# T13Q1: Solution

What is the molar mass of the compound, $Cu_3(PO_4)_2$?

A. 110.5 g/mol
B. 237.6 g/mol
C. 316.6 g/mol
D. 349.6 g/mol
E. 380.6 g/mol

$Cu_3(PO_4)_2$:

3 x Cu

2 x P

8 x O

$$3(63.55) + 2(30.97) + 8(16)$$
$$= 380.6 \text{ g/mol}$$

**molar mass = mass of 1 mole**

| 1A | 2A | | | | | | | | | | | 3A | 4A | 5A | 6A | 7A | 8A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 H 1.008 | | | | | | | | | | | | | | | | | 2 He 4.003 |
| 3 Li 6.941 | 4 Be 9.012 | | | | | | | | | | | 5 B 10.81 | 6 C 12.01 | 7 N 14.01 | 8 O 16.00 | 9 F 19.00 | 10 Ne 20.18 |
| 11 Na 23.00 | 12 Mg 24.31 | | | | | | | | | | | 13 Al 26.98 | 14 Si 28.09 | 15 P 30.97 | 16 S 32.06 | 17 Cl 35.45 | 18 Ar 39.95 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 Ni .70 | 29 Cu 63.55 | 30 Zn 65.38 | 31 Ga 69.72 | 32 Ge 72.59 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.90 | 36 Kr 83.80 |
| Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | 46 Pd | 47 Ag | 48 Cd | 49 In | 50 Sn | 51 Sb | 52 Te | 53 I | 54 Xe |

# T13Q2: Solution

The calcium sulfate used in gypsum is a hydrate (meaning that water is absorbed into the sulfate). The formula for gypsum is: $CaSO_4 \bullet 2H_2O$. How much would one mole of gypsum weight? In other words, what is its molar mass?

A. 172 g

B. 156 g

C. 147 g

D. 141 g

E. 136 g

$CaSO_4 \bullet 2H_2O$:

1 x Ca

1 x S

6 x O

4 x H

| 1A | | | | | | | | | | | | | | | | | 8A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 H 1.008 | 2A | | | | | | | | | | | 3A | 4A | 5A | 6A | 7A | 2 He 4.003 |
| 3 Li 6.941 | 4 Be 9.012 | | | | | | | | | | | 5 B 10.81 | 6 C 12.01 | 7 N 14.01 | 8 O 16.00 | 9 F 19.00 | 10 Ne 20.18 |
| 11 Na 23.00 | 12 Mg 24.31 | | | | | | | | | | | 13 Al 26.98 | 14 Si 28.09 | 15 P 30.97 | 16 S 32.06 | 17 Cl 35.45 | 18 Ar 39.95 |
| 19 K 39.10 | 20 Ca 40.08 | 21 Sc 44.96 | 22 Ti 47.90 | 23 V 50.94 | 24 Cr 52.00 | 25 Mn 54.94 | 26 Fe 55.85 | 27 Co 58.93 | 28 Ni 58.70 | 29 Cu 63.55 | 30 Zn 65.38 | 31 Ga 69.72 | 32 Ge 72.59 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.90 | 36 Kr 83.80 |
| 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 |

$$40.08 + 32.06 + 6(16.00) + 4(1.008) = 172\ g/mol$$

# T13Q3: Solution

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

**A.** 2.6 x $10^{24}$ moles
**B.** 64.8 moles
**C.** 3.6 moles
**D.** $\boxed{\text{0.20 moles}}$
**E.** 0.40 moles

| | |
|---|---|
| 1<br>H<br>1.008 | 8<br>O<br>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 $H_2O$

# T13Q4: Solution

How many grams of oxygen are there in 6.2 g of $Li_3PO_4$?

- **A.** 0.054 grams
- **B.** 0.21 grams
- **C.** $\boxed{\text{3.43 grams}}$
- **D.** 6.86 grams

| | | |
|---|---|---|
| 3 | 8 | 15 |
| Li | O | P |
| 6.94 | 16.00 | 30.97 |

$$1Li_3PO_4 \rightarrow 3Li + 1P + 4O$$

$M_w$ of $Li_3PO_4$:

3(6.94 g/mol) + 30.97 g/mol + 4(16.00 g/mol) = 115.73 g/mol

Grams molecules → Moles molecules → Moles O atoms → Grams O

$$6.2\ \cancel{g\ Li_3PO_4} \times \frac{1\ \cancel{mole\ Li_3PO_4}}{115.73\ \cancel{g\ Li_3PO_4}} \times \frac{4\ \cancel{moles\ O}}{1\ \cancel{mole\ Li_3PO_4}} \times \frac{16\ \boxed{\text{grams O}}}{1\ \cancel{mole\ O}}$$

Your answer will have units of

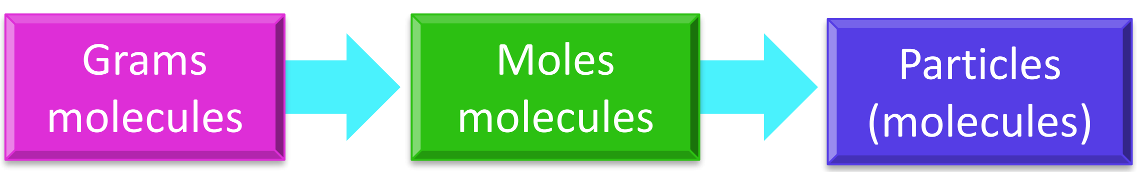
# T13Q5: Solution

How many molecules of water are in 4.1 grams of water?

