Recitation Worksheet Six

Name: Key UGA ID:

Instructions:

- Please enter your first and last name as it appears on the eLC roster (do not use a nickname that is not reflected in eLC).
- Your UGA myID is a combination of letters and numbers (example: mine is jmj81738). Do *not* enter your 81x number.
- Download this worksheet and print it if you have a printer. Write the answers in the answer boxes and show your work when appropriate. Using the instructions in the Welcome module on eLC, convert your worksheet to a PDF and then upload it to Gradescope. If you have an iPhone or Android device, you can scan and upload directly through the Gradescope app. The pages must be in the correct order or Gradescope will not be able to read it.
- If you do not have a printer, download the worksheet and type your answers in the answer boxes and upload it to Gradescope. Write your work on separate sheets of paper, convert these pages to a PDF using the instructions in the Welcome module on eLC, then upload them to the dropbox on eLC for this worksheet.
- If you are using an app to annotate the worksheet, make sure the pages are in the correct order and have the same layout as the original or Gradescope will not be able to read it.
- Answers must be written in the corresponding answer box or no credit will be awarded.
- This worksheet is due no later than **11:59 PM on the Friday of the recitation week.**
- The instructions for uploading worksheets to Gradescope can be found in the Content area of eLC in the Welcome Module.
- **You must show your work to receive credit.**

1. If 0.50 moles of nitrogen gas reacts with 0.50 moles of oxygen gas, how many molecules of nitrogen dioxide are produced?

3.0E23 molecules

$$N_2 + 2O_2 \rightarrow 2NO_2$$

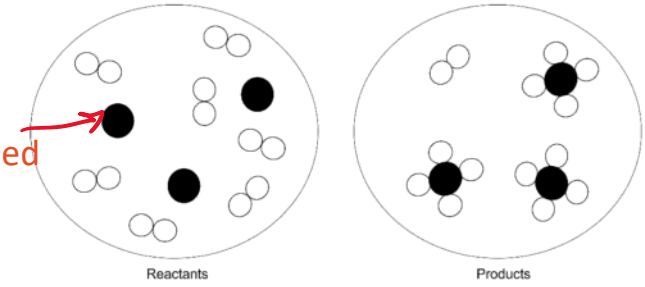
$$0.50\,\text{mol}\,N_2 \times \frac{2\,\text{mol}\,NO_2}{1\,\text{mol}\,N_2} \times \frac{6.022\times10^{23}\,\text{molecules}}{\text{mol}\,NO_2} = 6.022\times10^{23}\,\text{molecules}\,NO_2$$

limiting reagent

$$0.50\,\text{mol}\,O_2 \times \frac{2\,\text{mol}\,NO_2}{2\,\text{mol}\,O_2} \times \frac{6.022\times10^{23}\,\text{molecules}}{\text{mol}} = 3.011\times10^{23}\,\text{molecules}\,NO_2$$

2. The image below shows reactants before a reaction and the products afterward. If black spheres represent carbon and white spheres represent hydrogen, what is the limiting reactant?

All consumed



B

A. H_2
B. C
C. CH_4

3. What is the percent yield if 65.0 g of methane combusts with excess oxygen according to the balanced reaction below and 62.8 g of water is recovered?

$$CH_4\ (l) + 2\ O_2\ (g) \rightarrow CO_2\ (g) + 2\ H_2O\ (g)$$

43.0 %

① $65.0\text{ g } CH_4 \times \frac{\text{mol}}{16.05\text{ g}} \times \frac{2\text{ mol } H_2O}{1\text{ mol } CH_4} \times \frac{18.02\text{ g } H_2O}{\text{mol } H_2O} = 145.56\text{ g}$

② $\% = \frac{62.8\text{ g}}{145.56} \times 100 = 43.0\%$

4. A reaction is known to have a low percent yield of 18.29%. If a scientist needs 250.0 g of the product for the next step in their procedure, what theoretical yield (g) should they plan for?

1.367E3 g

$\frac{250.0\text{ g}}{\text{theoretical}} \times 100 = 18.29$

$\text{theoretical} = 250.0\text{ g}\left(\frac{100}{18.29}\right)$

5. If 9.0 g of iron is reacted with 9.0 g of water according to the chemical equation shown below, what mass (g) of the excess reactant is leftover?

$$3\ Fe\ (s) + 4\ H_2O\ (l) \rightarrow Fe_3O_4\ (s) + 4\ H_2\ (g)$$

5.1 g

(1) $9.0\ g\ Fe \times \frac{mol\ Fe}{55.85\ g\ Fe} \times \frac{mol\ Fe_3O_4}{3\ mol\ Fe} \times \frac{231.55\ g}{mol} = 12.4377\ g\ Fe_3O_4$

