

USE THE FOLLOWING EQUATION TO ANSWER QUESTIONS 1-5



$$M_m(\text{g/mol}) = \quad (17.0) \quad (32.0) \quad (16.0) \quad (27.0) \quad (18.0)$$

1. Calculate the number of **moles of H₂O** produced by the complete reaction of 6 moles NH₃.

_____ mol H₂O

2. Calculate the number of **grams of chlorine, HCN**, produced by the complete reaction of 175.0 grams NH₃.

_____ g HCN

3. If 100.0 grams **each** of NH₃, O₂, and CH₄ react, indicate which reactant is the limiting reagent.

4. If 90.0 g NH₃ reacts completely to produce only 148 g H₂O, calculate the **percent yield** of the reaction.

_____ %

5. How many **mL of 2.00 M NH₃** would be required to produce 40.0 g H₂O?

_____ mL

6. If you dilute 25.0 mL of 1.50 M HCl to 500 mL, what is the **molar concentration** of the diluted acid?

- a) 30.0 M b) 13.3 M c) 0.075 M d) 0.025 M e) none of these

7. Balance the following equations.

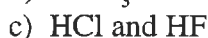
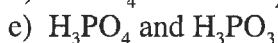
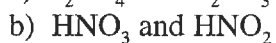
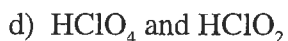
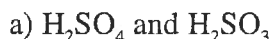


Classify each of the equations in #6 as **combination**, **decomposition**, **single displacement**, or **double displacement (metathesis)**.

a) _____

b) _____

8. Each of the following pairs contains **strong acids and weak acids, respectively**, except



9. Complete and balance the following acid/base neutralization reaction. Then write the **net ionic equation**.



10. Based on the solubility rules, **which of the following will occur** when a solution containing about 0.10 g of $\text{Pb}(\text{NO}_3)_{2(aq)}$ is mixed with a solution containing 0.10 g of $\text{KI}_{(aq)}/100 \text{ mL}$?

a) KNO_3 will precipitate; Pb^{+2} and I^{-1} are spectator ions.

b) No precipitate will form

c) $\text{Pb}(\text{NO}_3)_2$ will precipitate; K^{+1} and I^{-1} are spectator ions.

d) PbI_2 will precipitate; K^{+1} and NO_3^{-1} are spectator ions.

e) Pb^{+2} and I^{-1} are spectator ions, and PbI_2 will precipitate.

11. Write out the **complete ionic** and **net ionic** equation for the molecular equation given below. (refer to the attached solubility table)



12. A small bubble rises from the bottom of a lake, where the temperature and pressure are 4°C and 3.0 atm, to the water's surface, where the temperature is 25°C and the pressure is 0.95 atm. **Calculate the final volume of the bubble** if its initial volume was 2.1 mL.

a) 0.72 mL

b) 6.2 mL

c) 7.1 mL

d) 22.4 mL

e) 41.4 mL

13. 22.0 grams of CO_2 gas would occupy what **volume** at 0.416 atm and 85°C ?

_____ L

14. 1.018 g of Freon-113 is trapped in a 145 mL container at 760 mm Hg and 50.0°C . What is the **molecular weight of Freon-113**?

- a) 21.7 g/mol b) 28.8 g/mol c) 46.1 g/mol d) 186 g/mol e) 245 g/mol

15. What is the **density** of COCl_2 (MW = 98.9 g/mol) gas at 40°C and 850 mm Hg?

_____ g/L

16. A sample of hydrogen gas was collected over water at 21°C and 685 mm Hg. The volume of the container was 7.80 L. **Calculate the mass of $\text{H}_{2(g)}$ collected.** (Vapor pressure of water at 21°C is 18.6 mm Hg)

_____ g H_2

17. A mixture of three gases has a total pressure of 1,380 mm Hg. The mixture is found to contain 1.27 mol CO_2 , 3.04 mol CO , and 2.50 mol Ar. **What is the partial pressure of Ar?**

_____ mm Hg

18. The molecular weight of an unknown gas was measured by an effusion experiment. It was found that it took 72 seconds for the gas to effuse, whereas O_2 gas required 28 seconds. The **molecular mass** of the gas is:

_____ g/mol

19. If the pressure on a gas sample is tripled and the absolute temperature is quadrupled (4x), by **what factor** will the volume of the sample change?