A. 0.23 molecules
B. $\boxed{1.4 \times 10^{23}\ \text{molecules}}$
C. $2.5 \times 10^{24}$ molecules
D. $4.4 \times 10^{25}$ molecules

| | |
|---|---|
| 1 | 8 |
| H | O |
| 1.008 | 16.00 |

**$M_w$ of water:**
**2(1.008 g/mol) + (16.00 g/mol) = 18 g/mol**




$$4.1\ \text{g}\ \cancel{H_2O} \times \frac{1\ \text{mole}\ \cancel{H_2O}}{18\ \text{g}\ \cancel{H_2O}} \times \frac{6.022 \times 10^{23}\ \boxed{\text{molecules}\ H_2O}}{1\ \cancel{\text{mole}}\ H_2O}$$

Your answer will have units of

# T13Q6: Solution

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

| |
|---|
| 9 |
| F |
| 19.000 |

A. 2.289 x $10^{25}$ molecules

B. $\boxed{6.023 \text{ x } 10^{23} \text{ molecules}}$

C. 1.205 x $10^{24}$ molecules

D. 2.553 x $10^{24}$ molecules

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

Grams molecules → Moles molecules → Particles (molecules)

$$38 \cancel{g F_2} \times \frac{1 \cancel{mole} F_2}{38 \cancel{g F_2}} \times \frac{6.023 \times 10^{23} \text{ molecules } F_2}{1 \cancel{mole} F_2}$$

# T13Q7: Solution

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

| 9 |
|---|
| F |
| 19.000 |

**A.** 2.289 x $10^{25}$ atoms

**B.** 6.023 x $10^{23}$ atoms

$\boxed{\textbf{C. } 1.205 \times 10^{24} \text{ atoms}}$

**D.** 2.553 x $10^{24}$ 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**

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

# T13Q8: Solution

How many moles of sodium atoms are there in 6.3 grams of sodium carbonate?

$Na_2CO_3$

A. 0.06 moles
B. $\boxed{\text{0.12 moles}}$
C. $7.2 \times 10^{22}$ moles
D. $3.6 \times 10^{22}$ moles

| | | |
|---|---|---|
| 6 | 8 | 11 |
| C | O | Na |
| 12.01 | 16.00 | 23.00 |

$$1Na_2CO_3 \rightarrow 2Na + 1C + 3O$$

$M_W$ of $Na_2CO_3$:

2(23 g/mol) + (12.01 g/mol) + 3(16.00 g/mol)

= 106 g/mol

Grams molecules → Moles molecules → Moles Na atoms

$$6.3 \text{ g } \cancel{Na_2CO_3} \times \frac{1 \cancel{\text{ mol } Na_2CO_3}}{106 \text{ g } \cancel{Na_2CO_3}} \times \frac{2 \boxed{\text{mol Na}}}{1 \cancel{\text{ mol } Na_2CO_3}}$$

Your answer will have units of moles of Na

# 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

# T13Q10: Solution Alternate

How many C atoms are there in a sample of $C_3H_8$ that contains $6.59 \times 10^{26}$ H atoms?

A. $1.98 \times 10^{27}$ C atoms

B. $\boxed{2.47 \times 10^{26} \text{ C atoms}}$

C. $4.94 \times 10^{26}$ C atoms

D. $3.17 \times 10^{24}$ C atoms

| 1 | 6 |
|---|---|
| H | C |
| 1.008 | 12.01 |

$C_3H_8 \rightarrow 3C + 8H$

**Do you need Avogadro's number in this calculation?**

**NOPE, can go directly from**
**H atoms → C atoms**
**mole ratio = atom ratio**

$$6.59 \times 10^{26}\ \cancel{\text{H}} \times \frac{\cancel{1\ \text{mole H}}}{\cancel{6.022 \times 10^{23}\ \text{H}}} \times \frac{3\ \cancel{\text{mole}}\ \text{C}}{8\ \cancel{\text{mole}}\ \text{H}} \times \frac{\cancel{6.022 \times 10^{23}}\ \text{atoms C}}{\cancel{1\ \text{mole C}}}$$

# T13Q11: Solution

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

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

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

| 8 | 16 | 25 |
|---|---|---|
| O | S | Mn |
| 16.00 | 32.07 | 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**

$$33\ \cancel{g}\ MnSO_3 \times \frac{1\ \cancel{mole}\ MnSO_3}{135\ \cancel{g}\ MnSO_3} \times \frac{3\ \cancel{mole}\ O}{1\ \cancel{mole}\ MnSO_3} \times \frac{6.022 \times 10^{23}\ \boxed{\text{atoms O}}}{1\ \cancel{mole}\ O}$$

# Q0: Solution

How many moles of sodium atoms are there in 4.4 grams of sodium carbonate?