$9.0\ g\ H_2O \times \frac{mol\ H_2O}{18.02\ g\ H_2O} \times \frac{mol\ Fe_3O_4}{4\ mol\ H_2O} \times \frac{231.55\ g}{mol} = 28.91163\ g\ Fe_3O_4$

(2) $(28.91163\ g - 12.4377\ g)\ Fe_3O_4 \times \frac{mol}{231.55\ g} \times \frac{4\ mol\ H_2O}{mol\ Fe_3O_4} \times \frac{18.02\ g}{mol} = 5.1\ g$

6. A student goes to the lab and synthesizes ZnO (s) according to the balanced equation below. If the reaction was executed using 5.00 grams of ZnS (s) in the presence of excess O_2 (g), how many grams of ZnO (s) did they collect if the percent yield was 23.53 %?

$$2\ ZnS\ (s) + 3\ O_2\ (g) \rightarrow 2\ ZnO\ (s) + 2\ SO_2\ (g)$$

0.982 g

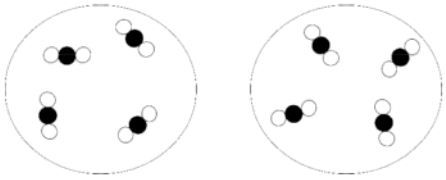
$5.00\ g\ ZnS \times \frac{mol}{97.45\ g} \times \frac{2\ mol\ ZnO}{2\ mol\ ZnS} \times \frac{81.38\ g}{mol} \times \frac{23.53}{100}$

7. Which of the following is a non-electrolyte? Choose all that apply.

AFG

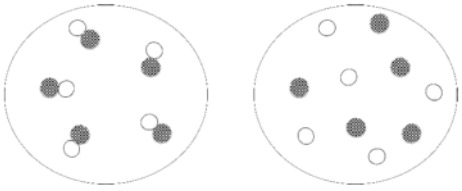
A. C_4H_9OH → alcohol
B. HCl → strong acid
C. $Mg(C_2H_3O_2)_2$ → salt
D. C_3H_7COOH → weak acid
E. NaOH → strong base
F. C_6H_{12} → hydrocarbon
G. N_2O_4 → molecule

8. The following compounds are shown before and after being dissolved in water. Label them as A. strong, B. weak, or C. non-electrolytes.

I. 

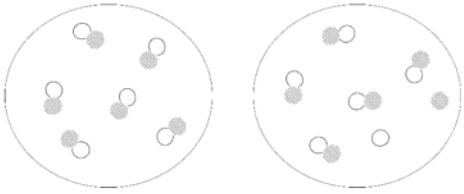
C

no dissociation

II. 

A

complete dissociation

III. 

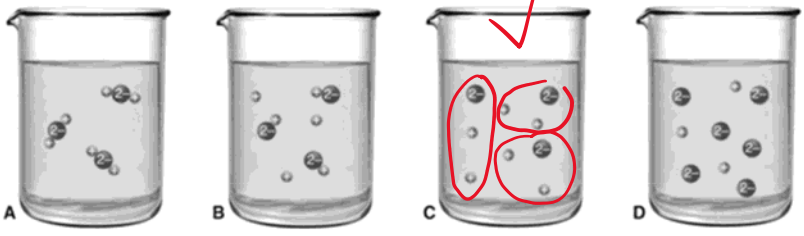
B

some dissociation

K_2SO_4

9. Which image best depicts potassium sulfate dissolved in water? (H_2O molecules are not shown in the drawings.)

C



- a strong electrolyte so C or D
- $2K^+$ for every one SO_4^{2-}

10. A sugar and salt solution is prepared by adding 10.0 g of sucrose and 0.50 g of sodium chloride to 500. mL of water. What is/are the solute(s)?

C

A. Sugar
B. Salt
C. Sugar and salt
D. Water
E. Sugar, salt, and water

water is the solvent

11. A researcher is making 750. mL of a 0.34 M sucrose solution. How many moles of sucrose are required?

$M = \frac{mol}{L}$

$0.34\ M = \frac{mol}{0.750\ L}$

0.26 moles

12. How many total ions are in 1.00 L of a 0.175 M solution of K_2CrO_4? (molar mass = 182.94 g/mol)

$K_2CrO_{4(aq)} \rightarrow 2K^+_{(aq)} + CrO_4^{2-}{}_{(aq)} = 3 \text{ ions}$

D

A. 9.57×10^{-4}
B. 1.05×10^{23}
C. 2.11×10^{23}
D. 3.16×10^{23}
E. 7.38×10^{23}

$0.175 \frac{mol\ K_2CrO_4}{L} \times 1.00\ L \times \frac{3\ mol\ ions}{mol\ K_2CrO_4} \times \frac{6.022 \times 10^{23}\ ions}{mol\ ions}$

