Spring Final 2017 Review

MEASUREMENTS

Write in the number of significant figures for each of the following measurements:

3 3.00 mL 3 0.00290 g 4 50.00 m 2 0.070 kg 1 400 L

Combine the masses 0.0562 kg, 124.213 g and 1635 mg. The answer should be reported as: 128.0 g

Convert to like units.

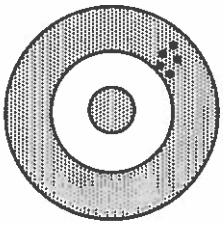
0.0562 kg → 56.2 g 1635 mg → 1.635 g

56.2
124.213
1.635
182.048

A 5.75 mL sample of mercury has a measured mass of 77.05 g. The density is 13.4 g/mL $\frac{77.05}{5.75}$

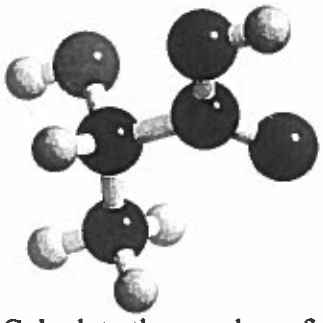
Mercury's accepted density is 13.53 g·mL^{-1}. The % error in your measurement is: 0.961 %

$$\frac{13.4 - 13.53}{13.53} \cdot 100$$



Is this person accurate? N Is the person precise? Y

MATTER



This molecule contains 3 elements and 12 atoms.

The molecular formula for this substance is: $C_3H_6O_3$

white - hydrogen
black - carbon
Red - oxygen

Calculate the number of seconds in 5.25 years using unit analysis: (1 year = 365.25 days)

$$5.25\ \text{yrs} \left|\frac{365.25\ \text{days}}{1\ \text{yr}}\right| \frac{24\ \text{hrs}}{1\ \text{day}} \left|\frac{3600\ \text{sec}}{1\ \text{hr}}\right| = 1.66 \times 10^8\ \text{sec}$$

A **calculator** displays the answer to a problem as **53.29841**
Report this answer to:

53.298 5 significant figures

53.3 3 significant figures

50 1 significant figure

MEASURING CHEMICALS

Calculate the molar mass of $Ba(NO_3)_2$.

261.33 g/mol

Calculate the percent composition of each element in the following compound.

$Ba(NO_3)_2$	Ba = 52.6 % =	$\frac{137.33}{261.33}$	N = 10.7 % =	$\frac{28}{261.33}$	O = 36.7 % =	$\frac{96}{261.33}$

Write the formula for ionic compounds made from these ions:

Name	Cation	Anion	Formula
sodium phosphate	Na^+	PO_4^{3-}	Na_3PO_4
stannic chloride	Sn^{4+}	Cl^-	$SnCl_4$
aluminum hydroxide	Al^{3+}	OH^-	$Al(OH)_3$
ammonium sulfate	NH_4^+	SO_4^{2-}	$(NH_4)_2SO_4$

MOLE PROBLEMS

Solve the following mole problems:

How many molecules of CO_2 (MM = 44.0 g/mol) are in 17.75 grams of CO_2?

$$17.75\text{g } CO_2 \left| \frac{1\text{mol}}{44.0} \right| \frac{6.022\times10^{23}\text{ molecules}}{1\text{mol}} = \boxed{2.43\times10^{23}\text{ molecules } CO_2}$$

What volume (in Liters) does 20.0 grams of butane, C_4H_{10}, occupy at STP? (MM C_4H_{10} = 58.14 g/mol)

$$20.0\text{g } C_4H_{10} \left| \frac{1\text{mol}}{58.145} \right| \frac{22.4\text{L}}{1\text{mol}} = \boxed{7.70\text{ L}}$$

List the 7 diatomic elements:	H_2	O_2	N_2	Cl_2	Br_2	I_2	F_2

REACTIONS

Balance these equations and classify their type (single replacement, double replacement, etc.)