A. $2.5 \times 10^{22}$ moles
B. $5.0 \times 10^{22}$ moles
C. 0.04 moles
D. 0.08 moles
E. 0.12 moles

$Na_2CO_3$

| | | |
|---|---|---|
| 6 | 8 | 11 |
| C | O | Na |
| 12.01 | 16.00 | 23.00 |

$$1Na_2CO_3 \rightarrow 2Na + 1C + 3O$$

$M_W$ of $Na_2CO_3$:

$$2(23\ g/mol) + (12.01\ g/mol) + 3(16.00\ g/mol) = 106\ g/mol$$

Grams molecules → Moles molecules → Moles Na atoms

$$4.4\ g\ \cancel{Na_2CO_3} \times \frac{1\ \cancel{mol\ Na_2CO_3}}{106\ g\ \cancel{Na_2CO_3}} \times \frac{\boxed{2\ mol\ Na}}{1\ \cancel{mol\ Na_2CO_3}}$$

Your answer will have units of moles of Na

# T14Q1: Solution

An aqueous solution containing 7.60 g of lead(II) nitrate is added to an aqueous solution containing 7.39 g of potassium chloride. If the percent yield is 84.0%, how many grams of excess reagent remain after the reaction is complete?

$$Pb(NO_3)_2(aq) + 2KCl(aq) \rightarrow PbCl_2(s) + 2KNO_3(aq)$$

| $Pb(NO_3)_2$ | KCl |
|---|---|
| 7.6 g /(331.12 g/n) = 0.023 moles | 7.39 g /(74.55g/n) = 0.099 moles |
| 0.023 n x (1/1) = 0.023 moles $PbCl_2$ | 0.099 n x (1/2) = 0.0495 moles $PbCl_2$ |
| Moles KCl reacted = 0.023 x (2/1) x (84%/100%) = 0.0386 moles | |
| Excess KCl (moles) = 0.099 moles - 0.0386 moles = 0.0604 moles | |
| Excess KCl (grams) = 0.0604moles x (74.55 g/mol) = 4.50 grams KCl | |

# T14Q2: Solution

Consider the production of Iron from magnetite ($Fe_3O_4$):

**$Fe_3O_4(s) + 2CO(g) \rightarrow 3Fe(s) + 2CO_2(g) + O_2(g)$**

What mass of magnetite is required to obtain 4.0 kg of iron if the process only runs to 66% completion?

**We know that: % yield = actual product (g)/theoretical yield (g) X 100%**

**Rearrange Eq: theoretical yield (g) = actual product (g)/ % yield X 100%**

| $Fe_3O_4$ | 3Fe(s) |
|---|---|
| Theoretical yield = (4000 g Fe)*100/(66) = 6060 g Fe | |
| 6060 g Fe / (55.85 g/mol) = 108.5 moles Fe | |
| 108.5 n x (1/3) = 36.17 n $Fe_3O_4$ | - |
| 36.17 n x ( 231.55 g/n) = 8375 g $Fe_3O_4$ | - |

# 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. $\boxed{\text{0.25 moles of } O_2}$
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 | - |

# T14Q4: Solution

Consider the production of Iron from magnetite ($Fe_3O_4$):

**$Fe_3O_4(s) + 2CO(g) \rightarrow 3Fe(s) + 2CO_2(g) + O_2(g)$**

What mass of magnetite is required to obtain 5.0 kg of iron if the process only runs to 88% completion?

**Percent yield = (Actual yield/theoretical yield) * 100%**

| $Fe_3O_4$ | 3Fe |
|---|---|
| **Theoretical yield = (5000 g Fe)*100%/88% = 5681 g Fe** | |
| **5681 g Fe / (55.85 g/mol) = 101.73 moles Fe** | |
| **101.73 n x (1/3) = 33.91 n $Fe_3O_4$** | - |
| **33.91 n x ( 231.55 g/n) = 7851 g $Fe_3O_4$** | - |

# 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) $\rightarrow$ 10.41 moles $H_2$**
**56 g $N_2$ / (28.02g/mol) $\rightarrow$ 1.99 moles $N_2$**

| 7 | 1 |
|---|---|
| **N** | **H** |
| **14.01** | **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>**

# 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)<br>0.162 moles x (55.85 g/mol) = 9.05 grams Fe | |

# T14Q7: Solution

Consider the chemical reaction that occurs when sodium metal reacts with oxygen gas: **$4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$**
How many grams of sodium oxide are produced when 5.00 g of sodium and 5.00 g of oxygen react and a 84% yield of sodium oxide is obtained.

| Na | $O_2$ |
|---|---|
| 5 g /(23 g/mol) = 0.217 moles | 5 g /(32g/mol) = 0.16 moles |
| 0.217 n x (2/4) = 0.1085 moles $Na_2O$ | 0.16 n x (2/1) = 0.32 moles $Na_2O$ |
| **Theoretical Yield:** 0.1085 moles x (61.98 g/mol) = 6.73 grams $Na_2O$ | |
| **Actual yield = (6.73 g)*(84%/100%) = 5.64 g $Na_2O$** | |

# 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 $H_2CO_3$ | |

# T14Q9: Solution

**B. 2.4 moles $CaCl_2$ * 110.98 grams/mol * 0.65**

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

2.5 moles    4.8 moles    65% yield

2.5 moles $CaCO_3$ x (1/1) = 2.5 moles $CaCl_2$

4.8 moles HCl x (1/2) = 2.4 moles $CaCl_2$

HCl is the limiting reagent and you can only make 2.4 moles of $CaCl_2$

Moles LR → Moles Product → Grams Product → % Yield Calculation

$$2.4 \text{ moles } CaCl_2 \times \frac{110.98 \text{ g } CaCl_2}{1 \text{ mole } CaCl_2} \times \frac{65\ \%}{100\%}$$

# 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**

# T15Q2: Solution

The percent water in the hydrate $CuSO_4 \cdot 6H_2O$ is:

A. 40.4%
B. 6.73%
C. 9.60%
D. 57.6%

| 1<br>H<br>1.008 | 8<br>O<br>16.00 | 16<br>S<br>32.06 | 29<br>Cu<br>63.55 |
|---|---|---|---|

$$\% \text{ Comp.} = \frac{\text{Mass of element in compound}}{\text{Total mass of compound}} \times 100\%$$