- a) 12 b) $3/4$ c) $4/3$ d) $1/3$ e) 4

EXTRA CREDIT (1pt.each)

Name the following

Give formulas for the following

Sn(CrO₄)₂ _____

Copper(II) nitride _____

(NH₄)₂SO₃ _____

Silver sulfate _____

PbSO₄ _____

Potassium carbonate _____

Table 4.1 Solubility Rules for Ionic Compounds

Rule	Applies to	Statement	Exceptions
1	Li ⁺ , Na ⁺ , K ⁺ , NH ₄ ⁺	Group IA and ammonium compounds are soluble.	--
2	C ₂ H ₃ O ₂ ⁻ , NO ₃ ⁻	Acetates and nitrates are soluble.	--
3	Cl ⁻ , Br ⁻ , I ⁻	Most chlorides, bromides and iodides are soluble.	AgCl, Hg ₂ Cl ₂ , PbCl ₂ , AgBr, HgBr ₂ , Hg ₂ Br ₂ , PbBr ₂ , AgI, HgI ₂ , Hg ₂ I ₂ , PbI ₂
4	SO ₄ ⁻²	Most sulfates are soluble.	CaSO ₄ , SrSO ₄ , BaSO ₄ , Ag ₂ SO ₄ , Hg ₂ SO ₄ , PbSO ₄
5	CO ₃ ⁻²	Most carbonates are insoluble.	Group IA carbonates, (NH ₄) ₂ CO ₃
6	PO ₄ ⁻³	Most phosphates are insoluble.	Group IA Phosphates, (NH ₄) ₃ PO ₄
7	S ⁻²	Most sulfides are insoluble.	Group IA sulfides, (NH ₄) ₂ S
8	OH ⁻	Most hydroxides are insoluble.	Group IA hydroxides, Ca(OH) ₂ , Sr(OH) ₂ , Ba(OH) ₂

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$$M_m(\text{g/mol}) = \quad (17.0) \quad (32.0) \quad (16.0) \quad (27.0) \quad (18.0)$$

1. Calculate the number of moles of H₂O produced by the complete reaction of 6 moles NH₃.

$$6 \text{ mol NH}_3 \left(\frac{6 \text{ mol H}_2\text{O}}{2 \text{ NH}_3} \right) = 18 \text{ mol H}_2\text{O}$$

18 mol H₂O

2. Calculate the number of grams of chlorine, HCN, produced by the complete reaction of 175.0 grams NH₃.

$$175 \text{ g NH}_3 \left(\frac{1 \text{ mol NH}_3}{17.0 \text{ g}} \right) \left(\frac{2 \text{ mol HCN}}{2 \text{ mol NH}_3} \right) \left(\frac{27.0 \text{ g HCN}}{1 \text{ mol HCN}} \right) = 278 \text{ g HCN}$$

278 g HCN

3. If 100.0 grams each of NH₃, O₂, and CH₄ react, indicate which reactant is the limiting reagent.

$$100 \text{ g NH}_3 \left(\frac{1 \text{ mol}}{17 \text{ g}} \right) \div 2 = 2.94$$

$$100 \text{ g O}_2 \left(\frac{1 \text{ mol}}{32 \text{ g}} \right) \div 3 = 1.04 \quad \leftarrow \text{SMALLEST WINS}$$

$$100 \text{ g CH}_4 \left(\frac{1 \text{ mol}}{16 \text{ g}} \right) \div 2 = 3.13$$

O₂

4. If 90.0 g NH₃ reacts completely to produce only 148 g H₂O, calculate the percent yield of the reaction.

$$90.0 \text{ g NH}_3 \left(\frac{1 \text{ mol}}{17.0 \text{ g}} \right) \left(\frac{6 \text{ mol H}_2\text{O}}{2 \text{ mol NH}_3} \right) \left(\frac{18 \text{ g H}_2\text{O}}{1 \text{ mol}} \right) = 286 \text{ g THEORETICAL}$$

$$\% \text{ YIELD} = \frac{148 \text{ g H}_2\text{O}}{286 \text{ g THEO}} \times 100 = \underline{51.8} \%$$