__C_5H_{12} + 8 O_2 → 5 CO_2 + 6 H_2O Classify this reaction: Comb.

2 H_2O_2 → 2 H_2O + __O_2 Classify this reaction: Decomp

2 $AgNO_3$ + __K_2CO_3 → __Ag_2CO_3 + 2 KNO_3 Classify this reaction: DR

Consider the balanced equation:

55.25 12.80 Xg
$N_2(g)$ + 3 $H_2(g)$ → 2 $NH_3(g)$
28.014 6.048 34.062

How many grams of $NH_3(g)$ is formed when 12.80 grams of $H_2(g)$ reacts with 55.25 grams of $N_2(g)$?

$\frac{55.25}{28.014} = 1.97 = \frac{X}{34.062}$ X = 67.1 g NH_3

$\frac{12.80}{6.048} = 2.116$

How many grams of CO_2 is produced when 11.0 g of C_5H_{12} burn?

$\frac{11.0\text{ g } C_5H_{12}}{72.151} = \frac{X}{220.05}$ X = 33.5 g CO_2

EMPIRICAL/MOLECULAR FORMULAS

Empirical Formulas:

A substance is 33.33% carbon, 7.47% hydrogen, and 59.20% oxygen.
What is its empirical formula? $C_3H_8O_4$

33.33 g C | 12.011 = 2.77 / 2.77 = 1 x3 = 3

7.47 g H_2 | 1.008 g H = 7.41 / 2.77 = 2.67 x3 = 8

59.20 | 16.0 g O = 3.7 / 2.77 = 1.33 x3 = 4

The molecular weight of the above substance is 432 g/mol. What is the molecular formula?

MM_{EF} = 108.097 $\frac{432}{108.97} = 4$ $C_{12}H_{32}O_{16}$

SOLUBILITY/NET IONICS

Circle the **precipitates:**	PbI_2	$Ba(OH)_2$	Ag_2CO_3	CaF_2	K_2SO_3	$(NH_4)_2S$

List the **strong acids:**	HNO_3	H_2SO_4	$HClO_4$	HCl	HBr	HI		

Write the balanced molecular, total ionic, and net ionic equation for:

Solutions of acetic acid and sodium nitrite are mixed.

$$HC_2H_3O_2(aq) + NaNO_2(aq) \rightarrow NaC_2H_3O_2(aq) + HNO_2(aq)$$

$$HC_2H_3O_2(aq) + Na^+(aq) + NO_2^-(aq) \rightarrow Na^+(aq) + C_2H_3O_2^-(aq) + HNO_2(aq)$$

$$HC_2H_3O_2(aq) + NO_2^-(aq) \rightarrow C_2H_3O_2^-(aq) + HNO_2(aq)$$

Solutions of aluminum nitrate and sodium oxalate.

$$2Al(NO_3)_3(aq) + 3Na_2C_2O_4(aq) \rightarrow Al_2(C_2O_4)_3(s) + 6NaNO_3(aq)$$

$$2Al^{3+}(aq) + 3NO_3^-(aq) + 6Na^+(aq) + 3C_2O_4^{2-}(aq) \rightarrow Al_2(C_2O_4)_3(s) + 6Na^+(aq) + 6NO_3^-(aq)$$

$$2Al^{3+}(aq) + 3C_2O_4^{2-}(aq) \rightarrow Al_2(C_2O_4)_3(s)$$

REDOX REACTIONS

Write the balanced net ionic equation for:

Aluminum metal is added to a solution of silver nitrate.

$$\overset{0}{Al}(s) + 3\overset{+1}{Ag}NO_3(aq) \rightarrow 3\overset{0}{Ag}(s) + \overset{+3}{Al}(NO_3)_3(aq)$$

→ lose e^-

What substance is being **oxidized**? Al Which **atom** is being **reduced**? Ag^+

What is the **oxidizing agent**? Ag^+

What is the **oxidation number** of N in the nitrate ion, $\underline{N}O_3^-$

+5 $\quad X + 3(-2) = -1$

$X = +5$

ENERGY IN REACTIONS

When solutions of NaOH and HCl are added together, the mixture gets hot.
50.0 mL of 2.00 M NaOH and 50.0 mL of 2.00 M HCl are mixed.
Both solutions are at room temperature, 18.0°C, and the final temperature of the mixture is 32.0°C.

a) Calculate the heat released by the reaction.

