Unit 2 MC Practice

1. What total gas volume (in liters) at 520°C and 880 torr would result from the decomposition of 33 g of potassium bicarbonate according to the equation:

$$2\,KHCO_3(s) \rightarrow K_2CO_3(s) + CO_2(g) + H_2O(g)$$

(2 mol gas)

39+1+12+48= 100

a. 10. L (b.) 19 L c. 37 L d. 56 L

$33\,g\,KHCO_3 \times \frac{1\,mol\,KHCO_3}{100\,g\,KHCO_3} \times \frac{2\,mol\,gas}{2\,mol\,KHCO_3} \approx 0.3\,mol\,gas$

$PV = nRT$

$(880\,torr)V = (0.3\,mol)(62.34)(T)$

$(900)V = (0.3)(60)(800)$

$(0.3)(48000) = 15000$

$V = \frac{15000}{900} = \frac{50}{3} \approx 16$

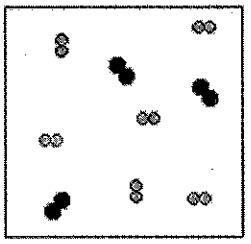
$$\ldots C_{10}H_{12}O_4S(s) + 12\,O_2(g) \rightarrow 10\,CO_2(g) + \ldots SO_2(g) + 6\,H_2O(s)$$

28 = 4 24 20 2 6 = 28

2. When the equation above is balanced and all coefficients are reduced to their lowest whole-number terms, the coefficient for $O_2(g)$ is

a. 7 (b.) 12 c. 14 d. 28

3. Consider the contents of the beaker shown below: what state/type of matter is being represented?



a. element/ gas
b. compound/ solid
c. heterogeneous mixture/ liquid
(d.) homogeneous mixture /gas

4. What volume of 0.150 molar HCl is required to neutralize 25.0 milliliters of 0.120 molar $Ba(OH)_2$?

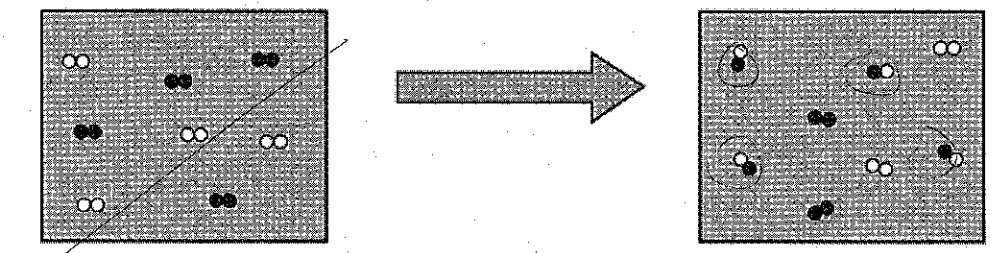
a. 20.0 mL b. 30.0 mL (c.) 40.0 mL d. 60.0 mL

$$2HCl + Ba(OH)_2 \rightarrow BaCl_2 + 2H_2O$$

$25\,mL \times \frac{0.120\,mmol\,Ba(OH)_2}{1\,mL} \times \frac{2\,mmol\,HCl}{1\,mmol\,Ba(OH)_2} = (50)(0.12) = 6\,mmol\,HCl$

$0.150\,M\,HCl = \frac{6\,mmol}{x\,mL}$ $\quad x = \frac{6}{0.15} = 40$

5. Below are 1.0 L containers for the initial and equilibrium condition for the reaction $A_2(g) + D_2(g) \rightleftharpoons 2\ AD(g)$.



Container Before Reaction Started | **Container After Reaction Achieves Equilibrium**

Calculate the magnitude of the equilibrium constant for the reaction.

a. 0.25 b. 1.0 c. 4.0 d. 8.0

$$K = \frac{[AD]^2}{[A_2][D_2]} = \frac{(4)^2}{(2)(2)} = \frac{16}{4} = 4$$

6. What is the complete ionic equation for the acid-base reaction that occurs when two aqueous solutions of hydrobromic acid and calcium hydroxide are mixed?

a. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ ⟶ always net ionic for acid-base!

