

B The mole ratios change

C The equation still represents the same reaction; only the amounts are scaled up

D The substances in the reaction change

E The reaction becomes faster automatically

14 **What is the coefficient of O_2 when propane combusts completely? ($C_3H_8 + O_2 \rightarrow CO_2 + H_2O$)**

A 3

B 4

C 5

D 8

E 10

15 **For the reaction $N_2 + 3H_2 \rightarrow 2NH_3$, how many moles of NH_3 can be produced from 6.0 mol of H_2 (with excess N_2)?**

A 2.0 mol

B 3.0 mol

C 4.0 mol

D 6.0 mol

E 12.0 mol

16 **In the reaction $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$, how many moles of CO are required to react with 0.50 mol Fe_2O_3?**

A 0.50 mol

B 1.0 mol

C 1.5 mol

D 2.0 mol

E 3.0 mol

17 **Which balanced equation correctly represents the formation of aluminum oxide from aluminum and oxygen?**

A $Al + O_2 \rightarrow AlO_2$

B $2Al + O_2 \rightarrow 2AlO$

C $4Al + 3O_2 \rightarrow 2Al_2O_3$

D $Al_2 + O_3 \rightarrow Al_2O_3$

E $2Al + 3O_2 \rightarrow Al_2O_3$

18 **Why must chemical equations be balanced before doing stoichiometry calculations?**

A Because balancing makes the reaction faster

B Because balancing changes the substances into safer forms

C Because balanced coefficients give the correct mole ratios and conserve atoms

D Because balanced equations always have smaller numbers

E Because unbalanced equations violate the octet rule

19 **Calcium carbonate decomposes: $CaCO3 \rightarrow CaO + CO2$. If 2.0 mol of $CaCO3$ decomposes completely, how many moles of $CO2$ form?**

A 1.0 mol

B 2.0 mol

C 3.0 mol

D 4.0 mol

E 0.50 mol

20 **For $2Na + Cl2 \rightarrow 2NaCl$, you have 3.0 mol Na and 1.0 mol $Cl2$. What is the maximum amount of NaCl that can form?**

A 1.0 mol

B 2.0 mol

C 3.0 mol

D 4.0 mol

E 6.0 mol

21 For $2H_2 + O_2 \rightarrow 2H_2O$, what mass of water forms when 4.0 g of H_2 reacts completely with excess O_2? ($M_r(H_2)=2.0$, $M_r(H_2O)=18.0$)

A 9.0 g

B 18 g

C 36 g

D 72 g

E 4.0 g

22 Magnesium reacts with hydrochloric acid: $Mg + 2HCl \rightarrow MgCl_2 + H_2$. If 24.0 g Mg reacts ($A_r(Mg)=24.0$), what volume of H_2 is produced at STP (22.4 L/mol)?

A 11.2 L

B 22.4 L

C 44.8 L

D 2.24 L

E 224 L

23 $CaCO_3 \rightarrow CaO + CO_2$. What mass of CO_2 forms from 10.0 g $CaCO_3$? ($M_r(CaCO_3)=100.0$, $M_r(CO_2)=44.0$)

A 2.20 g

B 4.40 g

C 10.0 g

D 22.0 g

E 44.0 g

24 **Carbon burns: C + O2 → CO2. If 12.0 g of carbon reacts completely, what mass of CO2 is produced? (Ar(C)=12.0, Mr(CO2)=44.0)**

A 12.0 g

B 22.0 g

C 44.0 g

D 88.0 g

E 56.0 g

25 **2Na + Cl2 → 2NaCl. If 11.5 g Na reacts with excess Cl2, what mass of NaCl forms? (Ar(Na)=23.0, Mr(NaCl)=58.5)**

A 11.5 g

B 14.6 g

C 29.3 g

D 58.5 g

E 117 g

26 **For 2H2 + O2 → 2H2O, you start with 3.0 mol H2 and 1.0 mol O2. Which reactant is limiting?**

A H2 is limiting

B O2 is limiting

C Both are limiting

D Neither is limiting; both are in excess

E Limiting reagent cannot be determined without masses

27 **For 2H2 + O2 → 2H2O, you react 5.0 g H2 with 32.0 g O2. What mass of H2O forms? (Mr(H2)=2.0, Mr(O2)=32.0, Mr(H2O)=18.0)**

A 18 g

B 36 g

C 45 g

D 72 g

E 90 g

28 **Using the same reaction as above (2H2 + O2 → 2H2O), if 5.0 g H2 reacts with 32.0 g O2, what mass of H2 is left over?**

