

T13Q2: Level 1 (L.G. 6)

The calcium sulfate used in gypsum is a hydrate (meaning that water is absorbed into the sulfate). The formula for gypsum is: $\text{CaSO}_4 \bullet 2\text{H}_2\text{O}$. How much would one mole of gypsum weight? In other words, what is its molar mass?

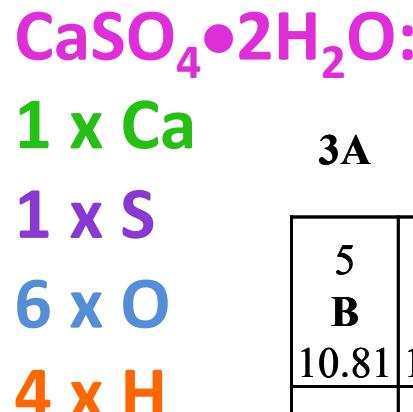
1A												8A	
1	H											2	He
1.008		2A											
3	Li	4	Be	6.941	9.012	A.	172 g	3A	4A	5A	6A	7A	10 Ne
11	Na	12	Mg	23.00	24.31	B.	156 g	5	6	7	8	9	17 Cl
19	K	20	Ca	39.10	40.08	C.	147 g	10.81	12.01	14.01	16.00	19.00	20.18 Ar
37	Rb	38	Sr	44.96	47.90	D.	141 g	13	14	15	16	17	18
39	V	40	Ti	50.94	52.00	E.	136 g	Al	Si	P	S	Cl	Ar
41	Cr	42	Mn	54.94	55.85	26	27	28	29	30	31	32	33
43	Tc	44	Fe	58.93	58.70	Co	Ni	Cu	Zn	Ga	Ge	As	Se
45	Ru	46	Rh	63.55	65.38	27	28	29	30	31	32	33	34
47	Pd	48	Ag	69.72	72.59	28	29	30	31	32	33	34	35
49	In	50	Cd	74.92	78.96	29	30	31	32	33	34	35	36
51	Sn	52	Te	79.90	83.80	30	31	32	33	34	35	36	Kr
53	Te	54	Xe			31	32	33	34	35	36	37	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: $\text{CaSO}_4 \bullet 2\text{H}_2\text{O}$. How much would one mole of gypsum weight? In other words, what is its molar mass?

1A	2A	3A	4A	5A	6A	7A	8A										
1 H 1.008							2 He 4.003										
3 Li 6.941	4 Be 9.012																
11 Na 23.00	12 Mg 24.31																
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 85.46	38 Sr 87.62	39 Y 88.90	40 Zr 90.90	41 Nb 92.90	42 Mo 95.94	43 Tc 97.90	44 Ru 101.90	45 Rh 102.90	46 Pd 106.90	47 Ag 107.90	48 Cd 112.90	49 In 114.90	50 Sn 118.70	51 Sb 121.70	52 Te 127.60	53 I 126.90	54 Xe 131.90

- A. 172 g
B. 156 g
C. 147 g
D. 141 g
E. 136 g



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

T13Q6: Level 2 (L.G. 5)

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

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

9
F
19.000

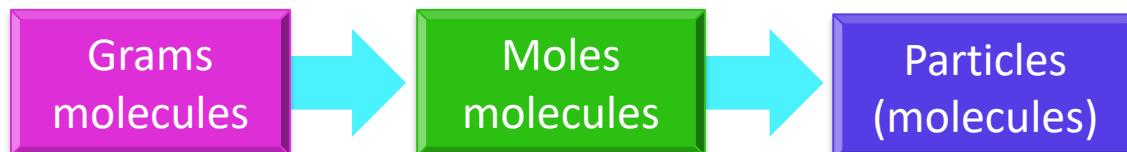
T13Q6: Solution

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9
F
19.000

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- B. 6.023×10^{23} molecules
- C. 1.205×10^{24} molecules
- D. 2.553×10^{24} molecules

$$M_w \text{ of fluorine (F}_2\text{:} \\ 2(19\text{g/mol}) = 38 \text{ g/mol}$$



$$\cancel{38 \text{ g F}_2} \times \frac{1 \text{ mole F}_2}{\cancel{38 \text{ g F}_2}} \times \frac{6.023 \times 10^{23} \text{ molecules F}_2}{\cancel{1 \text{ mole F}_2}}$$

