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												3A	4A	5A	6A	7A	8A
1 H 1.008	2A																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 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe

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

T13Q6: Solution

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

9
F
19.000

A. 2.289×10^{25} molecules
B. 6.023×10^{23} molecules
C. 1.205×10^{24} molecules
D. 2.553×10^{24} molecules

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

Grams molecules → Moles molecules → Particles (molecules)

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

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

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

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

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

T13Q8: Solution

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

Na_2CO_3

6	8	11
C	O	Na
12.01	16.00	23.00

A. 0.06 moles
B. 0.12 moles
C. 7.2×10^{22} moles
D. 3.6×10^{22} moles

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

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

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

Your answer will have units of moles of Na

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. $Na_2CO_3 \cdot 1H_2O$
C. $Na_2CO_3 \cdot 5H_2O$
D. $Na_2CO_3 \cdot 7H_2O$

$Na_2CO_3 \cdot XH_2O$ 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

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	8	16	29
H	O	S	Cu
1.008	16.00	32.06	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

$M_w\ CuSO_4 \cdot 6H_2O$

$= 63.55 \text{ g/mol} + 32.06 \text{ g/mol} + 4(16.00 \text{ g/mol}) + 6(18.02 \text{ g/mol})$

$= 267.73$ g/mol

$\% H_2O = [6(18.02 \text{ g/mol})]/(267.73/\text{mol})]^* 100\ \%$

$= 40.38\ \%$

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	

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.**

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	

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

$3(63.55) + 2(30.97) + 8(16)$
$= 380.6$ g/mol

1A												3A	4A	5A	6A	7A	8A
1 H 1.008	2A																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	Pd 46	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe

molar mass = mass of 1 mole

T14Q9: Solution

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

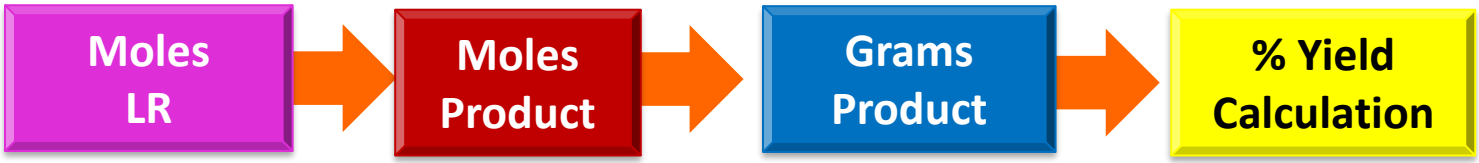
$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

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 $CaCl_2$



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

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	-

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

$n = m/M_w$

$PV = RT(m/M_w)$

$M_w = RTm/PV$

$M_w = (RT/P)(m/V)$

Density = mass/Vol

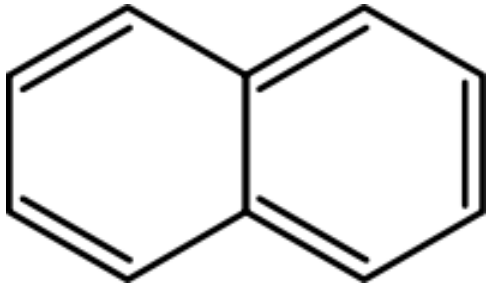
$M_w = [(RT)/P](Density)$

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

$= 129\ g/mol$

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!

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

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

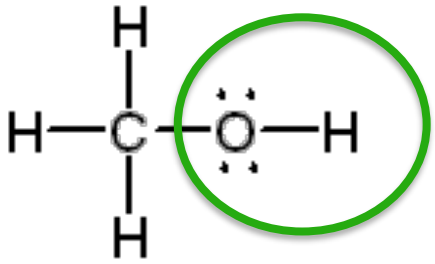
$$= 22.1\ \text{L}$$

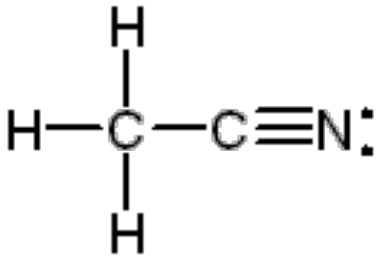
T16Q6: Solution

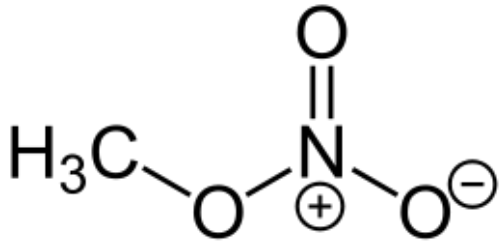
Pure samples of which of the following compounds will exhibit hydrogen bonding?

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.

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	

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. 0.23
B. 1.63
C. 1.75
D. 2.13
E. 2.9

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

DOUBLE STATE PROBLEM

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

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

$$= 2.13 \text{ moles at the end}$$

$$\text{Moles added} = n_f - n_i = 2.13 - 1.9 = 0.23 \text{ moles}$$

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