

CHEM 120
Fall 2009
Quiz 4

Name: _____

1. (10 Points) Fill in the blanks.

Name	Chemical Formula
carbon disulfide	CS ₂
sulfur tetrafluoride	SF ₄
copper(II) hydroxide	Cu(OH) ₂
cesium sulfate	Cs ₂ SO ₄
potassium iodate	KIO ₃
tin(IV) oxide	SnO ₂
ammonium dichromate	(NH ₄) ₂ Cr ₂ O ₇
lead(II) acetate	Pb(C ₂ H ₃ O ₂) ₂
calcium dihydrogenphosphate	Ca(H ₂ PO ₄) ₂
diiodine hexachloride	I ₂ Cl ₆

2. (10 Points) Malachite is a common copper-containing mineral whose chemical formula is Cu₂(OH)₂CO₃. What is the percent by mass of copper in malachite?

Determine the molar mass of malachite.

2 Cu	2 mole (63.546 g/mole)	127.09 ₂ g
5 O	5 mole (15.999 g/mole)	79.995 g
2 H	2 mole (1.0079 g/mole)	2.0158 g
1 C	1 mole (12.011 g/mole)	12.011 g
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1 mole Cu ₂ (OH) ₂ CO ₃		221.113 ₈ g

Determine the % by weight from the mass of Cu and the molar mass of malachite assuming 1 mole of the mineral.

$$\% \text{Cu by mass} = \frac{\text{mass Cu}}{\text{mass malachite}} \times 100 = \frac{127.09_2 \text{ g Cu}}{221.113_8 \text{ g malachite}} \times 100 = 57.478\%$$

Malachite is 54.478% Cu by mass.

3. (12 Points) A metal, which we will give the symbol M, forms the sulfate $M_2(SO_4)_3$. A 0.738-g pure sample of this sulfate is completely converted to 1.511 g $BaSO_4$. Identify the metal.

Determine the molar mass of $BaSO_4$.

Ba	1 mole (137.33 g/mole)	137.33 g
1 S	1 mole (32.066 g/mole)	32.066 g
4 O	4 mole (15.999 g/mole)	63.996 g
1 mole $BaSO_4$		233.392 g

All of the SO_4^{2-} in $BaSO_4$ came from $M_2(SO_4)_3$. Therefore, we may write

$$1.511 \text{ g } BaSO_4 \left(\frac{1 \text{ mole } BaSO_4}{233.392 \text{ g } BaSO_4} \right) \left(\frac{1 \text{ mole } SO_4^{2-}}{1 \text{ mole } BaSO_4} \right) \left(\frac{1 \text{ mole } M_2(SO_4)_3}{3 \text{ mole } SO_4^{2-}} \right) = 2.158_0 \times 10^{-3} \text{ mole } M_2(SO_4)_3$$

Now calculate the molar mass of the sulfate from the given mass and the moles of the compound that this mass represents, which we just found.

$$\text{molar mass } M_2(SO_4)_3 = \frac{0.738 \text{ g } M_2(SO_4)_3}{2.158_0 \times 10^{-3} \text{ mole } M_2(SO_4)_3} = 341._9 \text{ g/mole}$$

Determine the molar mass of M from the molar mass of $M_2(SO_4)_3$ and the molar masses of the other elements present. Let M represent the molar mass of the unknown metal.

$$(3 \text{ mole})(32.065 \text{ g/mole}) + (12 \text{ mole})(15.999 \text{ g/mole}) + (2 \text{ mole})(M) = (1 \text{ mole})(341._9 \text{ g/mole})$$

$$M = \frac{(1 \text{ mole})(341._9 \text{ g/mole}) - (3 \text{ mole})(32.065 \text{ g/mole}) - (12 \text{ mole})(15.999 \text{ g/mole})}{2 \text{ mole}}$$

$$M = \frac{341._9 \text{ g} - 96.195 \text{ g} - 191.988 \text{ g}}{2 \text{ mole}} = \frac{53._7 \text{ g}}{2 \text{ mole}} = 27. \text{ g/mole}$$

The molar mass of the metal is 27. g/mole, which most closely matches the molar mass of Al. Therefore, the unknown metal is Al.

4. (9 Points) A combustion analysis of a 1.510-g sample of a substance yields 2.094 g CO₂. What is the percent by weight of carbon in the sample?

Find the molar mass of CO₂.

C	1 mole (12.011 g/mole)	12.011 g
2 O	2 mole (15.999 g/mole)	31.998 g
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	1 mole CO₂	44.009 g

Since all of the C in the CO₂ comes from the substance, we can perform the following calculation to find the mass of C in the sample.

$$2.094 \text{ g CO}_2 \left(\frac{1 \text{ mole CO}_2}{44.009 \text{ g CO}_2} \right) \left(\frac{1 \text{ mole C}}{1 \text{ mole CO}_2} \right) \left(\frac{12.011 \text{ g C}}{1 \text{ mole C}} \right) = 0.5714_9 \text{ g C}$$

Next find the % by mass using the definition.

$$\% \text{ C by mass} = \frac{\text{mass C}}{\text{mass sample}} \times 100 = \frac{0.5714_9 \text{ g C}}{1.510 \text{ g sample}} \times 100 = 37.85\%$$

The sample is 37.85% by weight C.