T18Q2: Level 2 (L.G. 9)

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

- A. $3\text{Ba}(\text{NO}_3)_2(\text{aq}) + 2(\text{NH}_4)_3\text{PO}_4(\text{aq}) \rightarrow \text{Ba}_3(\text{PO}_4)_2(\text{s}) + 6\text{NH}_4\text{NO}_3(\text{aq})$
- B. $3\text{Ba}(\text{NO}_3)_2(\text{aq}) + 2(\text{NH}_4)_3\text{PO}_4(\text{aq}) \rightarrow \text{Ba}_3(\text{PO}_4)_2(\text{aq}) + 6\text{NH}_4\text{NO}_3(\text{s})$
- C. $2\text{NO}_3^-(\text{aq}) + 6\text{NH}_4^+(\text{aq}) \rightarrow 6\text{NH}_4\text{NO}_3(\text{s})$
- D. $3\text{Ba}^{2+}(\text{aq}) + 2\text{PO}_4^-(\text{aq}) \rightarrow \text{Ba}_3(\text{PO}_4)_2(\text{s})$
- E. $2\text{NO}_3^-(\text{aq}) + 6\text{NH}_4^+(\text{aq}) + 2\text{PO}_4^-(\text{aq}) \rightarrow \text{Ba}_3(\text{PO}_4)_2(\text{s}) + 6\text{NH}_4^+(\text{aq}) + \text{NO}_3^-(\text{aq})$

T18Q2: Solution

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- A. $3\text{Ba}(\text{NO}_3)_2(\text{aq}) + 2(\text{NH}_4)_3\text{PO}_4(\text{aq}) \rightarrow \text{Ba}_3(\text{PO}_4)_2(\text{s}) + 6\text{NH}_4\text{NO}_3(\text{aq})$
- B. $3\text{Ba}(\text{NO}_3)_2(\text{aq}) + 2(\text{NH}_4)_3\text{PO}_4(\text{aq}) \rightarrow \text{Ba}_3(\text{PO}_4)_2(\text{aq}) + 6\text{NH}_4\text{NO}_3(\text{s})$
- C. $2\text{NO}_3^-(\text{aq}) + 6\text{NH}_4^+(\text{aq}) \rightarrow 6\text{NH}_4\text{NO}_3(\text{s})$
- D. $3\text{Ba}^{2+}(\text{aq}) + 2\text{PO}_4^{2-}(\text{aq}) \rightarrow \text{Ba}_3(\text{PO}_4)_2(\text{s})$
- E. $2\text{NO}_3^-(\text{aq}) + 6\text{NH}_4^+(\text{aq}) + 2\text{PO}_4^{2-}(\text{aq}) \rightarrow \text{Ba}_3(\text{PO}_4)_2(\text{s}) + 6\text{NH}_4^+(\text{aq}) + \text{NO}_3^-(\text{aq})$

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: Level 2 (L.G. 9)

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

- A. $\text{Li}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + \text{Cu}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$
→ $\text{CuS}(\text{s}) + \text{Li}^+(\text{aq}) + \text{NO}_3(\text{aq})$
- B. $\text{Li}^+(\text{aq}) + \text{S}^-(\text{aq}) + \text{Cu}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$
→ $\text{CuS}(\text{s}) + \text{LiNO}_3(\text{aq})$
- C. $2\text{Li}^+(\text{aq}) + \text{S}^{2-}(\text{aq}) + \text{Cu}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq})$
→ $\text{Cu}^{2+}(\text{aq}) + \text{S}^{2-}(\text{aq}) + 2\text{LiNO}_3(\text{s})$
- D. $2\text{Li}^+(\text{aq}) + \text{S}^{2-}(\text{aq}) + \text{Cu}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq})$
→ $\text{CuS}(\text{s}) + 2\text{Li}^+(\text{aq}) + 2\text{NO}_3^-(\text{aq})$

T18Q1: Solution

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- A. $\text{Li}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + \text{Cu}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$
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- B. $\text{Li}^+(\text{aq}) + \text{S}^-(\text{aq}) + \text{Cu}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$
→ $\text{CuS}(\text{s}) + \text{LiNO}_3(\text{aq})$
- C. $2\text{Li}^+(\text{aq}) + \text{S}^{2-}(\text{aq}) + \text{Cu}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq})$
→ $\text{Cu}^{2+}(\text{aq}) + \text{S}^{2-}(\text{aq}) + 2\text{LiNO}_3(\text{s})$
- D. $2\text{Li}^+(\text{aq}) + \text{S}^{2-}(\text{aq}) + \text{Cu}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq})$
→ $\text{CuS}(\text{s}) + 2\text{Li}^+(\text{aq}) + 2\text{NO}_3^-(\text{aq})$