5. How many mL of 2.00 M NH₃ would be required to produce 40.0 g H₂O?

$$40.0 \text{ g H}_2\text{O} \left(\frac{1 \text{ mol H}_2\text{O}}{18 \text{ g}} \right) \left(\frac{2 \text{ mol NH}_3}{6 \text{ mol H}_2\text{O}} \right) \left(\frac{1000 \text{ mL NH}_3 \text{ SOLUTION}}{2.00 \text{ mol NH}_3} \right) = 370 \text{ mL}$$

370 mL

6. If you dilute 25.0 mL of 1.50 M HCl to 500 mL, what is the molar concentration of the diluted acid?

- a) 30.0 M b) 13.3 M c) 0.075 M d) 0.025 M e) none of these

$$M_1 V_1 = M_2 V_2 \quad (1.50 \text{ M})(25.0 \text{ mL}) = (M_2)(500 \text{ mL})$$

$$M_2 = 0.075 \text{ M}$$

7. Balance the following equations.

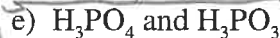
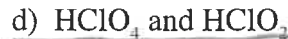
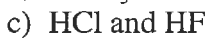
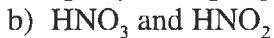
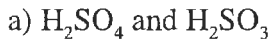


Classify each of the equations in #6 as **combination**, **decomposition**, **single displacement**, or **double displacement (metathesis)**.

a) SINGLE DISPL.

b) DOUBLE DISPL.

8. Each of the following pairs contains **strong acids and weak acids, respectively, except**



BOTH WEAK

9. Complete and balance the following acid/base neutralization reaction. Then write the **net ionic equation**.



ClO₄⁻ WAS ONLY SPECTATOR

10. Based on the solubility rules, **which of the following will occur** when a solution containing about 0.10 g of $\text{Pb}(\text{NO}_3)_{2(aq)}$ is mixed with a solution containing 0.10 g of $\text{KI}_{(aq)}/100 \text{ mL}$?

a) KNO_3 will precipitate; Pb^{+2} and I^- are spectator ions.

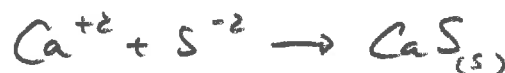
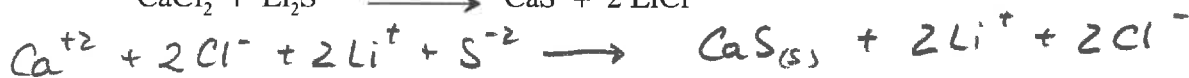
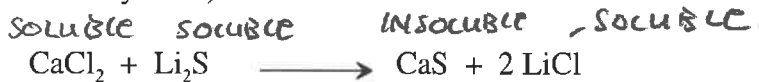
b) No precipitate will form

c) $\text{Pb}(\text{NO}_3)_2$ will precipitate; K^{+1} and I^- are spectator ions.

d) PbI_2 will precipitate; K^{+1} and NO_3^{-1} are spectator ions.

e) Pb^{+2} and I^- are spectator ions, and PbI_2 will precipitate.

11. Write out the **complete ionic** and **net ionic** equation for the molecular equation given below. (refer to the attached solubility table)



12. A small bubble rises from the bottom of a lake, where the temperature and pressure are 4°C and 3.0 atm , to the water's surface, where the temperature is 25°C and the pressure is 0.95 atm . **Calculate the final volume of the bubble** if its initial volume was 2.1 mL .

a) 0.72 mL

b) 6.2 mL

c) 7.1 mL

d) 22.4 mL

e) 41.4 mL

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$\frac{(3.0 \text{ atm})(2.1 \text{ mL})}{277 \text{ K}} = \frac{(0.95 \text{ atm})(V_2)}{298 \text{ K}}$

$V_2 = 7.13 \text{ mL}$

13. 22.0 grams of CO₂ gas would occupy what **volume** at 0.416 atm and 85°C?

$$\rightarrow \frac{1 \text{ mol}}{44 \text{ g}} = 0.500$$

$$V = \frac{nRT}{P} = \frac{(0.500 \text{ mol})(0.0821 \frac{\text{L}\cdot\text{ATM}}{\text{mol}\cdot\text{K}})(358 \text{ K})}{0.416 \text{ ATM}} = \underline{35.3 \text{ L}}$$

14. 1.018 g of Freon-113 is trapped in a 145 mL container at 760 mm Hg and 50.0°C. What is the **molecular weight of Freon-113**?