$M_w$ $H_2O$ = 18.02 g/mol

$M_w$ $CuSO_4 \bullet 6H_2O$

= 63.55 g/mol + 32.06 g/mol + 4(16.00 g/mol) + 6(18.02 g/mol)

= 267.73 g/mol

% $H_2O$ = [6(18.02 g/mol)]/(267.73/mol)]* 100 %

= 40.38 %

# 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?

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

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

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

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

# T15Q4: Solution

An unknown compound has the formula $C_xH_yO_z$. When 0.200 g of the compound is burned in oxygen you isolate 0.293 g of $CO_2$ and 0.120 g of $H_2O$. If the experimentally determined molar mass of the compound is 60.07 g/mol, what is its molecular formula?

| Atom | C | H | O |
|---|---|---|---|
| Mass (grams) | (12.01/44.01) x 0.293 g **= 0.07996** | (2.016/18.02) x 0.120 g **= 0.01343** | 0.2 - 0.07996 - 0.01343 **= 0.10661** |
| Moles | 0.07996/12.01 **= 0.00666** | 0.01343/1.008 **= 0.01332** | 0.10661/16.00 **= 0.00666** |
| EF mole Ratio | 0.00666/0.00666 **= 1** | 0.01332/0.00666 **= 2.000** | 0.00666/0.00666 **= 1.000** |
| | **1** | **2** | **1** |

**$CH_2O$**

**X 2**

**$= C_2H_4O_2$**

**Mass of EF: 12.01 + 2(1.008) + 16.00 = 30.026 g/mol**

**(60.07 g/mol)/(30.026 g/mol) = 2**

# T15Q5: Solution

A **8.943 g** sample containing only lead, carbon and hydrogen was burned in an oxygen rich environment. The products of the combustion were **9.795 g of $CO_2$ and 5.035 g of $H_2O$**.

| Atom | Pb | C | H |
|---|---|---|---|
| Mass (grams) | 8.943 – 2.673 – 0.563<br>**= 5.707** | (12.01/44.01) x 9.795g<br>**= 2.673** | (2.016/18.015) x 5.035 g<br>**= 0.563** |
| Moles | 5.707/207.2<br>**= 0.028** | 2.673/12.01<br>**= 0.223** | 0.563/1.008<br>**= 0.559** |
| EF mole Ratio | 0.028/0.028<br>**= 1** | 0.223/0.028<br>**= 7.96** | 0.559/0.028<br>**= 19.96** |
| | **1** | **8** | **20** |

**1 + 8 + 20 = 29**

# 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:**

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

$= 118.32\ g$

# T15Q9: Solution Alternative (no table)

When an unknown hydrate of $Na_2CO_3$ is heated until all the water is removed, it looses 54.3% of its mass. What was the formula of the hydrate before it was heated?

**A.** $Na_2CO_3$
**B.** $Na_2CO_3 \bullet 1H_2O$
**C.** $Na_2CO_3 \bullet 5H_2O$
**D.** $\boxed{Na_2CO_3 \bullet 7H_2O}$

**$Na_2CO_3 \bullet XH_2O$ What is X?**

**Mass of $XH_2O$ is 54.3%**

**Mass of $Na_2CO_3$ is (100 – 54.3) = 45.7%**

**$M_w(Na_2CO_3)$ = 106.01 g/mol**

**$M_w(H_2O)$ = 18.02 g/mol**

**45.7 % = 106.01 g/mol**
**100% = X**

**X = total mass**
**= 106.01g/mol x (100/45.7)**
**= 231.95 g/mol**

**Mass of $XH_2O$ = total - $Na_2CO_3$ mass**
**= 231.95 – 106.01**
**= 125.96 g/mol**

**Mol of $H_2O$ = mass/Mw**
**= 125.96/18.02**
**X = 6.99 = 7**

# T15Q12: Solution

Vanadinite (**$Pb_5(VO_4)_3Cl$**) and is one of the main industrial ores that are used for the extraction of elemental vanadium.
If you start with 1.21 kg of $Pb_5(VO_4)_3Cl$, what is the maximum number of grams of V that can be extracted from this ore.

A. 43.2 grams
B. 130 grams
C. 155 grams
D. 173 grams

**% V in $Pb_5(VO_4)_3Cl$:**

$$= [(\#V)(M_w\ V)/M_w\ Pb_5(VO_4)_3Cl\ ] \times 100\%$$

$$= 3(50.94)/(1416.27\ g/mol) \times 100\%$$

$$= 10.79\%$$

**Mass of V that can be extracted:**

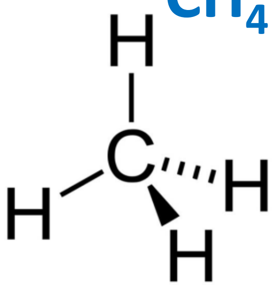
$$= (10.79/100) \times (1.21\ kg) * (1000g/1kg)$$

$$= 130.5\ g$$

# T16Q1: Solution

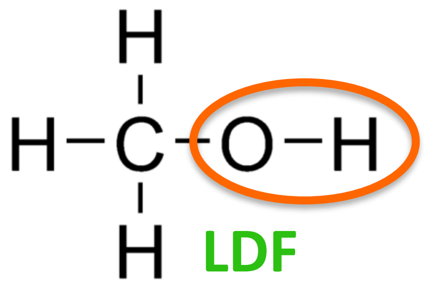
How many of the following molecules exhibit H-bonds, how many exhibit dipole-dipole interactions and how many exhibit London Dispersion forces respectively?