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

T13Q8: Level 2 (L.G. 8)

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

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

6 C 12.01	8 O 16.00	11 Na 23.00
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T13Q8: Solution

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

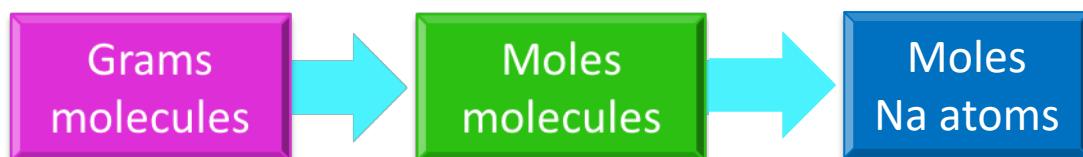
- A. 0.06 moles
- B. 0.12 moles
- C. 7.2×10^{22} moles
- D. 3.6×10^{22} moles



6	8	11
C	O	Na
12.01	16.00	23.00



$$\begin{aligned} M_w \text{ of } \text{Na}_2\text{CO}_3: \\ 2(23 \text{ g/mol}) + (12.01 \text{ g/mol}) + 3(16.00 \text{ g/mol}) \\ = 106 \text{ g/mol} \end{aligned}$$



$$6.3 \text{ g } \text{Na}_2\text{CO}_3 \times \frac{1 \text{ mol Na}_2\text{CO}_3}{106 \text{ g Na}_2\text{CO}_3} \times \frac{2 \text{ mol Na}}{1 \text{ mol Na}_2\text{CO}_3}$$

Your answer
will have
units of
moles of Na

T15Q9: Level 4 (L.G. 1)

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

- A. Na_2CO_3
- B. $\text{Na}_2\text{CO}_3 \cdot 1\text{H}_2\text{O}$
- C. $\text{Na}_2\text{CO}_3 \cdot 5\text{H}_2\text{O}$
- D. $\text{Na}_2\text{CO}_3 \cdot 7\text{H}_2\text{O}$

T15Q9: Solution Alternative (no table)

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

- A. Na_2CO_3
- B. $\text{Na}_2\text{CO}_3 \cdot 1\text{H}_2\text{O}$
- C. $\text{Na}_2\text{CO}_3 \cdot 5\text{H}_2\text{O}$
- D. $\text{Na}_2\text{CO}_3 \cdot 7\text{H}_2\text{O}$



Mass of XH_2O is 54.3%

Mass of Na_2CO_3 is $(100 - 54.3) = 45.7\%$

$M_w(\text{Na}_2\text{CO}_3) = 106.01 \text{ g/mol}$

$M_w(\text{H}_2\text{O}) = 18.02 \text{ g/mol}$

$$45.7 \% = 106.01 \text{ g/mol}$$

$$100\% = X$$

X = total mass

$$\begin{aligned} &= 106.01 \text{ g/mol} \times (100/45.7) \\ &= 231.95 \text{ g/mol} \end{aligned}$$

$$\begin{aligned} \text{Mass of } \text{XH}_2\text{O} &= \text{total} - \text{Na}_2\text{CO}_3 \text{ mass} \\ &= 231.95 - 106.01 \\ &= 125.96 \text{ g/mol} \end{aligned}$$

$$\begin{aligned} \text{Mol of H}_2\text{O} &= \text{mass/Mw} \\ &= 125.96/18.02 \\ X &= 6.99 = 7 \end{aligned}$$

T15Q2: Level 1 (L.G. 1)

The percent water in the hydrate $\text{CuSO}_4 \cdot 6\text{H}_2\text{O}$ is:

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

1 H 1.008	8 O 16.00	16 S 32.06	29 Cu 63.55
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T15Q2: Solution

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- B. 6.73%
- C. 9.60%
- D. 57.6%