13. How much water will you need to **add** to 500 mL of a 2.50 M KCl solution to prepare a 1.00 M KCl solution?

C

A. 250 mL
B. 500 mL
C. 750 mL
D. 1250 mL
E. 1500 mL

(1) $C_1V_1 = C_2V_2$

$(2.50\ M)(500\ mL) = (1.00\ M)V_2$

$1250\ mL = V_2$

(2) $\Delta V = 1250\ mL - 500\ mL = 750\ mL$ added

14. How many molecules of sucrose ($C_{12}H_{22}O_{11}$) are contained in 14.3 mL of 0.140 M sucrose solution?

A

A. 1.21×10^{21} molecules
B. 6.15×10^{22} molecules
C. 1.63×10^{23} molecules
D. 5.90×10^{24} molecules
E. 1.21×10^{22} molecules

$$0.140\ \frac{mol}{L} \times 0.0143\ L \times \frac{6.022 \times 10^{23}\ molecules}{mol}$$

15. What is the concentration of an $AlCl_3$ solution if 150. mL of the solution contains 550. mg of Cl^- ion?

0.0345 M

$$AlCl_{3(aq)} \rightarrow Al^{3+}_{(aq)} + 3Cl^{-}_{(aq)}$$

$$550\ mg \times \frac{1\ g}{1000\ mg} \times \frac{mol\ Cl}{35.45\ g} \times \frac{mol\ AlCl_3}{3\ mol\ Cl^-} \times \frac{1}{0.150\ L}$$

16. A student goes to the lab and starts cleaning out an old lab cabinet. While cleaning, they find a bottle of an unknown white solid. The curious student carefully adds the solid to a beaker of water and they note that the solid immediately dissolves. To the same beaker of water, they add an aqueous solution of Li_2SO_4, in which a white precipitate immediately forms. Based on these observations, which of the compounds below are potential identities of the unknown solid? Select all that apply.

Does a precipitate form?

AE

A. $BaCl_2$
B. $PbCl_2$
C. NaCl
D. $AlCl_3$
E. $CaCl_2$

(A) $BaCl_{2(aq)} + Li_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2LiCl_{(aq)}$ ✓

(B) $PbCl_{2(s)}$ is not soluble

(C) $2NaCl_{(aq)} + Li_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + 2LiCl_{(aq)}$

(D) $2AlCl_{3(aq)} + 3Li_2SO_{4(aq)} \rightarrow 3Al_2(SO_4)_{3(aq)} + 6LiCl_{(aq)}$

(E) $CaCl_{2(aq)} + Li_2SO_{4(aq)} \rightarrow CaSO_{4(s)} + 2LiCl_{(aq)}$ ✓

17. What is the total ionic equation for the balanced formula equation below?

$2\ HC_2H_3O_2\ (aq) + K_2CO_3\ (aq) \rightarrow H_2O\ (l) + CO_2\ (g) + 2\ KC_2H_3O_2\ (aq)$

C

only aqueous species dissociate
do not cancel spectator ions

A. $2\ H^+\ (aq) + 2\ C_2H_3O_2^-\ (aq) + 2\ K^+\ (aq) \rightarrow 2\ KC_2H_3O_2\ (aq)$

B. $2\ H^+\ (aq) + 2\ C_2H_3O_2^-\ (aq) + 2\ K^+\ (aq) + CO_3^{2-}\ (aq) \rightarrow 2\ H^+\ (l) + O^{2-}\ (l) + C^{4+} + 2\ O^{2-}\ (g) + 2\ K^+\ (aq) + 2\ C_2H_3O_2^-\ (aq)$

C. $2\ H^+\ (aq) + 2\ C_2H_3O_2^-\ (aq) + 2\ K^+\ (aq) + CO_3^{2-}\ (aq) \rightarrow H_2O\ (l) + CO_2\ (g) + 2\ K^+\ (aq) + 2\ C_2H_3O_2^-\ (aq)$

D. $2\ H^+\ (aq) + 2\ C_2H_3O_2^-\ (aq) \rightarrow H_2O\ (l) + 2\ C_2H_3O_2^-\ (aq)$

E. $2\ C_2H_3O_2^-\ (aq) + 2\ K^+\ (aq) \rightarrow 2\ KC_2H_3O_2\ (aq)$

18. When hydrochloric acid is added to potassium sulfide the products are hydrogen sulfide gas and potassium chloride. What is/are the spectator ion(s) in this reaction? Select all that apply.

