T18Q4: Solution

Consider the reaction between 100 mL of 0.41 M iron(II) nitrate with 63 mL of 0.35M potassium phosphate. How many moles of precipitate are formed from this reaction?

1 $3Fe(NO_3)_2(aq) + 2K_3PO_4(aq) \rightarrow 6KNO_3(aq) + Fe_3(PO_4)_2(s)$

A. 0.011
B. 0.014
C. 0.022
D. 0.041

2 $M = \frac{\text{moles of solute}}{\text{volume of solution (L)}}$ moles = M x vol (L)

	$3Fe(NO_3)_2$	$2K_3PO_4$
	0.41 M x 0.100 L = 0.041 mol	0.35 M x 0.063 L = 0.0221 mol
3 LR calcs	0.041 x (1/3) = 0.014 mol $Fe_3(PO_4)_2$	0.0221 x (1/2) = 0.011 mol $Fe_3(PO_4)_2$

T17Q6: Solution

Consider a sealed sample of gas at 33.0°C, 744 mm Hg, and 450 mL. If the pressure is decreased to 725 mm Hg and the temperature is raised to 66.0°C, what is the new volume of the gas?

A. 512 mL
B. 124 mL
C. 417 mL
D. 483 mL

DOUBLE STATE PROBLEM

PV = nRT

R is a constant so it is not included!

T must be in Kelvin

$$\frac{P_iV_i}{\cancel{n_i}T_i}$$

$$V_f = [(P_iV_i)/(P_f)] \times (T_f/T_i)$$

$$= [(744)(450)/(725)] \times [(273+66)/(273+33)]$$

$$= 511.58 \text{ mL}$$

Units cancel so can keep mm Hg. T must be in K!!

T14Q5: Solution

For the reaction $N_2 + 3H_2 \rightarrow 2NH_3$, Step 1

If you react 21 g hydrogen with 56 g nitrogen, what is the maximum number of grams of NH_3 that can be formed?

Step 2

21 g H_2 / (2.016 g/mol) → 10.41 moles H_2

56 g N_2 / (28.02g/mol) → 1.99 moles N_2

7 N 14.01	1 H 1.008

Step 3

Ratio H_2 to NH_3 is 3:2

10.41 moles H_2 * ($2NH_3$ /$3H_2$) = 6.94 moles NH_3

Ratio N_2 to NH_3 is 1:2

1.99 moles N_2 * ($2NH_3$ / $1N_2$) = 3.98 moles NH_3

N_2 is the limiting reagent

Step 4

(3.98 moles NH_3) * (17.034 g/mol) = <u>67.8 grams NH_3</u>

T15Q1: Solution

How many grams of sodium are in 23 g of sodium sulfate?

A. 32 g
B. 7.45 g
C. 6.57 g
D. 3.73 g
E. 0.710 g

sodium sulfate: Na_2SO_4

8	11	16
O	Na	S
16.00	22.99	32.06

M_w Na_2SO_4= = 142.04 g/mol

% Na = [2(22.99 g/mol)]/(142.04/mol)]* 100%
= 32.37 %

Grams Na = (% Na in Na_2SO_4) x mass of Na_2SO_4
= (32.37/100) x 23 g
= 7.45 g

Can do this is a single step:

Grams Na = [2(22.99 g/mol)]/(142.04/mol)] x 23g = 7.45g

T13Q7: Solution

How many fluorine atoms are there in a 38.00 g sample of fluorine gas?

9
F
19.000

A. 2.289×10^{25} atoms
B. 6.023×10^{23} atoms
C. $\boxed{1.205 \times 10^{24} \text{ atoms}}$
D. 2.553×10^{24} atoms

$F_2 \rightarrow 2F$

M_w of fluorine (F_2):
2(19g/mol) = 38 g/mol

Grams molecules → Moles molecules → Moles (atoms) → Particles (atoms)

Your answer will have units of

$$38\ \cancel{g\ F_2} \times \frac{1\ \cancel{mole\ F_2}}{38\ \cancel{g\ F_2}} \times \frac{2\ \cancel{moles\ F\ atoms}}{1\ \cancel{mole\ F_2}} \times \frac{6.023 \times 10^{23}\ \boxed{\text{atoms F}}}{1\ \cancel{mole\ F\ atoms}}$$

T14Q8: Solution

Consider the following chemical reaction:

$NaHCO_3$(aq) + HCl(aq) → H_2CO_3 (aq)+ NaCl(aq)

How many grams of hydrogen carbonate are produced if you react 2.8 g of sodium hydrogen carbonate with 3.1 g of hydrochloric acid and the yield is 45%.