1 H 1.008	8 O 16.00	16 S 32.06	29 Cu 63.55
-----------------	-----------------	------------------	-------------------

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

$$M_w \text{ H}_2\text{O} = 18.02 \text{ g/mol}$$

$$M_w \text{ CuSO}_4 \cdot 6\text{H}_2\text{O}$$

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

$$= 267.73 \text{ g/mol}$$

$$\begin{aligned}\% \text{ H}_2\text{O} &= [6(18.02 \text{ g/mol})]/(267.73/\text{mol}) * 100 \% \\ &= 40.38 \%\end{aligned}$$

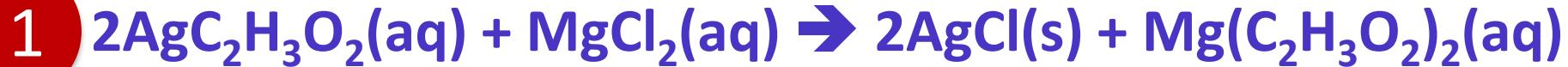
T18Q5: Level 3 (L.G. 10)

What mass, in g, of AgCl is formed from the reaction of 75.0 mL of a 0.078 M $\text{AgC}_2\text{H}_3\text{O}_2$ solution with 55.0 mL of 0.109 M MgCl_2 solution?

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

T18Q5: Solution

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B. 1.72 g

C. 2.56 g

D. 3.20 g

2

$$M \equiv \frac{\text{moles of solute}}{\text{volume of solution (L)}}$$

$$\text{moles} = M \times \text{vol (L)}$$



3

$$0.006 \times (2/2) = 0.006 \text{ mol AgCl}$$

$$0.006 \times (2/1) = 0.012 \text{ mol AgCl}$$

LR
calcs

4

$$0.006 \text{ mol} \times (143.35 \text{ g / 1 mol}) = 0.86 \text{ g}$$

T16Q13: Level 2 (L.G. 11)

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

- 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.

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: Level 4 (L.G. 8)

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?

- A. 5.66 g
- B. 4.50 g
- C. 3.33 g
- D. 0.0604 g

T14Q1: Solution

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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) = 0.0604 moles x (74.55 g/mol) = 4.50 grams KCl	

T13Q1: Level 1 (L.G. 6)

What is the molar mass of the compound, $\text{Cu}_3(\text{PO}_4)_2$?

- 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

1A												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 82.64	38 Sr 84.60	39 Y 88.91	40 Zr 90.91	41 Nb 92.91	42 Mo 95.94	43 Tc 96.91	44 Ru 101.92	45 Rh 102.91	46 Pd 106.90	47 Ag 107.90	48 Cd 112.91	49 In 114.91	50 Sn 118.71	51 Sb 121.80	52 Te 127.60	53 I 126.90	54 Xe 131.30

T13Q1: Solution

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- 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



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

1A												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	29 Ni 53.70	30 Cu 63.55	31 Zn 65.38	32 Ga 69.72	33 Ge 72.59	34 As 74.92	35 Se 78.96	36 Br 79.90	37 Kr 83.80
molar mass = mass of 1 mole																		
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sh	Te	I	Xe	

T14Q9: Level 3 (L.G. 8)

When 2.5 moles of calcium carbonate is added to 4.8 moles of hydrochloric acid, calcium chloride, carbon dioxide, and water are produced: $\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$

Which calculation represents the number of *grams* of calcium chloride that are produced if the reaction proceeds with a 65% yield?

- A. 2.5 moles CaCl_2 * 110.98 grams/mol * 0.65
- B. 2.4 moles CaCl_2 * 110.98 grams/mol * 0.65
- C. 2.5 moles CaCl_2 * 110.98 grams/mol / 0.65
- D. 2.4 moles CaCl_2 * 110.98 grams/mol / 0.65