$2HCl_{(aq)} + K_2S_{(aq)} \rightarrow H_2S_{(g)} + 2KCl_{(aq)}$

$2H^+_{(aq)} + 2Cl^-_{(aq)} + 2K^+_{(aq)} + S^{2-}_{(aq)} \rightarrow H_2S_{(g)} + 2K^+_{(aq)} + 2Cl^-_{(aq)}$

AC

A. K^+
B. H^+
C. Cl^-
D. S^{2-}
E. There are no spectator ions in this reaction

19. Copper(II) nitrate reacts with potassium sulfide. What is/are the spectator ion(s) in this reaction? Select all that apply.

BC

A. Cu^{2+}
B. NO_3^-
C. K^+
D. S^{2-}
E. SO_4^{2-}
F. There are no spectator ions in this reaction

$Cu(NO_3)_{2\,(aq)} + K_2S_{(aq)} \longrightarrow CuS_{(s)} + 2KNO_{3\,(aq)}$

$Cu^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} + 2K^+_{(aq)} + S^{2-}_{(aq)} \longrightarrow CuS_{(s)} + 2K^+_{(aq)} + 2NO_3^-{}_{(aq)}$

20. What is the net ionic equation for the balanced formula equation below?

$$2\ HClO_4\ (aq) + FeO\ (s) \rightarrow Fe(ClO_4)_2\ (aq) + H_2O\ (l)$$

D

$2H^+_{(aq)} + 2ClO_4^-{}_{(aq)} + FeO_{(s)} \rightarrow Fe^{2+}_{(aq)} + 2ClO_4^-{}_{(aq)} + H_2O_{(l)}$

A. $2\ ClO_4^-\ (aq) + Fe^{2+}\ (aq) \rightarrow Fe(ClO_4)_2\ (aq)$

B. $2\ H^+\ (aq) + OH^-\ (aq) \rightarrow H_2O\ (l)$

C. $2\ H^+\ (aq) + Fe^{2+}\ (aq) + O^{2-}\ (aq) \rightarrow Fe^{2+}\ (aq) + H_2O\ (l)$

D. $2\ H^+\ (aq) + FeO\ (s) \rightarrow Fe^{2+}\ (aq) + H_2O\ (l)$

E. $2\ ClO_4^-\ (aq) + 2\ H^+\ (aq) + Fe^{2+}\ (aq) + O^{2-}\ (aq) \rightarrow Fe(ClO_4)_2\ (aq) + H_2O\ (l)$

21. What is the net ionic equation for the balanced formula equation below?

$$NH_4Cl\ (aq) + NaOH\ (aq) \rightarrow NH_3\ (g) + H_2O\ (l) + NaCl\ (aq)$$

B

A. $Cl^-\ (aq) + Na^+\ (aq) \rightarrow NaCl\ (aq)$

B. $NH_4^+\ (aq) + OH^-\ (aq) \rightarrow NH_3\ (g) + H_2O\ (l)$

C. $NH_4^+\ (aq) + Na^+\ (aq) + OH^-\ (aq) \rightarrow N^{3-}\ (g) + 3\ H^+\ (g) + 2\ H_2O\ (l) + Na^+\ (aq)$

D. $2\ H^+\ (aq) + OH^-\ (aq) \rightarrow H_2O\ (l)$

E. $N^{3-}\ (aq) + 4\ H^+\ (aq) + OH^-\ (aq) \rightarrow NH_3\ (g) + H_2O\ (l)$

$NH_4^+{}_{(aq)} + Cl^-_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow NH_{3(g)} + H_2O_{(l)} + Na^+_{(aq)} + Cl^-_{(aq)}$

22. How many liters of a 2.0 M H_3PO_4 solution are required to react with 7.25 g of Zn? Start by balancing the equation below.

$$\_2\_ H_3PO_4\,(aq) + \_3\_ Zn\,(s) \rightarrow \_1\_ Zn_3(PO_4)_2\,(aq) + \_3\_ H_2\,(g)$$

0.037 L

(1) $7.25\ g\ Zn \times \frac{mol\ Zn}{65.38\ g\ Zn} \times \frac{2\ mol\ H_3PO_4}{3\ mol\ Zn} = 0.0739268\ mol\ H_3PO_4$

(2) $\frac{2.0\ mol}{L} = \frac{0.0739268\ mol}{X}$ $\quad X = 0.037\ L$

23. What volume (in milliliters) of a 0.185 M solution of sulfuric acid is needed to neutralize 35.0 mL of a 0.215 M solution of potassium hydroxide?

$$H_2SO_4\,(aq) + 2\,KOH\,(aq) \rightarrow 2H_2O\,(l) + K_2SO_4$$

20.3 mL

(1) $0.215\ M = \frac{mol\ KOH}{0.035\ L}$ $\quad mol\ KOH = 0.007525\ mol\ KOH$

(2) $0.007525\ mol\ KOH \times \frac{1\ mol\ H_2SO_4}{2\ mol\ KOH} \times \frac{L}{0.185\ mol\ H_2SO_4} \times \frac{1000\ mL}{L} = 20.3\ mL$

24. Remember the student from earlier in this worksheet who was cleaning out the old lab cabinet? They are almost done, but they find one more unknown bottle of solid. Based on the worn-out label, they at least know the bottle contains a hydroxide ion and an alkali metal.