$$MW = \text{mass} \cdot T / PV$$

- a) 21.7 g/mol b) 28.8 g/mol c) 46.1 g/mol **d) 186 g/mol** e) 245 g/mol

15. What is the **density** of COCl₂ (MW = 98.9 g/mol) gas at 40°C and 850 mm Hg?

$$D = \frac{P(\text{mol. wt.})}{RT} = \frac{(850 \text{ mmHg})(98.9 \text{ g/mol})}{62.4 \frac{\text{L}\cdot\text{mmHg}}{\text{mol}\cdot\text{K}} \cdot 313 \text{ K}} = 4.30 \text{ g/L}$$

4.30 g/L

16. A sample of hydrogen gas was collected over water at 21°C and 685 mm Hg. The volume of the container was 7.80 L. Calculate the mass of H_{2(g)} collected. (Vapor pressure of water at 21°C is 18.6 mm Hg)

$$P_{H_2} = 685 - 18.6 \approx 666 \text{ mmHg}$$

$$n_{H_2} = \frac{PV}{RT} = \frac{(666 \text{ mmHg})(7.80 \text{ L})}{(62.4 \frac{\text{L}\cdot\text{mmHg}}{\text{mol}\cdot\text{K}})(294 \text{ K})} = 0.283 \text{ mol H}_2 \rightarrow \times 2.00/\text{mol}$$

0.566 g H₂

17. A mixture of three gases has a total pressure of 1,380 mm Hg. The mixture is found to contain 1.27 mol CO₂, 3.04 mol CO, and 2.50 mol Ar. What is the **partial pressure of Ar**?

$$n_{\text{TOTAL}} = 1.27 + 3.04 + 2.50 = 6.81 \text{ mol}$$

$$P_{Ar} = \frac{2.50 \text{ mol Ar}}{6.81 \text{ mol TOTAL}} \times 1380 \text{ mmHg} = 507 \text{ mmHg}$$

507 mmHg

18. The molecular weight of an unknown gas was measured by an effusion experiment. It was found that it took 72 seconds for the gas to effuse, whereas O₂ gas required 28 seconds. The **molecular mass of the gas** is:

$$\frac{t_{\text{UNK}}}{t_{O_2}} = \sqrt{\frac{MW_{\text{UNK}}}{MW_{O_2}}}$$

$$M.W. \text{ UNK} = 32 \left(\frac{72}{28}\right)^2 = 212$$

$$\text{SO } \frac{72 \text{ s}}{28 \text{ s}} = \sqrt{\frac{MW_{\text{UNK}}}{32 \text{ g/mol}}}$$

212 g/mol

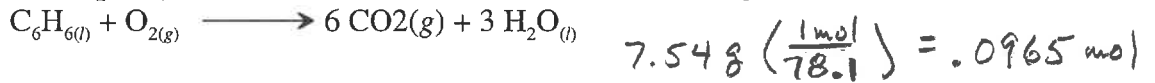
19. If the pressure on a gas sample is tripled and the absolute temperature is quadrupled (4x), by **what factor** will the volume of the sample change?

- a) 12 b) 3/4 **c) 4/3** d) 1/3 e) 4

20. Copper metal has a specific heat of $0.385 \text{ J/g}^\circ\text{C}$. Calculate the amount of heat required to raise the temperature of 32.8 g of copper from 120.0°C to 475°C .

$$q = (0.385 \text{ J/g}^\circ\text{C})(32.8 \text{ g})(355^\circ) = 4483 \text{ J} \quad \xrightarrow{\div 1000} \quad \underline{4.48 \text{ kJ}}$$

21. Combustion of 7.54 g of liquid benzene (C_6H_6) causes a temperature rise of 50.3°C in a constant-pressure calorimeter that has a heat capacity of $6.27 \text{ kJ}^\circ\text{C}$. What is ΔH for the following reaction in kJ/mol ?