A 0 g

B 0.5 g

C 1.0 g

D 2.0 g

E 3.0 g

29 **2Al + 3Cl2 → 2AlCl3. You have 0.20 mol Al and 0.20 mol Cl2. Which statement is correct?**

A Al is limiting and 0.20 mol AlCl3 forms

B Cl2 is limiting and 0.13 mol AlCl3 forms

C Cl2 is limiting and 0.30 mol AlCl3 forms

D Neither is limiting; both are exactly consumed

E Al is limiting and 0.30 mol AlCl3 forms

30 **$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$. If you start with 0.50 mol CH_4 and 1.00 mol O_2, what is true?**

A CH_4 is limiting

B O_2 is limiting

C Both are limiting (both run out first)

D Neither is in excess; both are completely consumed

E No reaction occurs because the coefficients are not equal

31 **Which statement best defines the limiting reactant?**

A The reactant with the highest molar mass

B The reactant present in the greatest mass

C The reactant that is completely used up first and determines the maximum amount of product

D The reactant written first in the equation

E The reactant that never gets consumed

32 **A reaction has a theoretical yield of 20.0 g but an actual yield of 15.0 g. What is the percent yield?**

A 35%

B 60%

C 75%

D 85%

E 133%

33 **Which is the best overall reason why actual yield is often less than theoretical yield in real experiments?**

A Atoms disappear during reactions

B The limiting reactant changes into an excess reactant

C Side reactions, incomplete reaction, and losses during separation/purification

D Balanced equations are never correct

E Avogadro's constant changes with temperature

34 **For $N_2 + 3H_2 \rightarrow 2NH_3$, you start with 2.0 mol N_2 and 3.0 mol H_2. Which statement is correct?**

A N_2 is limiting and 4.0 mol NH_3 forms

B H_2 is limiting and 2.0 mol NH_3 forms

C H_2 is limiting and 3.0 mol NH_3 forms

D Neither is limiting; both are fully consumed

E N_2 is limiting and 2.0 mol NH_3 forms

35 **$2KClO_3 \rightarrow 2KCl + 3O_2$. If 24.5 g $KClO_3$ decomposes completely, what volume of O_2 is produced at STP? ($M_r(KClO_3)=122.5$, molar gas volume = 22.4 L/mol)**

A 2.24 L

B 4.48 L

C 6.72 L

D 11.2 L

E 22.4 L

36 **$2KClO_3 \rightarrow 2KCl + 3O_2$. If 0.10 mol O_2 is produced, how many moles of $KClO_3$ decomposed?**

A 0.050 mol

B 0.067 mol

C 0.10 mol

D 0.15 mol

E 0.20 mol

37 **$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$. If 0.50 mol Ca reacts completely with excess water, what mass of $Ca(OH)_2$ forms? ($M_r(Ca(OH)_2)=74.0$)**

A 18.5 g

B 37.0 g

C 74.0 g

D 148 g

E 0.50 g

38 **$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$. You react 10.0 g $CaCO_3$ with 10.0 g HCl. Which statement is correct? ($M_r(CaCO_3)=100.0$, $M_r(HCl)=36.5$, $M_r(CO_2)=44.0$)**

A HCl is limiting and 2.2 g CO_2 forms

B $CaCO_3$ is limiting and 4.4 g CO_2 forms

C $CaCO_3$ is limiting and 8.8 g CO_2 forms

D Neither is limiting; both are used completely

E HCl is limiting and 4.4 g CO_2 forms

39 **In the reaction above, the theoretical CO_2 mass is 4.4 g, but you collect only 3.5 g. What is the percent yield?**

A 50%

B 70%

C 79.5%

D 95%

E 125%

40 **A student calculates a percent yield of 120% for a product. Which is the most likely explanation?**

A The balanced equation must be wrong because yields cannot exceed 100% under any circumstances

B The product likely contained impurities or solvent/water, making the measured mass too high

C Atoms were created during the reaction

D Avogadro's constant increased during the experiment

E The limiting reactant became unlimited

41 **Molarity (concentration) is defined as:**

A Mass of solute ÷ mass of solution

B Moles of solute ÷ volume of solution in liters

C Volume of solute ÷ moles of solution

D Mass of solute ÷ volume of solute

E Number of particles ÷ volume in mL

42 **What is the molarity of a solution made by dissolving 0.50 mol NaCl in 2.0 L of solution?**