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

c. $2\ HBr(aq) + Ca(OH)_2(aq) \rightarrow CaBr_2(aq) + 2\ H_2O(l)$

d. $2\ H^+(aq) + 2\ Br^-(aq) + Ca^{2+}(aq) + 2\ OH^-(aq) \rightarrow Ca^{2+}(aq) + 2\ Br^-(aq) + 2\ H_2O(l)$

$2\ HBr + Ca(OH)_2 \rightarrow CaBr_2 + 2\ H_2O$

7. Calculate the weight of $KClO_3$ that would be required to produce 29.5 L of oxygen at 127°C and 760. torr. = 1 atm

$39 + 35 + 48 = 122$

$$2\ KClO_3(s) \rightarrow 2\ KCl(s) + 3\ O_2(g)$$

a. 7.82 g b. 14.6 g c. 24.4 g d. 73.5 g

$PV = nRT$

$(1\ atm)(29.5\ L) = n(0.08206)(400\ K)$

$(30\ L) = n(0.1)(400)$

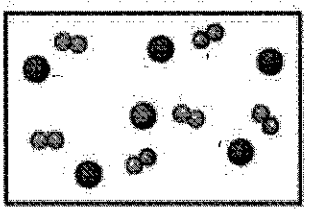
$n = \frac{30}{40} = 0.75\ mol\ O_2$

$0.75\ mol\ O_2 \times \frac{2\ mol\ KClO_3}{3\ mol\ O_2} \times \frac{120\ g\ KClO_3}{1\ mol} = 60\ g\ KClO_3$

8. The equation for the reaction is:

$$2\,S(g) + 3\,O_2(s) \rightarrow 2\,SO_3(g)$$

Consider a mixture of sulfur atoms and dioxygen molecules in a closed container below:



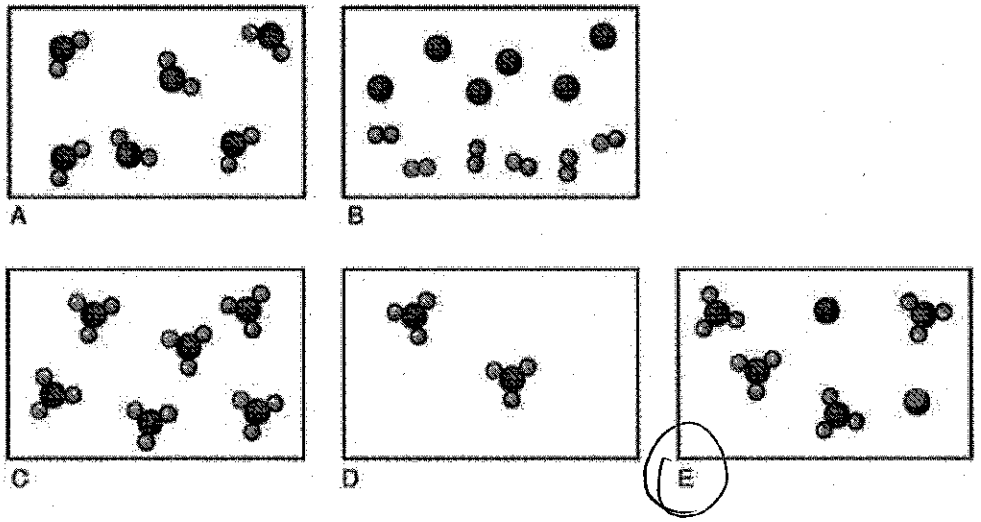
$2S + 3O_2 \rightarrow 2SO_3$

B 6 6 0

C −4 −6 +4

A 2 0 4

Which of the following images best represents what will be in the container after the reaction goes to completion?