To determine the bottle's identity, they dissolve 17.422 grams of the solid in water, and then neutralize the bottle's contents using 34.00 mL of 5.00 M HCl solution. Assuming the equation provided below is balanced, what is the most probable alkali metal ("M") in the unknown compound?

$$MOH\,(aq) + HCl\,(aq) \rightarrow MCl\,(aq) + H_2O\,(l)$$

D

A. Li^+
B. Na^+
C. K^+
D. Rb^+
E. Cs^+

(1) $5.00\ \frac{mol\ HCl}{L} \times 0.03400\ L \times \frac{mol\ MOH}{mol\ HCl} = 0.170\ mol\ MOH$

(2) $Molar\ mass\ MOH = \frac{17.422\ g}{0.170\ mol} = 102.482\ \frac{g}{mol}$

(3) $mass\ M^+ = MOH - OH = 102.482\ \frac{g}{mol} - 17.01\ \frac{g}{mol} = 85.47\ \frac{g}{mol}$

25. Consider the balanced reaction below in which 52.0 mL of 2.35 M $AgNO_3$ was added to 21.9 mL of 4.60 M NaCl. What is the concentration of Cl^- in solution after the reaction goes to completion? States of matter have been omitted.

$$AgNO_3 + NaCl \rightarrow NaNO_3 + AgCl$$
$$(aq)\quad (aq)\quad (aq)\quad (s)$$

A

A. 0.00 M
B. 1.36 M
C. 1.65 M
D. 2.35 M
E. 4.60 M

$2.35 \frac{mol\ AgNO_3}{L} \times 0.0520\ L \times \frac{1\ mol\ AgCl}{1\ mol\ AgNO_3} = 0.1222 \approx 0.122\ mol\ AgCl$

$4.60 \frac{mol\ NaCl}{L} \times 0.0219\ L \times \frac{1\ mol\ AgCl}{1\ mol\ NaCl} = 0.10074\ mol\ AgCl$

limiting

since NaCl is limiting, all Chloride is consumed

26. Label the following as an A. acid-base, B. precipitation, or C. oxidation-reduction (redox) reaction.

A $HCl\ (aq) + KOH\ (aq) \rightarrow KCl\ (aq) + H_2O\ (l)$

B $CuCl\ (aq) + KOH\ (aq) \rightarrow KCl\ (aq) + CuOH\ (s)$

A $H^+\ (aq) + OH^-\ (aq) \rightarrow H_2O\ (l)$

C $\overset{0}{2\ Fe}\ (s) + \overset{0}{3\ Cl_2}\ (g) \rightarrow \overset{+3\ -1}{2\ FeCl_3}\ (s)$

27. In which substance does nitrogen have the **lowest** (most negative) oxidation state?

E

A. N_2
B. NF_3
C. NO_2
D. NO_3^-
E. NH_3

(A) $2N = 0$, $N = 0$

(B) $N + 3F = 0$, $N + 3(-1) = 0$, $N = +3$

(C) $N + 2O = 0$, $N + 2(-2) = 0$, $N = +4$

(D) $N + 3O = -1$, $N + 3(-2) = -1$, $N = +5$

(E) $N + 3H = 0$, $N + 3(+1) = 0$, $N = -3$

28. Which of the following unbalanced half-reactions represent **reduction**? Select all that apply.

BC

A. $Cu \rightarrow CuCl_2$
✓ B. $\overset{+4}{CrO_2} \rightarrow \overset{+2}{CrO}$
✓ C. $\overset{+6}{SO_4^{2-}} \rightarrow \overset{-2}{S^{2-}}$
D. $Mg \rightarrow MgO$
E. $SF_4 \rightarrow SF_6$

(A) $\overset{0}{Cu} \rightarrow \overset{2+}{Cu}\overset{-1}{Cl_2}$, $Cu + 2(-1) = 0$, $Cu = +2$

(B) $Cr + 2O = 0$, $Cr + 2(-2) = 0$, $Cr = +4$ | $Cr + O = 0$, $Cr + (-2) = 0$, $Cr = +2$

(C) $S + 4O = -2$, $S + 4(-2) = -2$, $S = +6$ | $S = 2-$

(D) $Mg = 0$ | $Mg + O = 0$, $Mg - 2 = 0$, $Mg = +2$

(E) $S + 4F = 0$, $S + 4(-1) = 0$, $S = +4$ | $S + 6F = 0$, $S + 6(-1) = 0$, $S = +6$

must balance atoms AND electrons

29. Consider the oxidation-reduction reaction below and answer the following questions. Write the **chemical formula** in the boxes below.