T14Q9: Solution

B. $2.4 \text{ moles CaCl}_2 * 110.98 \text{ grams/mol} * 0.65$

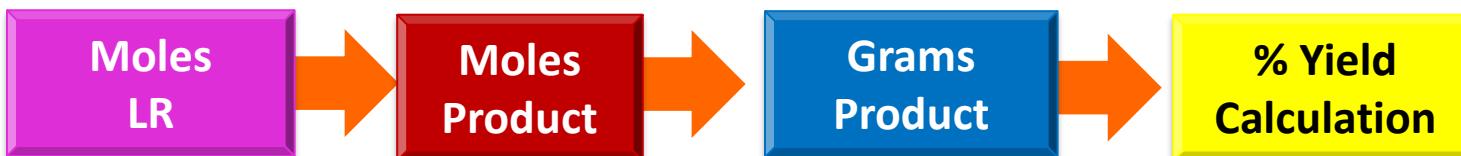


2.5 moles 4.8 moles 65% yield

$$2.5 \text{ moles CaCO}_3 \times (1/1) = 2.5 \text{ moles CaCl}_2$$

$$4.8 \text{ moles HCl} \times (1/2) = 2.4 \text{ moles CaCl}_2$$

HCl is the limiting reagent
and you can only make
2.4 moles of CaCl₂



$$2.4 \text{ moles CaCl}_2 \times \frac{110.98 \text{ g CaCl}_2}{1 \text{ mole CaCl}_2} \times \frac{65 \%}{100 \%}$$

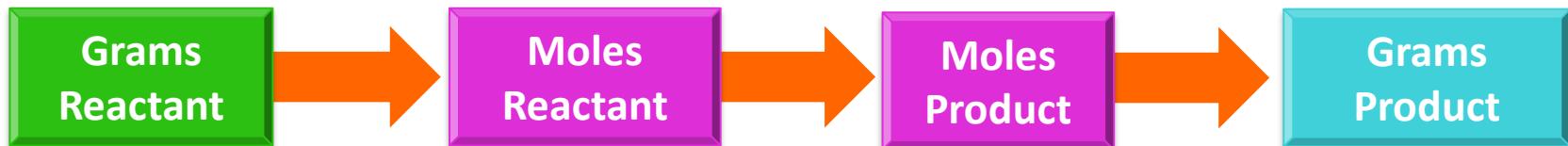
T14Q4: Level 3 (L.G. 4)

Calculate the maximum amount of aluminum oxide (Al_2O_3) that could be produced if 2.5 g of Al react with 2.5 g of oxygen .

- A. 4.7 g
- B. 5.3 g
- C. 7.4 g
- D. 9.4 g

Before doing any math:

We need to write a balanced equation for the reaction



T14Q4: Solution

Consider the production of Iron from magnetite (Fe_3O_4):



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

$$\text{Percent yield} = (\text{Actual yield}/\text{theoretical yield}) * 100\%$$



$$\text{Theoretical yield} = (5000 \text{ g Fe}) * 100\% / 88\% = 5681 \text{ g Fe}$$

$$5681 \text{ g Fe} / (55.85 \text{ g/mol}) = 101.73 \text{ moles Fe}$$

$$101.73 \text{ n} \times (1/3) = 33.91 \text{ n } \text{Fe}_3\text{O}_4$$

-

$$33.91 \text{ n} \times (231.55 \text{ g/n}) = 7851 \text{ g } \text{Fe}_3\text{O}_4$$

-

T17Q4: Level 3 (L.G. 11)

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

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

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

$$PV = nRT$$

$$n = m/M_w$$

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

$$M_w = RTm/PV$$

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

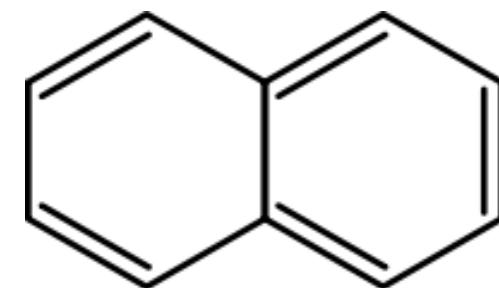
Density = mass/Vol

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

$$M_w = [(0.082 \text{ L-atm/mol-K})(273 \text{ K})/(1 \text{ atm})](5.75 \text{ g/L}) \\ = 129 \text{ g/mol}$$

T16Q4: Level 3 (L.G. 12)

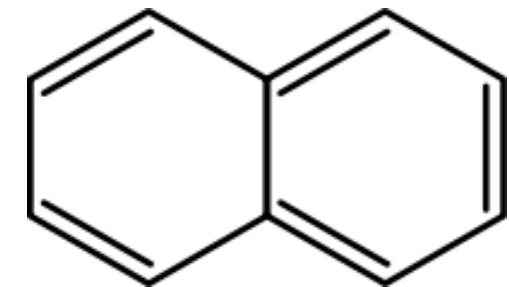
Naphthalene ($C_{10}H_8$) is an organic molecule that has only LDF. How is it possible then that naphthalene is a solid at room temperature, but water is a liquid?