9. If 0.40 mol of H_2 and 0.15 mol of O_2 were to react as completely as possible to produce H_2O, what mass of reactant would remain?

(a.) 0.20 g of H_2 b. 0.40 g of H_2 c. 3.2 g of O_2 d. 4.0 g of O_2

$2H_2 + O_2 \rightarrow 2H_2O$ (O_2: LR)

B 0.40 mol 0.15 mol

C −0.30 −0.150

A 0.10 mol H_2 0

$0.10\,mol\,H_2 \times \frac{2\,g}{1\,mol} = 0.20\,g\,H_2$

10. All chemical equilibriums must have:

a. $K_{eq} = 1$ (c.) rate forward = rate reverse

b. [reactants] = [products] d. mass of reactants = mass of products

* Yes, calculator.

11. Consider the following reversible reaction. In a 3.00 liter container, the following amounts are found in equilibrium at 400°C: 0.0420 moles N_2, 0.516 moles H_2 and 0.0357 moles NH_3. Evaluate K_c.

$2NO_2(g) \rightleftharpoons N_2O_4(g)$ $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

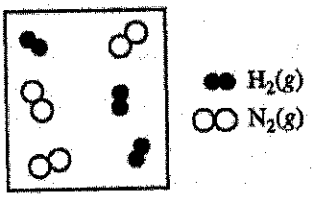
a. 0.202 b. 1.99 c. 4.94 d. 16.0

$[N_2] = 0.0420/3 = 0.014$

$[H_2] = 0.516/3 = 0.172$

$[NH_3] = 0.0357/3 = 0.0119$

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{(0.0119)^2}{(0.014)(0.172)^3} = 1.99$

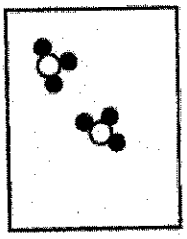


12. The diagram above represents $H_2(g)$ and $N_2(g)$ in a closed container. Which of the following diagrams would represent the results if the reaction shown below were to proceed as far as possible?

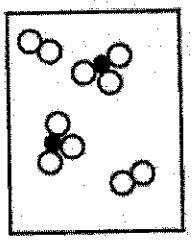
$N_2(g) + 3\,H_2(s) \rightarrow 2\,NH_3(g)$

B	3	3	0
C	-1	-3	+2
A	2	0	2

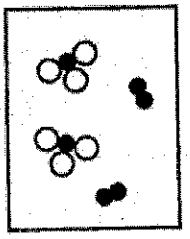
(A)



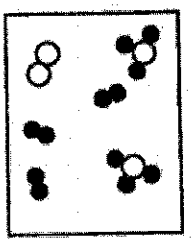
(B)



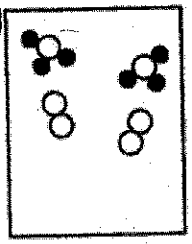
(C)



(D)



(E)



13. What is the net ionic equation for the acid-base reaction that occurs when nitric acid is added to solid copper (II) hydroxide?

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

b. $2\,H^+(aq) + Cu(OH)_2(s) \rightarrow Cu^{2+}(aq) + 2\,H_2O(l)$

c. $2\,H^+(aq) + 2\,NO_3^-(aq) + Cu^{2+}(aq) + 2\,OH^-(aq) \rightarrow Cu(NO_3)_2(aq) + 2\,H_2O(l)$

d. $2\,H^+(aq) + 2\,NO_3^-(aq) + Cu^{2+}(aq) + 2\,OH^-(aq) \rightarrow Cu^{2+}(aq) + 2\,NO_3^-(aq) + 2\,H_2O(l)$