**$CH_4$**



LDF

**$CH_3OH$**

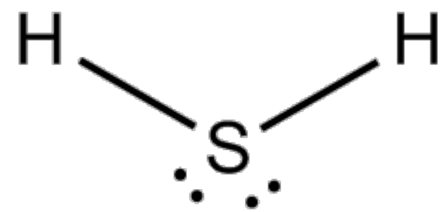


LDF

D-D

H-Bonds

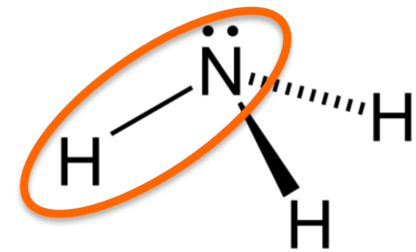
**$H_2S$**



LDF

D-D

**$NH_3$**



LDF

D-D

H-Bonds

**A.** 1, 2 and 4

**B.** 2, 2 and 4

$\boxed{\textbf{C. } 2, 3 \text{ and } 4}$

**D.** 2, 0 and 2

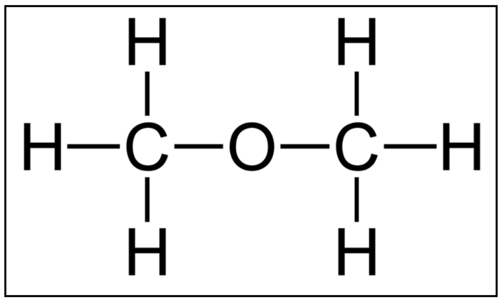
**E.** 1, 2 and 1

**IMF are not mutually exclusive! Just because you have stronger forces like H-bonds, doesn't mean the D-D and LDFs go away**

# T16Q2: Solution

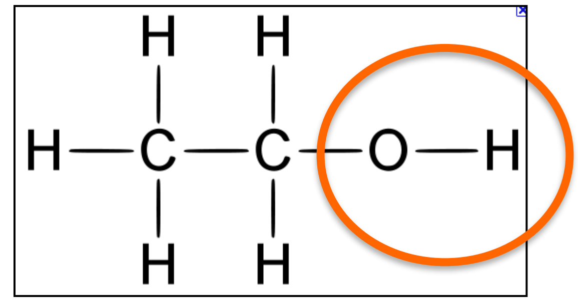
Which of the following has a higher boiling point and why?

POLAR



Dimethyl ether ($CH_3OCH_3$)

POLAR



Ethanol ($CH_3CH_2OH$)

**A.** **Dimethyl ether because it has LDF, dipole-dipole interactions and hydrogen bonds**

**B.** **Dimethyl ether because it has only LDF and dipole-dipole interactions**

**As IMF's get stronger bp increases.**

**C.** **Ethanol because it has LDF, dipole-dipole interactions and hydrogen bonds**

**D.** **Ethanol because it has only LDF and dipole-dipole interactions**

# T16Q3: Solution

Based on the $\Delta H_{vaporization}$ values shown in the table below, which of the following compounds has the strongest intermolecular forces (IMF's)?

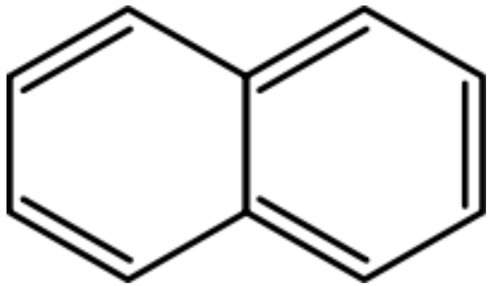
A. Argon
B. Benzene
C. Ethanol
D. Water
E. Methane

| Substance | $\Delta H_{vap}$ |
|---|---|
| Argon (Ar) | 6.3 kJ/mol |
| Benzene ($C_6H_6$) | 31 kJ/mol |
| Ethanol ($C_2H_5OH$ | 39.3 kJ/mol |
| Methane ($CH_4$ ) | 9.2 kJ/mol |
| Water ($H_2O$ ) | 40.8 kJ/mol |

**$\Delta H_{vap}$ ➔ energy required to vaporize a substance**
**Higher $\Delta H_{vap}$ corresponds to more energy required to go from liquid to gas ➔ IMFs must be stronger**

# T16Q4: Solution

Napthalene ($C_{10}H_8$) is an organic molecule that has only LDF. How is it possible then that napthalene is a solid at room temperature, but water is a liquid?



A. Molecules with stronger IMF always have have higher boiling points.
B. Water molecules can form H-bonds so water must have stronger IMF than those of napthalene.
C. Napthalene is a large planar molecule and so its LDF's are stronger than the H-bond in water.
D. Molecules with stronger IMF are more likely to be solids at room temperature.

**Napthalene is a large planar molecule with a flat surface that allows for two molecules to interact in many positions and at a very close range!**

# 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.**

# T16Q6: Solution

Pure samples of which of the following compounds will exhibit hydrogen bonding?