- A. Molecules with stronger IMF always have higher boiling points.
- B. Water molecules can form H-bonds so water must have stronger IMF than those of naphthalene.
- C. Naphthalene 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.

T16Q4: Solution

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



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- B. Water molecules can form H-bonds so water must have stronger IMF than those of naphthalene.
- 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.

Naphthalene 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: Level 2 (L.G. 9)

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

T17Q1: Solution

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- 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

$$\begin{aligned}V &= \frac{nRT/P}{1.5 \text{ atm}} = \frac{2.0 \text{ mol} \times (0.082 \text{ L-atm/mol-K}) \times (-73 + 273) \text{ K}}{1.5 \text{ atm}} \\&= 22.1 \text{ L}\end{aligned}$$

T16Q6: Level 3 (L.G. 12)

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



- A. I only
- B. I and II only
- C. II and III only
- D. I, II and III

T16Q6: Solution

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

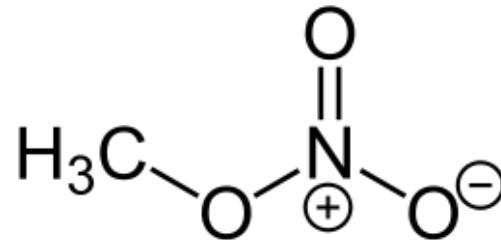
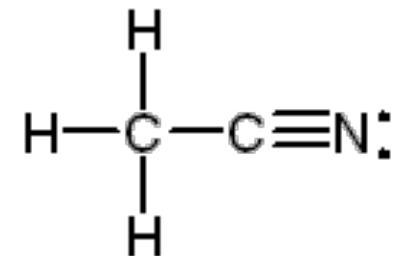
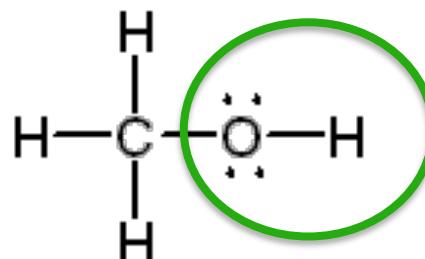


A. I only

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: Level 3 (L.G. 8)

Consider the chemical reaction that occurs when sodium metal reacts with oxygen gas: $4\text{Na(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{Na}_2\text{O(s)}$

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.

- A. 5.64 grams
- B. 6.73 grams
- C. 8.33 grams
- D. 9.92 grams



T14Q7: Solution

Consider the chemical reaction that occurs when sodium metal reacts with oxygen gas: $4\text{Na(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{Na}_2\text{O(s)}$

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
$5 \text{ g} / (23 \text{ g/mol}) = 0.217 \text{ moles}$	$5 \text{ g} / (32 \text{ g/mol}) = 0.16 \text{ moles}$
$0.217 \text{ n} \times (2/4) = 0.1085 \text{ moles Na}_2\text{O}$	$0.16 \text{ n} \times (2/1) = 0.32 \text{ moles Na}_2\text{O}$
Theoretical Yield:	
$0.1085 \text{ moles} \times (61.98 \text{ g/mol}) = 6.73 \text{ grams Na}_2\text{O}$	
Actual yield = $(6.73 \text{ g}) * (84\% / 100\%) = 5.64 \text{ g Na}_2\text{O}$	

T17Q7: Level 3 (L.G. 10)

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

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**

$$\begin{aligned} n_f &= [(n_i T_i) / (T_f)] \times (P_f / P_i) \\ &= [(1.9)(21+273) / (26+273)] \times [(795) / (697)] \\ &= 2.13 \text{ moles at the end} \end{aligned}$$

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

T15Q4: Level 3 (L.G. 4)

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?

- A. CH_2O
- B. $C_2H_4O_2$
- C. $C_2H_2O_2$
- D. C_2H_2O

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)	$(12.01/44.01) \times 0.293 \text{ g}$ = 0.07996	$(2.016/18.02) \times 0.120 \text{ g}$ = 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



X 2



$\text{Mass of EF: } 12.01 + 2(1.008) + 16.00 = 30.026 \text{ g/mol}$

$(60.07 \text{ g/mol})/(30.026 \text{ g/mol}) = 2$