$NaHCO_3$	HCl
2.8 g /(84.007 g/mol) = 0.033 moles	3.1 g /(36.46g/mol) = 0.085 moles
0.033 n x (1/1) = 0.033 moles H_2CO_3	0.085 n x (1/1) = 0.085 moles H_2CO_3
Theoretical Yield: 0.033 moles x (62.03 g/mol) = 2.07 grams H_2CO_3	
Actual yield = (2.07 g)*(45%/100%) = 0.93 g H_2CO_3	

T16Q7: Solution

Which one of the following molecules is predicted to have the lowest boiling point?

A. H_2S
B. PH_3
C. HCl
D. SiH_4
E. H_2O

As BP increases IMF must get stronger.
SiH_4 is the only non-polar molecule thus it has the weakest IMFs (only LDFs).

Make sure you can draw all the Lewis structures and predict the polarity.

T14Q3: Solution

How many moles of O_2 are required for the complete combustion of 2.2 g of C_3H_8 to form CO_2 and H_2O?

A. 0.050 moles of O_2
B. 0.15 moles of O_2
C. 0.25 moles of O_2
D. 0.50 moles of O_2

$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$

M_w of C_3H_8
= 3(12.01 g/mol) + 8(1.008 g/mol)
= 44.1 g/mol

Reaction	C_3H_8 +	$5O_2$ $\rightarrow$	$3CO_2 + 4H_2O$
In the vessel before rxn (no coefficient used)	2.2 g	-	-
	2.2 g /(44.1 g/n) = 0.049 moles	?	-
What reacted	0.049 moles	0.049 moles x (5/1) = 0.25 moles	-

T15Q3: Solution

Combustion of a 0.9835 g sample of a compound containing only C, H, and O produced 1.900 g of CO_2 and 1.072 g of H_2O. What is the empirical formula of the compound?

$$C_xH_yO_z + O_2 \rightarrow CO_2 + H_2O$$

$$\frac{0.518\ \text{g C}}{12.01\ \text{g/mol}} \qquad \frac{0.120\ \text{g H}}{1.008\ \text{g/mol}} \qquad \frac{0.345\ \text{g O}}{16.00\ \text{g/mol}}$$

$$\frac{C_{0.0432}}{0.0216} \quad \frac{H_{0.120}}{0.0216} \quad \frac{O_{0.0216}}{0.0216}$$

$$\left(C_{2.00}H_{5.51}O_1\right) \times 2 \rightarrow C_4H_{11}O_2$$

T13Q3: Solution

How many moles of water are in 3.6 grams of water?

A. 2.6×10^{24} moles
B. 64.8 moles
C. 3.6 moles
D. 0.20 moles
E. 0.40 moles

1	8
H	O
1.008	16.00

M_W of water:
2(1.008 g/mol) + (16.00 g/mol) = 18 g/mol

Grams H_2O → Moles H_2O

$$3.6\ \cancel{g\ H_2O} \times \frac{1\ mol\ H_2O}{18\ \cancel{g\ H_2O}} = 0.20\ \boxed{mol\ H_2O}$$

Your answer will have units of moles of H_2O

T16Q5: Solution

Consider the molecules: H_2O, CO_2, NH_3, CCl_4. The boiling points of these four molecules from lowest boiling point to highest boiling point are -78°C, -34°C, 76°C, 100°C. Place these molecules in order from highest boiling point to lowest boiling point.
(**HINT:** Both NH_3 and CO_2 are gases at room temperature.)

A. $\boxed{H_2O, CCl_4, NH_3, CO_2}$

~~**B.** H_2O, NH_3, CCl_4, CO_2~~

~~**C.** NH_3, CO_2, CCl_4, H_2O~~

~~**D.** H_2O, CCl_4, CO_2, NH_3~~

You know the bp of H_2O is 100 so you know H_2O must be first.

NH_3 and CO_2 are gases, so they must have weaker IMF than CCl_4 which is a liquid.

NH_3 is polar and forms hydrogen bonds, whereas CO_2 only has LDF.

T18Q6: Solution

What precipitate is most likely formed from a solution containing Ba^{+2}, Na^{+1}, OH^{-1}, and CO_3^{-2}?

A. NaOH → **Soluble, bc Na is a group 1 metal**

B. $\boxed{BaCO_3}$

C. Na_2CO_3 → **Soluble, bc Na is a group 1 metal**

D. $Ba(OH)_2$ → **Slightly soluble, bc OH & Ba^{2+}**

2. Alkali metal (Group 1A) salts and NH_4^+ are soluble.

3. F^-, S^{2-}, CO_3^{2-}, CrO_4^{2-}, PO_4^{3-} salts are insoluble, except for those containing Group 1A cations.

6. OH salts are insoluble (except for those containing Group 1A cations and NH_4^+ which are soluble and those containing Ca^{2+}, Sr^{2+} and Ba^{2+} which are slightly soluble).

T17Q8: Solution

Which of the following samples contains molecules with the greatest average kinetic energy?