____Cl_2 (g) + ____Fe^{2+} (aq) → ____Fe^{3+} (aq) + ____Cl^- (aq)

I. What species is oxidized? [Fe^{2+}]

$Fe^{2+} \rightarrow Fe^{3+} + e^-$ X 2

II. What species is reduced? [Cl_2]

$Cl_2 + 2e^- \rightarrow 2Cl^-$

III. Fully balance the equation and list the coefficients as whole numbers with no commas or spaces (e.g. 1234).

[1222]

$Cl_2 + 2Fe^{2+} \rightarrow 2Fe^{3+} + 2Cl^-$

IV. How many electrons were transferred after balancing the equation,? Answer by using an integer (e.g. 0, 1, etc.).

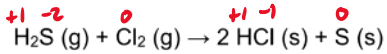
[2]

$2Fe^{2+} \rightarrow 2Fe^{3+} + 2e^-$

$Cl_2 + 2e^- \rightarrow 2Cl^-$

$Cl_{2(aq)} + 2Fe^{2+}_{(aq)} + 2e^- \rightarrow 2Fe^{3+}_{(aq)} + 2Cl^-_{(aq)} + 2e^-$

30. Consider the oxidation-reduction reaction below and answer the following questions. Write the **chemical formula** in the boxes below.



I. What species is oxidized? H_2S or S^{2-}

II. What species is reduced? Cl_2

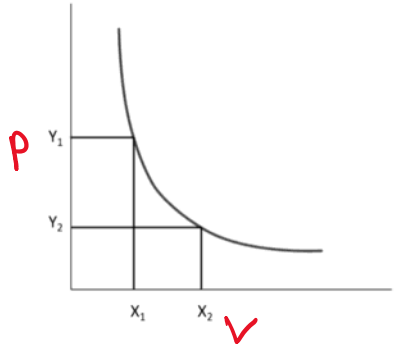
III. What species is the oxidizing agent? Cl_2

IV. What species is the reducing agent? H_2S

31. Two parameters for gases - pressure, volume, moles, or temperature – are held constant, while the other two are varied and measured. The resulting graph is shown below. What two parameters could have been measured and resulted in this graph?

B

A. Volume vs Temperature
B. Pressure vs Volume
C. Volume vs Moles
D. Pressure vs Temperature

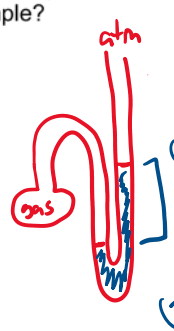


volume increases
as pressure decreases

32. An open-ended manometer is filled with an unknown gas sample. The liquid mercury on the side open to the atmosphere rises so that it is 0.95 cm higher than the side connected to the gas. If atmospheric pressure is measured at 0.972 atm, what is the pressure (mm Hg) of the gas sample?

A

A. 748 mm Hg
B. 729 mm Hg
C. 1.92 mm Hg
D. 0.02 mm Hg
E. 1460 mm Hg



① $0.972\ \text{atm} \times \frac{760\ \text{mm}}{\text{atm}} = 738.72\ \text{mm}$

② $0.95\ \text{cm} \times \frac{10\ \text{mm}}{\text{cm}} = 9.5\ \text{mm}$

③ $738.72\ \text{mmHg} + 9.5\ \text{mmHg} = 748\ \text{mmHg}$

33. A rigid metal tank contains helium gas. What happens to the gas in the tank when some helium is removed at constant temperature?

B

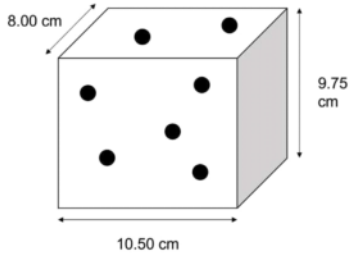
A. the volume of the gas decreases
B. the pressure of the gas decreases
C. the average speed of the gas molecules decreases
D. the total number of gas molecules remains the same
E. the average distance between the gas molecules decreases

34. A sample of gas is placed in a container, with the dimensions pictured below. Which of the following changes would result in an increase in the density of the gas?