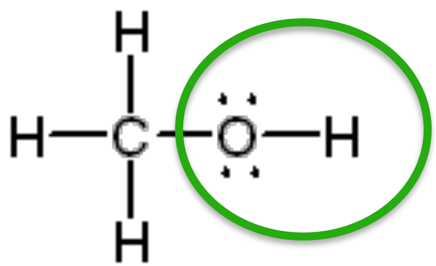
I. $CH_3OH$ II. $CH_3NO_3$ III. $CH_3CN$

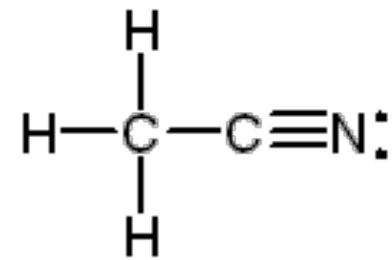
**A.** **I only**

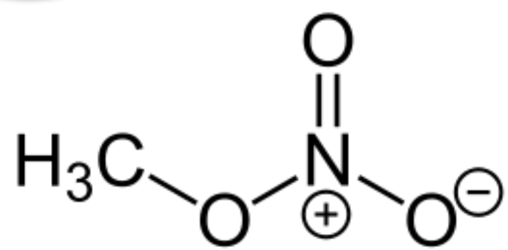
**B.** **I and II only**

**C.** **II and III only**

**D.** **I, II and III**







**In order to form a hydrogen bond, a molecule must have a hydrogen attached to one of the following: O, N or F.**

# 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. $\boxed{SiH_4}$
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.**

# T16Q13: Solution

Which of the following statements is **not** characteristic of a hydrogen bond?

**Electronegative atom in H-bond: N, O or F**

**A.** **The other atom involved in the hydrogen bond (not the hydrogen atom) must be a very electronegative atom that is attached to another hydrogen atom.**

**B.** **The other atom involved in the hydrogen bond (not the hydrogen atom) always possesses at least one lone pair of electrons.**

**C.** **The hydrogen atom involved must be covalently bonded to a very electronegative atom.**

**D.** **Hydrogen bonds are typically weaker than ionic or covalent bonds.**

# T16Q14: Solution

The boiling point of water is about 200°C higher than one would predict from the boiling points of hydrogen sulfide and hydrogen selenide. One may explain this apparent anomaly by which of the following?

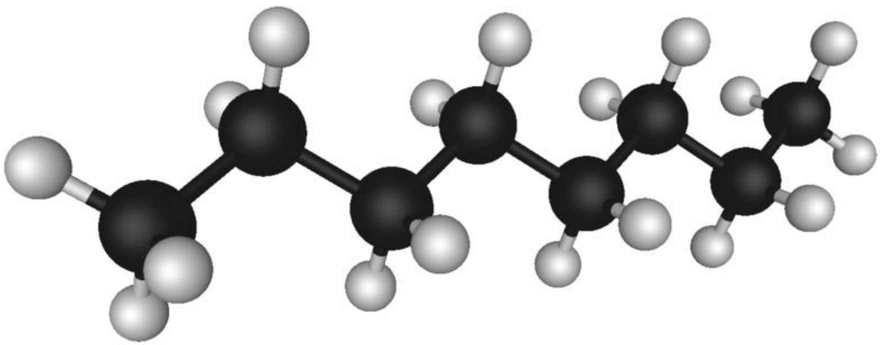
**A.** **The H-O covalent bond is much stronger than the H-S and H-Se bonds**

**B.** **Water has the lowest molecular weight**

**C.** **The intermolecular attractive forces are much greater in water than in hydrogen sulfide and hydrogen selenide.** **Hydrogen bonding!**

**D.** **Water is less polar than hydrogen sulfide and hydrogen selenide.**

# Q0: Solution



of carbon atoms with no dipole
25°C. Water has a dipole moment,
ling point of 100°C. The difference
s can best be rationalized by:

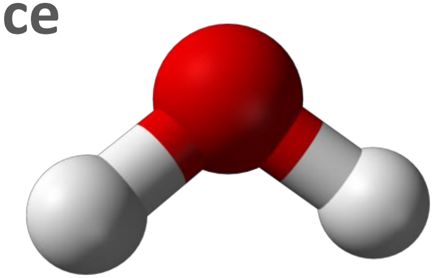
**A.** Intermolecular forces between molecules with dipole moments are greater than between molecules with no dipole moment

**B.** Hydrogen bonding is a strong intermolecular force

**C.** London dispersion forces are weak but there are many LDFs in octane so the net IMF in $C_8H_{18}$ is greater than the net IMF in $H_2O$

**D.** London dispersion forces are strong and so the boiling point of octane is greater than the boiling point of water

**E.** There is no trend, this is a magical mystery of science



# T17Q1: Solution

Calculate the volume of helium in a 2-mole helium balloon that floats up into the atmosphere and is left inflated to a total pressure of 1.5 atm at a temperature of -73 deg C.

**A.** 37.9 L

**B.** 22.1 L

**C.** 7.98 L

**D.** 0.045 L

**SINGLE STATE PROBLEM**

**PV = nRT**

**T: Kelvin**

**P: atm**

**R = 0.082 L-atm/mol-K**

$$V = nRT/P = \frac{2.0\ \text{mol} \times (0.082\ \text{L-atm/mol-K}) \times (-73 + 273)\text{K}}{1.5\ \text{atm}}$$

$$= 22.1\ \text{L}$$

# T17Q2: Solution

**SINGLE STATE PROBLEM**
**CHEM RXN**

How many moles of nitrogen will be needed to rea... with 1.5 L of $H_2$ gas measured at 20°C and 0.95 atm?