$q = mc\Delta T$
$= (100)(4.184)(14.0) = 5,857.6 = \boxed{5.86\ kJ}$

b) Calculate the moles of H_2O formed.

$n = Vol \cdot M = (0.050)(2.00) = \boxed{0.100\ mol}$

c) Calculate the ΔH of neutralization in kJ/mol.

$\Delta H = \frac{5.86\ kJ}{0.100\ mol} = \boxed{-58.6\ \frac{kJ}{mol}}$

ENERGY & HESS'S LAW

Calculate the standard enthalpy of the reaction for the process

$$3NO\ (g) \rightarrow N_2O\ (g) + NO_2\ (g)$$

Using the standard enthalpies of formation ($\Delta H_f°$) NO = 90 kJ/mol, N_2O = 82.1 kJ/mol, NO_2 = 34.0 kJ/mol

$\Delta H_{rxn} = (\Delta H_{N_2O} + \Delta H_{NO_2}) - 3\Delta H_{NO}$
$(82.1 + 34.0) - 3(90)$
$\boxed{= -154\ \frac{kJ}{mol}}$

How much energy is required to change the temperature of 2.00 g of aluminum from 20.0°C to 25.0°C? The specific heat of aluminum is 0.902 J/g°C.

heat: $q = mc\Delta T$
$2.00(0.902)(5.00)$
$\boxed{= 9.02\ J}$

PROPERTIES OF GASES

What is the mass of a 84.50 L sample of helium (MM=4.00 g/mol) measured at 20.0°C and 700. mmHg?

b 293 K

$PV = nRT$ $\quad n = \frac{m}{MM}$ $\quad PV = \frac{m}{MM} \cdot RT$

$700.(84.50) = \left(\frac{X}{4.00}\right)62.4(293)$

$\boxed{X = 12.9\ g\ He}$

A balloon with a volume of 2.50 L at 20.0°C and 745 mmHg would have what volume at STP?

$V_1 = 2.50\ L$
$T_1 = 20 \rightarrow 293$
$P_1 = 745\ mmHg$
$V_2 = ?$
$T_2 = 273$
$P_2 = 760\ mmHg$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{2.50(745)(273)}{293(760)} = 2.28\ L$$

KINETICS - RATE LAW

Below is initial rate date for the reaction $A + B \rightarrow 2C$

[A]	[B]	Rate (mol/(L*s)
0.40	0.10	3.6×10^3
0.20	0.10	1.8×10^3
0.20	0.50	4.5×10^3

Determine the **orders** of the reactants A 1st B 2nd.

Write the **rate law** for the above reaction. $rate = k[A][B]^2$

Calculate the value of the **rate constant, k**, with appropriate units $2.25 \times 10^5\ \frac{1}{M^2 \cdot s}$

eqn 1 / eqn 2: $\frac{3.6 \times 10^3}{1.8 \times 10^3} = \frac{k(0.40)^m(0.10)^n}{k(0.20)^m(0.10)^n}$

$2 = 2^m$
$m = 1$

eqn 2 / eqn 3: $\frac{4.5 \times 10^4}{1.8 \times 10^3} = \frac{k(0.20)^m(0.50)^n}{k(0.20)^m(0.10)^n}$

$25 = 5^n$
$n = 2$

$3.6 \times 10^3 = k(0.40)^1(0.20)^2$
$k = 2.25 \times 10^5\ \frac{1}{M^2 \cdot s}$

EQUILIBRIUM

Consider the following reaction: **NH_4^+ (aq) + NO_2^- (aq) ↔ N_2 (g) + 2 H_2O (l)**
At 400 K, the 1.0 L reaction vessel is found to contain 1.55 mol NH_4^+, 0.912 mol NO_2^-, and 3.20 mol H_2O.
Given the equilibrium constant = 39.5, calculate the concentration of the N_2.