D

$d = \frac{MP}{RT}$

A. Raising the temperature of the container
B. Removing ½ of the gas from the container
C. Increasing the length of the 8.00 cm side
D. Decreasing the length of the 10.50 cm side
E. Decreasing the pressure of the container



must be Kelvin to double

35. If the Celsius temperature of a fixed amount of a gas is doubled at constant pressure, the volume is…

C

A. Doubled
B. Halved
C. Increased, but not doubled
D. Quadrupled
E. Constant

36. A sample of gas is held in a 7.50 L container at 1.66 atm. If the temperature of the gas is 43.0 °C, how many moles of the gas are in the container?

+273.15

0.480 moles

$PV = nRT$

$(1.66\,atm)(7.50\,L) = n\left(0.08206\,\frac{L\,atm}{mol\,K}\right)(313.15\,K)$

$n = 0.480\,mol$

37. If a sample of gas originally in a 5.0 L container at 0.89 atm and 25°C is moved to a 2.0 L container and cooled to 1.0°C, what is the final pressure of the gas?

E

A. 0.089 atm
B. 0.33 atm
C. 0.014 atm
D. 2.6 atm
E. 2.0 atm

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{(0.89\,atm)(5.0\,L)}{(25+273.15\,K)} = \frac{P_2(2.0\,L)}{(1.0+273.15\,K)}$

38. A 249.9 mL sample of a diatomic gas has a mass of 1.782 g at STP. Calculate the molecular weight and determine the identity of the diatomic gas. Write the chemical formula of the gas in the answer box.

Br_2

① $PV = nRT$

$(1\,atm)(0.2499\,L) = n\left(0.08206\,\frac{L\,atm}{mol\,K}\right)(273.14\,K)$

$n = 0.01114893\,mol$

② X_2 molar mass $= \frac{1.782\,g}{0.01114893\,mol} = 159.8358\,\frac{g}{mol}$

$X = \frac{159.8358}{2} = 79.9179\,\frac{g}{mol} = Br$

$Mg_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + MgCl_{2(aq)}$

39. A 1.10 g ribbon of magnesium reacted with 300.0 mL of 0.800 M HCl to produce magnesium chloride and hydrogen gas. If the reaction occurred at 25.0 °C at 1.00 atm, how much hydrogen gas (in liters) was generated? Begin the problem by writing a balanced chemical equation and determining the limiting reagent.

1.11 L

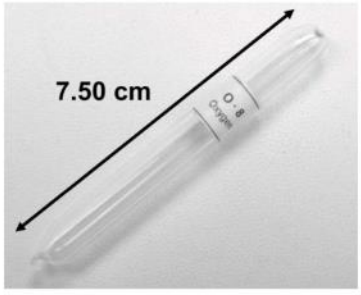
① $1.10\ g\ Mg \times \frac{mol}{24.31\ g} \times \frac{1\ mol\ H_2}{1\ mol\ Mg} = 0.0452483\ mol\ H_2$ limiting

$0.800\ \frac{mol\ HCl}{L} \times 0.3000\ L \times \frac{1\ mol\ H_2}{2\ mol\ HCl} = 0.120\ mol\ H_2$

② $PV = nRT$

$(1.00\ atm)(V) = (0.0452483\ mol)\left(0.08206\ \frac{L\cdot atm}{mol\cdot K}\right)(25.0 + 273.15\ K)$

40. Sealed ampoules are a common way to store and ship small samples of gas. They are sealed in order to be completely airtight. Oxygen gas is sealed in the ampoule below. Which of the following are true? Select all that apply.



A. reduces volume, increases P
B. must be double Kelvin

CDE

A. The pressure of the gas would decrease if the gas were put in an ampoule with the same dimensions except with a length of 5.00cm.
B. The pressure of the ampoule would double if the temperature were raised from 10.0°C to 20.0°C.
C. The pressure of the ampoule would increase, but not double, if the temperature were raised from 10.0°C to 20.0°C.
D. The moles of gas in the ampoule would stay the same if the temperature were raised from 10.0°C to 20.0°C.
E. The pressure of the gas would increase if the gas were put in an ampoule with the same dimensions except with a length of 5.00cm.

41. A 45 g sample of methane reacts with an excess of oxygen at 245 °C to produce carbon dioxide gas and water vapor. The carbon dioxide was captured in a 30 L sealed container. What is the pressure (in atm) of the carbon dioxide within the container?