A 0.10 M

B 0.25 M

C 0.50 M

D 1.0 M

E 2.5 M

43 How many moles of HCl are in 250 mL of 0.20 M HCl?

A 0.0050 mol

B 0.050 mol

C 0.20 mol

D 0.80 mol

E 50 mol

44 How many grams of NaOH are needed to make 500 mL of 0.10 M NaOH? (Mr(NaOH)=40.0)

A 0.50 g

B 2.0 g

C 4.0 g

D 20 g

E 40 g

45 You dilute 100 mL of 2.0 M HCl to a final volume of 500 mL. What is the new concentration?

A 0.10 M

B 0.40 M

C 1.0 M

D 2.5 M

E 10 M

46 **Which statement is always true when you dilute a solution by adding water (no reaction occurs)?**

A The number of moles of solute increases

B The number of moles of solute stays the same, but concentration decreases

C The molar mass of the solute changes

D The solute turns into a different chemical

E The volume decreases

47 **$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$. If you mix 50.0 mL of 0.10 M $AgNO_3$ with 50.0 mL of 0.10 M NaCl, how many moles of AgCl form?**

A 0.0010 mol

B 0.0025 mol

C 0.0050 mol

D 0.010 mol

E 0.100 mol

48 **$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$. If you mix 50.0 mL of 0.10 M $AgNO_3$ with 100 mL of 0.020 M NaCl, how many moles of AgCl form?**

A 0.0010 mol

B 0.0020 mol

C 0.0050 mol

D 0.010 mol

E 0.020 mol

49 **How many grams of NaCl are needed to prepare 250 mL of 0.50 M NaCl? (Mr(NaCl)=58.5)**

A 1.46 g

B 3.66 g

C 7.31 g

D 14.6 g

E 29.3 g

50 **How many formula units are in 0.10 mol of NaCl? (NA = 6.02×10^{23} mol−1)**

A 6.02×10^{22}

B 6.02×10^{23}

C 3.01×10^{23}

D 1.20×10^{24}

E 0.10×10^{23}

51 **HCl + NaOH → NaCl + H2O. 25.0 mL of HCl is neutralized by 30.0 mL of 0.100 M NaOH. What is the concentration of HCl?**

A 0.0400 M

B 0.0800 M

C 0.120 M

D 0.300 M

E 0.400 M

52 **$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$. If 20.0 mL of 0.50 M NaOH is required to neutralize some H_2SO_4, how many moles of H_2SO_4 were neutralized?**

A 0.010 mol

B 0.0050 mol

C 0.020 mol

D 0.040 mol

E 0.0025 mol

53 **$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$. What volume of 0.100 M NaOH is needed to completely neutralize 25.0 mL of 0.200 M H_2SO_4?**

A 25.0 mL

B 50.0 mL

C 100 mL

D 200 mL

E 400 mL

54 **$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$. How many moles of HCl are needed to neutralize 0.010 mol $Ca(OH)_2$?**

A 0.005 mol

B 0.010 mol

C 0.020 mol

D 0.030 mol

E 0.040 mol

55 **How many moles of OH^- are required to fully neutralize 0.10 mol of H_2SO_4?**

A 0.05 mol

B 0.10 mol

C 0.20 mol

D 0.30 mol

E 0.40 mol

56 **How many moles of NaOH are needed to fully neutralize 1.0 mol of H_3PO_4 (complete neutralization)?**

A 1.0 mol

B 2.0 mol

C 3.0 mol

D 4.0 mol

E 6.0 mol

57 **$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$. What volume of 0.200 M HCl is needed to neutralize 25.0 mL of 0.100 M Na_2CO_3?**

A 12.5 mL

B 25.0 mL

C 50.0 mL

D 100 mL

E 200 mL

58 **$HCl + NaOH \rightarrow NaCl + H_2O$. If 10.0 mL of 0.200 M HCl is neutralized by 25.0 mL of NaOH, what is the NaOH concentration?**

A 0.0400 M

B 0.0600 M

C 0.0800 M

D 0.120 M

E 0.200 M

59 **In a titration, a student overshoots the endpoint (adds too much base) and still records that final, larger volume as if it were the equivalence volume. How does this affect the calculated concentration of the acid (assuming base concentration is known and correct)?**

A Calculated acid concentration is too high

B Calculated acid concentration is too low

C Calculated acid concentration is unchanged

D The calculation becomes impossible

E Calculated acid concentration becomes zero

60 **A burette was not rinsed with the NaOH solution before filling; it still contained some distilled water. The student then uses the labeled NaOH concentration in calculations. How will the calculated acid concentration be affected?**