$NH_4^+(aq)$	+ $NO_2^-(aq)$	⇌ $N_2(g)$	+ $2H_2O(l)$
1.55 M	0.912 M	0	
$-x$	$-x$	$+x$	

$[N_2] = 0.878\ M$

$$39.5 = \frac{x}{(1.55-x)(0.912-x)}$$

$$39.5(1.413 - 1.55x - 0.912x + x^2) = x$$

$$39.5x^2 - 98.249x + 55.814 = 0$$

$x = 0.878$

At 900 K, Keq for the reaction below is 0.64. You start with 0.10 M CO_2 & 0.10 M H_2. What are the concentrations of all species at equilibrium?

$$CO_2\,(g) + H_2\,(g) \leftrightarrow CO\,(g) + H_2O\,(g)$$

← leave in gas

.10	.10	0	0
−x	−x	x	x

$$0.64 = \frac{x^2}{(0.10-x)(0.10-x)}$$

$$0.64(0.01 - 0.10x - 0.10x + x^2) = x^2$$

$$.0064 - 0.128x + 0.64x^2 = x^2$$

$$0.36x^2 + 0.128x - 0.0064 = 0$$

$X = \frac{0.4}{}$

$X = 0.044$

$[CO_2]$: 0.06 M

$[H_2]$: 0.06 M

$[CO]$: 0.04 M

$[H_2O_{(g)}]$: 0.04 M

Consider the gaseous equilibrium: $2\,CCl_4\,(g) + O_2\,(g) \leftrightarrow 2\,COCl_2\,(g) + 2\,Cl_2\,(g)$ $\Delta H = +35$ kJ
Predict the effect each change would have on the equilibrium position of the above reaction.

	CCl_4	O_2	$COCl_2$	Cl_2
Add CCl_4	↑	↓	↑	↑
Remove Cl_2	↓	↓	↑	↓
Add $COCl_2$	↑	↑	↑	↓
Increase Temp	↓	↓	↑	↑
Reduce Container Volume	↑	↑	↓	↓
Add a Catalyst	—	—	—	—
Remove O_2	↑	↓	↓	↓
Add He to Increase Pressure	—	—	—	—

↳ Inert gases have no effect.

A different equilibrium shifts towards the reactants when the temperature is increased. From this observation, you know that the reaction is exothermic (exothermic/endothermic).

ACIDS AND BASES

Acetic Acid is a weak acid, with a k_a of 1.8×10^{-5}.

Write the dissociation equation for acetic acid.

$$HC_2H_3O_2\,(aq) \rightleftharpoons H^+\,(aq) + C_2H_3O_2^-\,(aq)$$

Calculate the pOH of a 0.250 M acetic acid

0.250	0	0
−x	x	x

$$1.8 \times 10^{-5} = \frac{x^2}{0.250 - x}$$

$X = 0.00212$

$[H^+] = 0.00212$

$pH = -\log(0.00212)$

$= 2.67$

$pOH = 14 - 2.67 = \boxed{11.33}$

If 20.0 mL of the 0.250 M acetic acid was used to neutralize 14.0 mL of NaOH:

4 0.0200 L

How many moles of NaOH were in the flask to begin with?

@ eq pt mol H^+ = mol OH^-

$n = (0.0200)(0.250)$

$n = 0.00500$ mol NaOH

What is the concentration of the NaOH used to neutralize the 0.250 M acetic acid?

$M = \frac{n}{V} = \frac{0.00500}{0.014} = 0.357$ M

or

$20(0.250) = X(14)$

$X = 0.357$ M

$K_w = [H^+][OH^-]$ $\quad pH = -\log[H^+]$ $\quad pH + pOH = 14$

Fill in the chart.