4.0 atm

① $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 4H_2O_{(g)}$

$45\,g\,CH_4 \times \frac{mol}{16.05\,g} \times \frac{1\,mol\,CO_2}{1\,mol\,CH_4} = 2.803738\,mol\,CO_2$

② $PV = nRT$

$(P)(30.L) = (2.803738\,mol)(0.08206\,\frac{L\,atm}{mol\,K})(245 + 273.15\,K)$

42. Find the partial pressure of oxygen in dry air whose molar composition is O_2 (21.0%), N_2 (78.0%) and Ar (1.00%) and which has a total pressure of 5.00 atm.

D

A. 5.00 atm
B. 3.95 atm
C. 3.90 atm
D. 1.05 atm
E. 0.0500 atm

$5.00\,atm \times 0.210$

43. A 15.50 L gas bulb contains 8.17 g of N_2, 2.64 g of H_2, and 15.08 g of O_2. If the gas bulb is cooled to 15.0 °C, what is the partial pressure of nitrogen gas in atm?

0.445 atm

① $0.29165\,mol\,N_2$
$1.3056\,mol\,H_2$
$0.47127\,mol\,O_2$
$2.07257\,mol\,Total$

② $P_T V = nRT$

$P_T(15.50L) = (2.07257\,mol)(0.08206\,\frac{L\,atm}{mol\,K})(15.0 + 273.15K)$

$P_{Total} = 3.161674\,atm$

③ $X_{N_2} = \frac{0.29165}{3.161674} = 0.1407224$

④ $P_{N_2} = P_T \cdot X_{N_2}$
$= (3.161674\,atm)(0.1407224)$
$= 0.445$

44. A small piece of zinc reacts with an excess of hydrochloric acid according to the balanced reaction below.

$$Zn\ (s) + 2\ HCl\ (aq) \rightarrow ZnCl_2\ (aq) + H_2\ (g)$$

A total of 87.5 mL of gas was collected over water at 25.0 °C while monitoring the reaction. The gas pressure was recorded at 757 mm Hg. What was the initial mass of zinc metal (in grams) assuming all of the H_2 gas was captured? A table listing the vapor pressure of water at various temperatures is provided below.

Temperature (°C)	Vapor Pressure (torr)=mmHg
15.0	12.79
17.0	14.54
19.0	16.49
21.0	18.66
23.0	21.08
25.0	23.78
30.0	31.86

(1) $P_{Tot} = P_{H_2} + P_{H_2O}$

$757\ mmHg = P_{H_2} + 23.78\ mmHg$

$P_{H_2} = 733.22\ mmHg \times \frac{atm}{760\ mmHg}$

$= 0.9647632\ atm$

0.226 g

(2) $PV = nRT$

$(0.9647632\ atm)(0.0875\ L) = n\left(0.08206 \frac{L\,atm}{mol\,K}\right)(25.0 + 273.15\ K)$

$n = 0.0034503\ mol\ H_2$

(3) $0.0034503\ mol\ H_2 \times \frac{1\ mol\ Zn}{1\ mol\ H_2} \times \frac{65.38\ g\ Zn}{mol} = 0.226\ g$

45. At constant temperature, which gas has the **highest** average molecular speed?

B

A. Ne
B. CH_4
C. H_2O
D. Ar
E. F_2

smallest molar mass will have higest avg molecular speed

$1\,J = \frac{kg\,m^2}{s^2}$

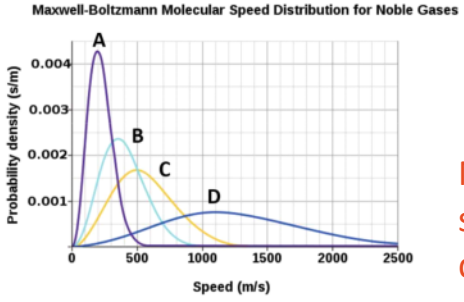
$v_{rms} = \sqrt{\frac{3RT}{m}}$

so need to convert molar mass into kg from g to cancel

46. A sample of carbon dioxide is at a temperature of 369 K. What is the average velocity (in m/s) of the carbon dioxide molecules in this sample?

457 m/s $= \sqrt{\frac{3(8.314\,J)(369\,K)}{44.01\,\frac{g}{mol} \times \frac{1\,kg}{1000\,g}}}$

47. Four noble gases – neon, argon, krypton, and xenon - are put into identical containers and held at the same temperature. Their speeds were measured and graphed below. Which of the lines represents neon? Write the corresponding letter in the box below.



Ne has lowest molar mass so highest velocity distribution

D

48. Which of the following would be false according to kinetic molecular theory?

D

A. All gases behave identically regardless of identity
B. Gases do not exchange energy when they collide with other gases or their container
C. The volume of a gas particle is negligible
D. Gases exert small attractive forces on other gases, but no repulsive forces
E. The average kinetic energy of a gas rises with rising temperature