A Too high, because the NaOH delivered was actually more dilute than assumed

B Too low, because the NaOH delivered was actually more concentrated than assumed

C Unchanged, because water does not matter in titrations

D Exactly correct, because dilution cancels out perfectly

E Impossible to predict without knowing the acid formula

61 **A compound is 40.0% C, 6.7% H, and 53.3% O by mass. What is the empirical formula? (Ar: C=12, H=1, O=16)**

A CH_4O

B CH_2O

C $C_2H_4O_2$

D C_2H_6O

E CHO_2

62 **The empirical formula of a compound is CH_2O (empirical mass = 30 g/mol). If its molar mass is 180 g/mol, what is the molecular formula?**

A CH2O

B C2H4O2

C C3H6O3

D C6H12O6

E C12H24O12

63 **A sample contains 0.20 mol of nitrogen atoms and 0.60 mol of hydrogen atoms. What is the simplest formula (empirical) for the compound?**

A NH

B NH2

C NH3

D N2H3

E N3H

64 **A 2.495 g sample of CuSO4 · xH2O is heated to constant mass and becomes 1.595 g of anhydrous CuSO4. What is x? (Ar: Cu=63.5, S=32.0, O=16.0, H=1.0)**

A 2

B 3

C 4

D 5

E 6

65 **$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$. If you mix 100 mL of 0.10 M $BaCl_2$ with 100 mL of 0.050 M Na_2SO_4, how many moles of $BaSO_4$ form?**

A 0.010 mol

B 0.0075 mol

C 0.0050 mol

D 0.0025 mol

E 0.0010 mol

66 **$2KClO_3 \rightarrow 2KCl + 3O_2$. If 3.36 L of O_2 is collected at STP, what mass of $KClO_3$ decomposed? ($M_r(KClO_3)=122.5$, molar gas volume = 22.4 L/mol)**

A 4.08 g

B 8.17 g

C 12.25 g

D 24.5 g

E 36.8 g

67 **$N_2 + 3H_2 \rightarrow 2NH_3$. At the same temperature and pressure, you mix 10 L N_2 with 20 L H_2. Assuming complete reaction, what volume of NH_3 forms?**

A 6.7 L

B 10 L

C 13.3 L

D 20 L

E 30 L

68 **What is the mass percent of oxygen in CO2? (Ar: C=12, O=16)**

A 27.3%

B 50.0%

C 72.7%

D 80.0%

E 88.0%

69 **How many atoms are there in 0.20 mol of CaCO3? (NA = 6.02 × 10^{23} mol−1)**

A 1.20 × 10^{23} atoms

B 6.02 × 10^{22} atoms

C 6.02 × 10^{23} atoms

D 3.01 × 10^{23} atoms

E 1.20 × 10^{24} atoms

70 **How many moles of oxygen atoms are contained in 1.0 mol of glucose (C6H12O6)?**

A 1.0 mol

B 3.0 mol

C 6.0 mol

D 12.0 mol

E 18.0 mol

#	Ans	Answer Text
1	B	Exactly 6.02 × 10^{23} particles (atoms, molecules, or formula units) of t...
2	B	Moles and number of particles
3	B	3.01 × 10^{23}
4	C	1.00 mol
5	B	14.6 g
6	A	The student is correct: molar mass in g/mol has the same number as Mr
7	B	3.32 mol
8	C	0.20 mol
9	D	1.0 mol CH4
10	A	1.0 L He(g) and 1.0 L N2(g)
11	B	2H2 + O2 → 2H2O
12	B	2 moles of H2 react with 1 mole of O2 to form 2 moles of H2O
13	C	The equation still represents the same reaction; only the amounts are sc...
14	C	5
15	C	4.0 mol
16	C	1.5 mol
17	C	4Al + 3O2 → 2Al2O3
18	C	Because balanced coefficients give the correct mole ratios and conserve ...
19	B	2.0 mol
20	B	2.0 mol
21	C	36 g
22	B	22.4 L
23	B	4.40 g
24	C	44.0 g
25	C	29.3 g
26	B	O2 is limiting
27	B	36 g
28	C	1.0 g
29	B	Cl2 is limiting and 0.13 mol AlCl3 forms
30	D	Neither is in excess; both are completely consumed
31	C	The reactant that is completely used up first and determines the maximum...
32	C	75%
33	C	Side reactions, incomplete reaction, and losses during separation/purifi...
34	B	H2 is limiting and 2.0 mol NH3 forms
35	C	6.72 L
36	B	0.067 mol
37	B	37.0 g
38		CaCO3 is limiting and 4.4 g CO2 forms