$2H^+ + NO_3^- + Cu(OH)_2(s) \rightarrow 2H_2O(l) + Cu(NO_3)_2$

$2H^+ + Cu(OH)_2(s) \rightarrow H_2O(l) + Cu^{2+}$

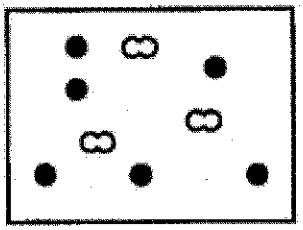
14. When 2.00 g of H_2 reacts with 32.0 g of O_2 in an explosion, the final gas mixture will contain:

a. H_2, H_2O, and O_2 b. H_2 and H_2O only c. O_2 and H_2O only d. H_2O only

$2H_2 + O_2 \rightarrow 2H_2O$

$2g H_2 \times \frac{1 mol}{2g}$ $32g O_2 \times \frac{1 mol}{32g}$

	$2H_2$	O_2	$2H_2O$
B	1 mol	1 mol	0
C	−1	−0.5	+1
A	0	0.5	1



$NO_2 = \bullet$
$N_2O_4 = \infty$

15. The diagram above represents a mixture of $NO_2(g)$ and $N_2O_4(g)$ in a 1.0 L container at a given temperature. The two gases are in equilibrium according to the equation

$$2\,NO_2(g) \rightleftharpoons N_2O_4(g)$$

Which of the following must be true about the value of the equilibrium constant, *K*, for the reaction at this temperature?

a. K = 0 b. 0 < K < 1 c. K = 1 d. K > 1

$$K = \frac{[N_2O_4]}{[NO_2]^2} = \frac{(3)}{(6)^2} = \frac{3}{36}$$

16. The spectator ions in the following reaction is/are:

$$Na_2CO_3(aq) + Ba(NO_3)_2(aq) \rightarrow BaCO_3(s) + 2\,NaNO_3(aq)$$

a. Ba^{2+} and CO_3^{2-} b. CO_3^{2-} only c. Na^+ and NO_3^- d. Na^+ only

17. When the system A + B ⇌ C + D is at equilibrium,

a. the forward reaction has stopped
b. the reverse reaction has stopped
c. both the forward and reverse reactions have stopped
d. neither the forward nor reverse reactions have stopped

18. Balance the following equation with the smallest whole number coefficients possible. Select the number that is the sum of the coefficients in the balanced equation.

$$2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$$

a. 3 b. 5 c. 6 (d.) 7

19. The reaction of 7.8 g benzene, C_6H_6, with excess HNO_3 resulted in 0.90 g of H_2O. What is the percent yield? (Molar masses (g mol^{-1}): C_6H_6 = 78; HNO_3 = 63; $C_6H_5NO_2$ = 123; H_2O = 18.)

actual yield.

$$C_6H_6 + HNO_3 \rightarrow C_6H_5NO_2 + H_2O$$

a. 90.% (b.) 50.% c. 12% d. 2.0%

$$7.8\,g\,C_6H_6 \times \frac{1\,mol\,C_6H_6}{78\,g} \times \frac{1\,mol\,H_2O}{1\,mol\,C_6H_6} \times \frac{18\,g\,H_2O}{1\,mol\,H_2O} = (0.1)(18) = 1.8\,g\,H_2O$$

$$\%\,yield = \frac{0.9}{1.8} \times 100 = 50\%$$

$$2\ SO_3(s) \rightleftharpoons 2\ SO_2(g) + O_2(g)$$

20. The equilibrium constant expression, K_c, for the system described by the above equation is:

a. $\frac{[SO_3]^2}{[SO_2]^2[O_2]}$ (b.) $[SO_2]^2[O_2]$ c. $\frac{[SO_2]^2[O_2]}{[SO_3]^2}$ d. $\frac{1}{[SO_2]^2[O_2]}$

21. At 445°C, K_c for the following reaction is 0.020.

$$2\ HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

A mixture of H_2, I_2, and HI in a vessel at 445°C has the following concentrations: [HI] = 2.0 M, [H_2] = 0.50 M and [I_2] = 0.10 M. Which of the following statements concerning the reaction quotient, Q_c, is **TRUE** for the above system?