$[H^+]$	$[OH^-]$	pH	pOH	Acid/Base
5.6×10^{-4}	1.78×10^{-11}	3.25	10.75	ACID
0.0251	3.98×10^{-13}	**1.60**	12.4	ACID
1.41×10^{-10}	**7.1×10^{-5}**	9.85	4.15	BASE
1.78×10^{-9}	5.62×10^{-6}	8.75	**5.25**	BASE

ATOMIC THEORY

Identify the # of protons, neutrons, and electrons in the following atoms:

^{31}P p= 15 n= 16 e= 15

$^{39}Ca^{2+}$ p= 20 n= 19 e= 18

$^{128}Te4-$ p= 52 n= 76 e= 56

Write the complete symbol for the atoms which have the following # of p, n, & e's:

p= 26 n= 30 e= 26 $^{56}_{26}Fe$

p= 23 n= 28 e= 18 $^{51}_{23}V^{+5}$

p= 80 n= 120 e= 79 $^{200}_{80}Hg^{+}$

Write the entire electronic configuration for the following:

boron: $1s^2 2s^2 2p^1$

magnesium: $1s^2 2s^2 2p^6 3s^2$

Use the short-cut method to write the following electronic configurations:

technetium: $[Kr]\ 5s^2 4d^{10} 5p^4$

selenium: $[Ar]\ 4s^2 3d^{10} 4p^4$

francium: $[Rn]\ 7s^1$

tungsten: $[Xe]\ 6s^2 4f^{14} 5d^4$ (W)

Give the quantum numbers for the last electron placed:

technetium: 5, 1, -1, $+\frac{1}{2}$ selenium: 4, 1, -1, $+\frac{1}{2}$

francium: 7, 0, 0, $-\frac{1}{2}$ tungsten: 5, 2, 1, $-\frac{1}{2}$

How much energy is contained in a photon of green light? (frequency is 2.05 x 10^{14} Hz?)

$E = h\nu$: $6.626 \times 10^{-34} (2.05 \times 10^{14}) = 1.36 \times 10^{-19}$ J

NUCLEAR

Strontium-90 is a hazardous isotope present in the fallout from nuclear explosions. If 1.00 gram of strontium-90 diminishes to 0.786 gram in 10 years, as measured by its activity, what is the half-life of strontium-90?

$n = \frac{t}{t_{1/2}}$ $A = \frac{A_0}{2^n}$ $n = \frac{\log\left(\frac{A_0}{A}\right)}{\log 2}$ $n = \frac{\log\left(\frac{1.00}{0.786}\right)}{\log 2}$ $n = 0.3474 = \frac{10}{t_{1/2}}$

$t_{1/2} = 28.78$ yrs

Charcoal retrieved from the site of Stonehenge in England has a carbon-14 activity 62.0% that of carbon-14 in living plants. Assuming that the abundance of carbon-14 in the atmosphere has remained more or less constant for the past few thousand years, how old is the charcoal? The half-life of carbon-14 is 5730 years.

Write the "isotopic symbols" for:

alpha, α	beta, β^-	gamma, γ	positron, β^+	neutron, n^0
^4_2He	$^0_{-1}e$ or $^0_{-1}\beta$	$^0_0\gamma$	$^0_{+1}\beta$	$^1_0n^0$

$\left(\frac{\log\left(\frac{100}{62}\right)}{\log 2}\right) \cdot 5730 = t$ $t =$ 3950 yrs

$^{238}_{92}U \rightarrow {}^{234}_{90}Th + \boxed{{}^{4}_{2}He}$ (alpha decay)

$^{234}_{90}Th \rightarrow {}^{234}_{91}Pa + \boxed{{}^{0}_{1}\beta}$ (positron decay)
emission

$^{234}_{91}Pa \rightarrow \boxed{{}^{238}_{93}Np} + {}^{4}_{2}He$ (alpha decay)

$^{220}_{86}Rn \rightarrow \boxed{{}^{224}_{88}Ra} + {}^{4}_{2}He$ (alpha decay)

$^{216}_{84}Po \rightarrow \boxed{{}^{216}_{85}At} + {}^{0}_{-1}e$ (beta decay)

$^{14}_{6}C \rightarrow {}^{14}_{7}N + \boxed{{}^{0}_{-1}\beta}$ (Beta decay)

$^{210}_{83}Bi \rightarrow \boxed{{}^{0}_{-1}\beta} + \boxed{{}^{210}_{84}Po}$ (beta decay)

BONDING

A Ionic bond is formed when a positive ion and a negative ion come together.