A. 0.059 moles
B. 0.020 moles
C. 0.18 moles
D. 0.87 moles

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

**PV = nRT**

**Find moles of $H_2$ first**

$$n = PV/RT$$

$$= \frac{(0.95\text{atm})\,(1.5\text{ L})}{(0.082\text{ L-atm/mol-K})\,(20 + 273)\text{K}}$$

$$= 0.059 \text{ moles } H_2$$

$$0.059 \text{ mol } H_2 \times (1 \text{ mol } N_2 / 3 \text{ mol } H_2) = 0.020 \text{ moles } N_2$$

# T17Q3: Solution

SINGLE STATE PROBLEM
CHEM RXN

What volume of $O_2$ is needed to completely react with 28.0 g $NH_3$ at 24°C and 0.950 atm to form NO and water?

A. 4.26 L
B. 42.3 L
C. 46.1 L
D. 52.8 L

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

**Find moles of $O_2$ using Stoich calcs first**

28 g x (1 mol/(17 g/mol) = 1.65 moles $NH_3$

1.65 moles $NH_3$ x (5 mol $O_2$/4 mol $NH_3$)
= 2.06 moles $O_2$

**Now find volume of $O_2$**

**PV = nRT**

V = nRT/P
= (2.06 moles)(0.082 L-atm/mol-K)(24 + 273 K)/0.95 atm
= 52.8 L

# T17Q4: Solution

**SINGLE STATE Molecular Weight**

Determine the molecular weight of a gas that has a density of 5.75 g/L at STP.

**STP: 1atm, 273K**

A. 3.90 g/mol
B. 129 g/mol
C. 141 g/mol
D. 578 g/mol

$$PV = nRT$$

$$n = m/M_w$$

$$PV = RT(m/M_w)$$

$$M_w = RTm/PV$$

$$M_w = (RT/P)\boxed{(m/V)}$$

**Density = mass/Vol**

$$M_w = [(RT)/P](\text{Density})$$

$$M_w = [(0.082\ \text{L-atm/mol-K})(273\ \text{K})/(1\ \text{atm})](5.75\ \text{g/L})$$

$$= 129\ \text{g/mol}$$

# T17Q5: Solution

Determine the density of a sample of unknown gas with a molar mass of 129 g/mol at STP.

A. 0.174 g/L
B. 5.76 g/L
C. 8.64 g/L
D. 576 g/L

STP: 1atm, 273K

$n = m/M_w$

Density = mass/Vol

$PV = nRT$

$PV = RT(m/M_w)$

$P = (RT/M_w)\boxed{(m/V)}$

$P = (RT/M_w)(\text{density})$

$\text{Density} = PM_w/RT$

$\text{Density} = (1)(129) /(0.082)(273)$

$= 5.76 \text{ g/L}$

# 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**

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

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

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

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

$$= 511.58 \text{ mL}$$

# T17Q7: Solution

A 1.9 mol sample of gas in a rigid flask at 21°C and 697 mm Hg is opened to the atmosphere and more gas is added to the flask. The pressure after the addition of gas is 795 mm Hg and the temperature is 26°C. How many moles of gas have been added to the container?

A. $\boxed{0.23}$
B. 1.63
C. 1.75
D. 2.13
E. 2.9

$$\frac{P_i \cancel{V_i}}{P_f \cancel{V_f}} = \frac{n_i T_i}{n_f T_f}$$

DOUBLE STATE PROBLEM

$$n_f = [(n_i T_i)/(T_f)] \times (P_f/P_i)$$

$$= [(1.9)(21+273)/(26+273)] \times [(795)/(697)]$$

= 2.13 moles at the end

Moles added = $n_f - n_i$ = 2.13 - 1.9 = 0.23 moles

# T17Q8: Solution

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

A. 1.0 moles of $N_2$ 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**

# T17Q9: Solution

Consider 1L gaseous samples of He (4amu), Ne (20amu), and Ar (40amu). If each sample is at STP (273K, 1 atm). Which gas will have the highest molar kinetic energy?

**A.** **He**
**B.** **Ne**
**C.** **Ar**
**D.** **They all have the same energy**

**KE = 3/2RT**

The KE of a gas = the **internal energy** of the system

**All at the same temperature so all have the same 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

# Q0: Solution

Consider the following gas reaction that runs with 100% yield:

1 $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

How many liters of oxygen gas do you need to completely react with 54 L of carbon monoxide gas at STP?

A. 22 L
B. 27 L
C. 54 L
D. 81 L
E. 108 L

2 $PV = nRT$ $n = PV/RT$

$= 1\text{ atm}(54\text{ L})/(0.082(273K))$

$= 2.41$ moles

3 $2.41$ moles CO x ($1$ mol $O_2$/$2$ mol CO)

$= 1.21$ moles $O_2$

4 $PV = nRT$ $V = nRT/P$

$= 1.21\text{ moles}(0.082)(273K)/1\text{ atm}$

$= 27$ L

# T18Q1: Solution

Give the **complete ionic equation** for the reaction that occurs when aqueous solutions of lithium sulfide and copper (II) nitrate are mixed:

**A.** $Li^+(aq) + SO_4^{2-}(aq) + Cu^+(aq) + NO_3^-(aq)$
$\rightarrow CuS(s) + Li^+ (aq) + NO_3(aq)$

**B.** $Li^+(aq) + S^-(aq) + Cu^+(aq) + NO_3^-(aq)$
$\rightarrow CuS(s) + LiNO_3(aq)$

**C.** $2Li^+(aq) + S^{2-}(aq) + Cu^{2+}(aq) + 2NO_3^-(aq)$
$\rightarrow Cu^{2+}(aq) + S^{2-}(aq) + 2LiNO_3(s)$

**D.** $\boxed{2Li^+ (aq) + S^{2-}(aq) + Cu^{2+}(aq) + 2NO_3^-(aq) \rightarrow CuS(s) + 2Li^+ (aq) + 2NO_3^-(aq)}$

**Complete Ionic Equation:**
**contains the solids and ALL the ionic species**

# T18Q2: Solution

Give the **net ionic equation** for the reaction that occurs when aqueous solutions of barium nitrate and ammonium phosphate are mixed:

**A.** $3Ba(NO_3)_2(aq) + 2(NH_4)_3PO_4(aq) \rightarrow Ba_3(PO_4)_2(s) + 6NH_4NO_3(aq)$

**B.** $3Ba(NO_3)_2(aq) + 2(NH_4)_3PO_4(aq) \rightarrow Ba_3(PO_4)_2(aq) + 6NH_4NO_3(s)$

**C.** $2NO_3^-(aq) + 6NH_4^+(aq) \rightarrow 6NH_4NO_3(s)$

**D.** $\boxed{3Ba^{2+}(aq) + 2PO_4^-(aq) \rightarrow Ba_3(PO_4)_2(s)}$

**E.** $2NO_3^-(aq) + 6NH_4^+(aq) + 2PO_4^-(aq) \rightarrow Ba_3(PO_4)_2(s) + 6NH_4^+(aq) + NO_3^-(aq)$

**Net Ionic Equation:**

**Only the species that ACTUALLY react to form a solid!**

**All $NH_4^+$ and $NO_3^-$ ion salts are soluble so any species with those ions will cancel out**

# T18Q3: Solution

Consider the decomposition of calcium carbonate to form calcium oxide and carbon dioxide. If the reaction produced 732 mL of $CO_2$ at 21°C and 77.1 cm Hg, how many grams of CaO are produced?

A. 0.21 g
B. 1.73 g
C. 1.86 g
D. 3.10 g
E. 17.2 g

1 $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

77.1 cm Hg = 1.01 atm
21°C = 294 K

2 **PV = nRT**

n = PV/RT
= (1.01 atm)(0.732L)/(0.082 L-atm/mol-K)(294 K)
= 0.031 moles

3 1:1 mole ratio
0.031 moles CaO

4 0.031 moles CaO x 56.08 g/mol
= 1.73 grams

# 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)

3 LR calcs

| $3Fe(NO_3)_2$ | $2K_3PO_4$ |
|---|---|
| 0.41 M x 0.100 L = 0.041 mol | 0.35 M x 0.063 L = 0.0221 mol |
| 0.041 x (1/3)<br>= 0.014 mol $Fe_3(PO_4)_2$ | 0.0221 x (1/2)<br>= 0.011 mol $Fe_3(PO_4)_2$ |

# T18Q5: Solution

What mass, in g, of AgCl is formed from the reaction of 75.0 mL of a 0.078 M $AgC_2H_3O_2$ solution with 55.0 mL of 0.109 M $MgCl_2$ solution?

1 $2AgC_2H_3O_2(aq) + MgCl_2(aq) \rightarrow 2AgCl(s) + Mg(C_2H_3O_2)_2(aq)$

A. 0.860 g
B. 1.72 g
C. 2.56 g
D. 3.20 g

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

| | $AgC_2H_3O_2$ | $MgCl_2$ |
|---|---|---|
| | 0.078 M x 0.075 L = 0.006 mol | 0.109 M x 0.055 L = 0.0060 mol |
| LR calcs 3 | 0.006 x (2/2) = 0.006 mol AgCl | 0.006 x (2/1) = 0.012 mol AgCl |
| 4 | 0.006 mol x (143.35 g / 1 mol ) = 0.86 g | |

# 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. $BaCO_3$

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).**

# T18Q7: Solution

How many of the following compounds are **soluble** in water?

$Cu(OH)_2$ $\boxed{LiNO_3}$ $\boxed{NH_4Br}$ $\boxed{K_2SO_4}$ $PbCl_2$ $BaSO_4$

Soluble Soluble Soluble

A. 0
B. 1
C. 2
D. 3
E. 4

1. Nitrate ($NO_3^{-1}$) and acetate ($C_2H_3O_2^{-1}$) salts are soluble.
2. Alkali metal (Group 1A) salts and $NH_4^+$ are soluble.
4. $Cl^{-1}$, $Br^{-1}$, and $I^{-1}$ salts are soluble (except when combined with $Ag^+$, $Hg_2^{2+}$, $Pb^{2+}$).
5. Sulfate salts are soluble (except when combined with $Ag^+$, $Hg_2^{2+}$, $Pb^{2+}$, $Ca^{2+}$, $Sr^{2+}$ and $Ba^{2+}$).
6. $OH^{-1}$ 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).

# T18Q8: Solution

Choose the reaction that represents a combustion reaction:

A. $\boxed{C_6H_{12}O_2(l) + 8O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g)}$
B. $Mg(s) + Cl_2(l) \rightarrow MgCl_2(aq)$
C. $C_6H_{12}O_2(l) \rightarrow 6C(s) + 6H_2(g) + O_2(g)$
D. $NaOH(aq) + CuCl_2(aq) \rightarrow NaCl_2(aq) + Cu(OH)_2(s)$
E. None of the above are combustion

**A = Combustion (reaction with oxygen)**

**B = Synthesis (combining things)**

**C = Decomposition (breaking down)**

**D = Double displacement (swapping ions)**