A. $\boxed{\text{1.0 moles of } N_2 \text{ at 580 K}}$
B. 1.0 moles of CO at 140 K
C. 1.0 moles of N_2O at 298 K
D. 1.0 moles of CO_2 at 440 K

KE is based only on the temperature of the gas
The higher the T the higher the KE

T17Q10: Solution

If the temperature of a gas is raised from 100 °C to 200 °C, the average kinetic energy of the gas will _____.

A. increase by a factor of 2
B. increase by a factor of 1.27
C. increase by a factor of 100
D. decrease by a factor of 2
E. decrease by a factor of 100

KE = 3/2RT

R is a constant
3/2 is a constant

DOUBLE STATE PROBLEM

$$\frac{KE_i}{KE_f} = \frac{T_i}{T_f}$$

$$KE_f = KE_i \boxed{(T_f/T_i)}$$

FACTOR

$$(T_f/T_i) = (473)/(373)$$
$$= 1.27$$

T increases so KE increases

T13Q11: Solution

How many oxygen atoms are found in a 33 g sample of manganese(II) sulfite?

A. 1.44×10^{23} O atoms
B. 3.94×10^{23} O atoms
C. $\boxed{4.44 \times 10^{23} \text{ O atoms}}$
D. 7.22×10^{23} O atoms

Manganese(II) sulfite: $MnSO_3$
→ 1Mn + 1S + 3O

8 O 16.00	16 S 32.07	25 Mn 54.94

M_w of $MnSO_3$:
54.94 g/mol + 32.07 g/mol + 3(16.00 g/mol) = 135.0 g/mol

Grams molecules → Moles molecules → Moles O atoms → Particles (O atoms)

Your answer will have units of $\boxed{\text{atoms O}}$

$$33 \cancel{\text{ g}} \text{ MnSO}_3 \times \frac{1 \cancel{\text{ mole}} \text{ MnSO}_3}{135 \cancel{\text{ g}} \text{ MnSO}_3} \times \frac{3 \cancel{\text{ mole}} \text{ O}}{1 \cancel{\text{ mole}} \text{ MnSO}_3} \times \frac{6.022 \times 10^{23} \text{ atoms O}}{1 \cancel{\text{ mole}} \text{ O}}$$

T15Q6: Solution

Carnotite ($K_2(UO_2)_2(VO_4)_2$) and is one of 3 common vanadium ores. Vanadium metal can be extracted from this ore as pure vanadium. If you start with 985 g of carnotite, what is the maximum number of grams of V that can be extracted?

A. 59.2 grams
B. 98.5 grams
C. $\boxed{\text{118 grams}}$
D. 120 grams
E. 130 grams

% V in $K_2(UO_2)_2(VO_4)_2$:

$$= [(\#V)(M_w\, V)/M_w\, K_2(UO_2)_2(VO_4)_2\,] \times 100\%$$

$$= [2(50.94)/(848.12\ g/mol)] \times 100\%$$

$$= 12.01\%$$

Mass of V that can be extracted:

$$= (12.01/100) \times (985\ g)$$

$$= 118.32\ g$$

T13Q9: Solution

How many moles of ions are there in a sample that is 10 g of magnesium phosphate, $Mg_3(PO_4)_2$?

A. 5.0 moles
B. 0.49 moles
C. $\boxed{\text{0.19 moles}}$
D. 0.038 moles

$3\ Mg^{2+}\ \&\ 2\ PO_4^{3-}$

5 ions per 1 molecule

8	12	15
O	Mg	P
16.00	24.31	30.97

M_w of magnesium phosphate:

$3(24.31) + 2(30.97) + 8(16.00) = 263$ g/mol

Grams molecules → Moles molecules → Moles ions

$$10\ \cancel{g}\ Mg_3(PO_4)_2 \times \frac{1\ \cancel{mole}\ Mg_3(PO_4)_2}{263\ \cancel{g}\ Mg_3(PO_4)_2} \times \frac{5\ \boxed{\text{moles ions}}}{1\ \cancel{mole}\ Mg_3(PO_4)_2}$$

Your answer will have units of

T14Q6: Solution

Consider the chemical reaction that occurs when iron(III) oxide reacts with carbon to produce iron metal and carbon dioxide: **$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$** If 13.00 g of Fe_2O_3 reacts completely with 4.20 g of C, how much Fe will be formed?

Fe_2O_3	C
13 g /(159.7 g/mol) = 0.081 moles	**4.2 g /(12.01 g/mol) = 0.350 moles**
0.081 n x (4/2) = 0.162 moles Fe	**0.350 n x (4/3) = 0.467 moles Fe**
Theoretical Yield: (grams of product formed if all LR reacts) **0.162 moles x (55.85 g/mol) = 9.05 grams Fe**	