The metal will (gain / lose) electrons, giving it a (positive / negative) charge. The nonmetal will (gain / lose) electrons, giving it a (positive / negative) charge.

Determine how many electrons were transferred to make the following ionic compounds:

CaS 2 CaCl2 2 Al2O3 6 AlN 3 KBr 1 MgO 2

How do you distinguish the difference between an ionic bond and a covalent bond?

Ionic containing metals & non-metals covalent only nonmetals

List the general properties of:

Ionic:

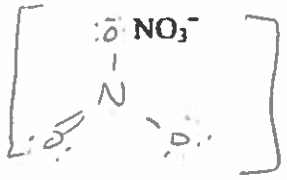
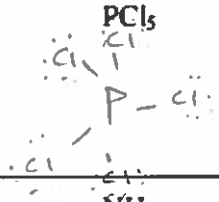
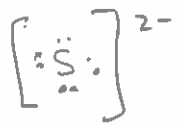
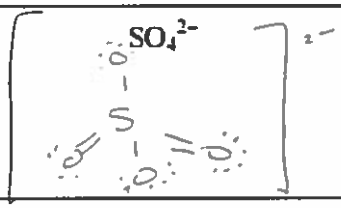
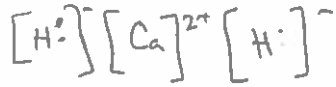
Solid
Crystalline
High melting & boiling
Shiny
Ductile
Malleable

Covalent:

Waxy Solids
Soft
most likely gases @ room temp
lower melting / BP

LEWIS STRUCTURES AND VSEPR

Draw the Lewis Structure for the following substances using **VSEPR Theory** and identify the **molecular geometry**.

Ca^{2+} 	NO_3^- 	PCl_5 
C_2H_2 	S^{2-} 	NH_3 
SO_4^{2-} 	SO_2 	CaH_2 

IMFs

Indicate **all** forces (IMFs, Ionic Bonds, or Metallic bonds) holding the following substances together:

NH_3	Kr	HCl	F_2	$KMnO_4$	NaCl	SO_2
H-Bond D-D LDF	Metallic	D-D LDF	LDF	ionic	ionic	D-D LDF

CO_2	C_3H_8	CH_4	CH_3Cl	HF	C_6H_6	NO
LDF	LDF	LDF	D-D LDF	H-Bond DD LDF	LDF	DD LDF

SATURATION

Identify the difference between saturated, unsaturated, and supersaturated.

Unsaturated - can dissolve more solute

Sat - contains max dissolved solute

Super - contains more dissolved solute than Saturated

Use the reference table below.

How many grams of water will it take to dissolve 28.0 g NH_4Cl at 60.0°C? 50 g

$$\frac{28.0}{x} = \frac{56}{100}$$

↓ from chart on back

How much water is needed to dissolve 46.6 g of SO_2 at 28°C? _____ NOT on chart ignore

$\frac{46.6}{x} =$

What temperature would be required to get 71.0 g of KCl to dissolve in 156 g of water? ~70°

$\frac{71}{156} = \frac{x}{100}$ 45.5 g

Based on what you've learned in class about soda & fish, do gases behave the same as or different than solids when it comes to solubility & temperature? Take a look at your graph. SO_2, NH_3, and HCl are all gases. How do these solubilty curves differ from the others?

NO - solubility decreases for gases with an increase in temp

What is the percent $KClO_3$ in a solution that is saturated at 61°C? 21.3%

~27 g +100 g H_2O

$\frac{27}{127} \cdot 100$