- a) -315 kJ/mol
 b) $-3.27 \times 10^3 \text{ kJ/mol}$
 c) -41.8 kJ/mol
 d) $+315 \text{ kJ/mol}$
 e) 41.8 kJ/mol

$$q = -(6.27 \text{ kJ}^\circ\text{C})(50.3^\circ) = -315.4 \text{ kJ}$$

$$\Delta H = \frac{-315.4 \text{ kJ}}{.0965 \text{ mol}} = \underline{-3268 \text{ kJ/mol}}$$

22. From a consideration of the reaction



if 200.0 g of NO_2 were produced, then the amount of heat released should be:

- a) 114 kJ b) 124 kJ c) 248 kJ d) 314 kJ

e) 496 kJ

$$200 \text{ g NO}_2 \left(\frac{1 \text{ mol}}{46 \text{ g}} \right) \left(\frac{114.1 \text{ kJ}}{2 \text{ mol NO}_2} \right) = 496 \text{ kJ}$$

23. For the reaction



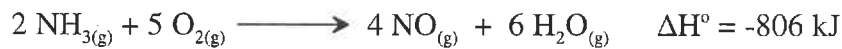
[ΔH_f 's in kilojoules per mol are ($\text{O}_{2(g)}$, 0) ; ($\text{C}_2\text{H}_{4(g)}$, $+52.3$) ; ($\text{CO}_{2(g)}$, -393.5) ; ($\text{H}_2\text{O}_{(l)}$, -285.8)]

the ΔH of reaction is

$$\Delta H = [2(-393.5 \text{ kJ/mol}) + 2(-285.8 \text{ kJ/mol})] - [(1)(52.3 \text{ kJ/mol}) + 2(0 \text{ kJ/mol})]$$

$$= \underline{-1411 \text{ kJ}}$$

24. Given the thermochemical equation:



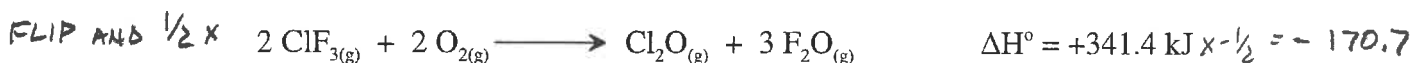
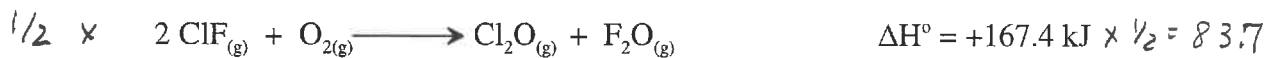
find ΔH° for the following reaction



FLIPPED (CHANGE SIGN)
 HALVED

$$\underline{+403 \text{ kJ}}$$

25. At 25°C , the following heats of reactions are known.



At the same temperature, use Hess's Law to calculate the ΔH° for the reaction:



EXTRA CREDIT (1pt.each)

Name the following

Give formulas for the following

$\text{Sn}(\text{CrO}_4)_2$ TIN(IV) CHROMATE

Copper(II) nitride Cu_3N_2

$(\text{NH}_4)_2\text{SO}_3$ AMMONIUM SULFITE

Silver sulfate Ag_2SO_4

PbSO_4 LEAD(II) SULFATE

Potassium carbonate K_2CO_3

Table 4.1 Solubility Rules for Ionic Compounds

Rule	Applies to	Statement	Exceptions
1	Li^+ , Na^+ , K^+ , NH_4^+	Group IA and ammonium compounds are soluble.	--
2	$\text{C}_2\text{H}_3\text{O}_2^-$, NO_3^-	Acetates and nitrates are soluble.	--
3	Cl^- , Br^- , I^-	Most chlorides, bromides and iodides are soluble.	AgCl , Hg_2Cl_2 , PbCl_2 , AgBr , HgBr_2 , Hg_2Br_2 , PbBr_2 , AgI , HgI_2 , Hg_2I_2 , PbI_2
4	SO_4^{2-}	Most sulfates are soluble.	CaSO_4 , SrSO_4 , BaSO_4 , Ag_2SO_4 , Hg_2SO_4 , PbSO_4
5	CO_3^{2-}	Most carbonates are insoluble.	Group IA carbonates, $(\text{NH}_4)_2\text{CO}_3$
6	PO_4^{3-}	Most phosphates are insoluble.	Group IA Phosphates, $(\text{NH}_4)_3\text{PO}_4$
7	S^{2-}	Most sulfides are insoluble.	Group IA sulfides, $(\text{NH}_4)_2\text{S}$
8	OH^-	Most hydroxides are insoluble.	Group IA hydroxides, $\text{Ca}(\text{OH})_2$, $\text{Sr}(\text{OH})_2$, $\text{Ba}(\text{OH})_2$