(a.) $Q_c < K_c$; more H_2 and I_2 will be produced
b. $Q_c > K_c$; more H_2 and I_2 will be produced
c. $Q_c < K_c$; more HI will be produced
d. $Q_c > K_c$; more HI will be produced

$$Q = \frac{[H_2][I_2]}{[HI]^2} = \frac{(0.50)(0.10)}{(2)^2} = \frac{0.05}{4}$$

$$Q < K$$

22. How many grams of nitric acid, HNO_3, can be prepared from the reaction of 138 g of NO_2 with 54.0 g H_2O according to the equation below?

$$3\ NO_2 + H_2O \rightarrow 2\ HNO_3 + NO$$

a. 108 b. 126 c. 189 d. 279

$138\text{g } NO_2 \times \frac{1\text{mol}}{46\text{g}} = \frac{3\text{mol } NO_2}{3} = 1$ LR

$54\text{g } H_2O \times \frac{1\text{mol}}{18\text{g}} = \frac{3\text{mol } H_2O}{1} = 3$

$3\text{mol } NO_2 \times \frac{2\text{mol } HNO_3}{3\text{mol } NO_2} \times \frac{63\text{ g}}{1\text{mol}} = 126\text{g}$

23. For a specific reaction, which of the following statements can be made about *K*, the equilibrium constant?

a. It always remains the same at different reaction conditions.

b. It increases if the concentration of one of the products is increased.

c. It changes with changes in the temperature.

d. It increases if the concentration of one of the reactants is increased.

24. When 8.0 g of N_2H_4 (32 g mol^{-1}) and 92 g of N_2O_4 (92 g mol^{-1}) are mixed together and react according to the equation below, what is the maximum mass of H_2O that can be produced?

$$2\ N_2H_4(g) + N_2O_4(g) \rightarrow 3\ N_2(g) + 4\ H_2O(g)$$

a. 9.0 g b. 18 g c. 36 g d. 72 g

$8\text{g } N_2H_4 \times \frac{1\text{mol}}{32\text{g}} = \frac{0.25\text{ mol } N_2H_4}{2} = 0.125$ LR

$92\text{g } N_2O_4 \times \frac{1\text{mol}}{92\text{g}} = \frac{1\text{mol } N_2O_4}{1} = 1$

$0.25\text{ mol } N_2H_4 \times \frac{2\text{ mol } H_2O}{2\text{ mol } N_2H_4} \times \frac{18\text{g}}{1\text{mol}} = 9\text{g}$

$$3\ NaHCO_3(aq) + C_6H_8O_7(aq) \rightarrow 3\ CO_2(g) + 3\ H_2O(s) + Na_3C_6H_5O_7(aq)$$

25. Which of the following statements is true about the reaction shown above?

a. 22.4 L of CO_2(g) are produced for every liter of $C_6H_8O_7$(aq) reacted.

b. 1 mole of water is produced for every mole of carbon dioxide produced. ✓

c. 6.02×10^{23} molecules of $Na_3C_6H_5O_7$(aq) are produced for every mole of $NaHCO_3$(aq) used.

d. 54 g of water are produced for every mole of $NaHCO_3$(aq) ~~produced~~ used.

$= 3\text{mol}$

26. Which of the following applies to a chemical equilibrium?

I. Forward and reverse reaction rates are equal. ✓
II. Equilibrium can be achieved from either direction. ✓
III. Macroscopic properties are constant. ✓
↳ like concentration

a. I only b. I and II only c. II and III only (d.) I, II, and II

27. Calculate the mass of hydrogen formed when 27 g of aluminum reacts with excess hydrochloric acid according to the balanced equation below.

$$2\ Al + 6\ HCl \rightarrow 2\ AlCl_3 + 3\ H_2$$

a. 1.5 g b. 2.0 g (c.) 3.0 g d. 6.0 g

$$27\,g\,Al \times \frac{1\,mol\,Al}{27\,g\,Al} \times \frac{3\,mol\,H_2}{2\,mol\,Al} \times \frac{2\,g\,H_2}{1\,mol\,H_2} = 3\,g\,H_2$$

$$2\ MnO_2 + 4\ KOH + O_2 + Cl_2 \rightarrow 2\ KMnO_4 + 2\ KCl + 2\ H_2O$$

28. For the reaction above, there is 100. g of each reactant available. Which reagent is the limiting reagent? (Molar masses (g/mol): MnO_2 = 86.9; KOH = 56.1; O_2 = 32.0; Cl_2 = 70.9.)

a. MnO_2 b. O_2 (c.) KOH d. Cl_2

$\frac{100\,g\,MnO_2}{86.9} \approx \frac{1.2}{2} = 0.6$ $\frac{100\,g\,KOH}{56.1} \approx \frac{2}{4} = 0.5$ (LR, smaller) $\frac{100\,g\,O_2}{32} \approx \frac{3}{1} = 3$ $\frac{100\,g\,Cl_2}{70.9} \approx \frac{1.5}{1} = 1.5$

29. How is the reaction quotient used to determine whether a system is at equilibrium?

a. At equilibrium, the reaction quotient is undefined.
b. The reaction is at equilibrium when $Q < K_{eq}$.
c. The reaction is at equilibrium when $Q > K_{eq}$.
(d.) The reaction is at equilibrium when $Q = K_{eq}$.

30. How many grams of H_2O will be formed when 32.0 g H_2 is allowed to react with 16.0 g O_2 according to

$$2\ H_2 + \_\_\ O_2 \rightarrow 2\ H_2O$$

a. 9.00 g b. 16.0 g c. 18.0 g d. 32.0 g

$32.0\text{g}\ H_2 \times \frac{1\text{mol}}{2\text{g}} = 16\text{mol}\ H_2$ / 2

$16\text{g}\ O_2 \times \frac{1\text{mol}}{32\text{g}} = 0.5\text{mol}\ O_2$ LR / 1

$0.5\text{mol}\ O_2 \times \frac{2\text{mol}\ H_2O}{1\text{mol}\ O_2} \times \frac{18\text{g}}{1\text{mol}\ H_2O} = 18\text{g}$

31. Methane and hydrogen sulfide form when hydrogen reacts with carbon disulfide. Identify the excess reagent and calculate how much remains after 36 L of H_2 reacts with 12 L of CS_2.

assume constant T & P
can use L to L ratio

$$4\ H_2(g) + CS_2(g) \rightarrow CH_4(g) + 2\ H_2S(g)$$

a. 3 L b. 6 L c. 9 L d. 12 L

$4\ H_2 + CS_2 \rightarrow CH_4 + 2H_2S$ (CS_2 excess)

	$4\ H_2$	CS_2
B	36	12
C	−36	−9
A	0	3

$$2\ H_2O(l) + 4\ MnO_4^-(aq) + 3\ ClO_2^-(aq) \rightarrow 4\ MnO_2(g) + 3\ ClO_4^-(aq) + 4\ OH^-(aq)$$

32. According to the balanced equation above, how many moles of ClO_2^-(aq) are needed to react completely with 20. mL of 0.20 M $KMnO_4$ solution?

a. 0.0030 mol b. 0.0075 mol c. 0.013 mol d. 0.030 mol

$(.020\text{L})(0.20\text{M}) = 0.004\text{mol}\ KMnO_4 \times \frac{1\text{mol}\ MnO_4^-}{1\text{mol}\ KMnO_4} \times \frac{3\text{mol}\ ClO_2^-}{4\text{mol}\ MnO_4^-}$

$= (0.004)(0.75) = 0.003\ \text{mol}\ ClO_2^-$