

Exit Exam (Written Portion)

Name \_\_\_\_\_

**Get at least 3/5 correct to pass.**

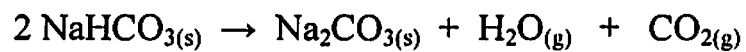
1) A saturated aqueous solution of sucrose,  $C_{12}H_{22}O_{11}$  contains 525g of sucrose (MW = 342) per 100g of water. What is the molecular ratio of  $C_{12}H_{22}O_{11} : H_2O$  in this solution ?

2) What is the mass of 1 molecule of water in grams ?

3) A 100 mL portion of 0.250 M Calcium Nitrate is mixed with 400 mL of 0.100 M Nitric acid solution. What is the final concentration of the Nitrate ion ?

4) At 20.0°C water has  $K_w = 6.807 \times 10^{-15}$ . What is the pH of pure water at this temperature ?

5) Calculate the change in enthalpy (in kJ per mole of CO<sub>2</sub>) for the decomposition of sodium hydrogen carbonate according to the below equation and provided standard enthalpies of formation.



	<u><math>\Delta H_f^0</math> (in kJ.mol<sup>-1</sup>)</u>
NaHCO <sub>3(s)</sub>	-947.7
Na <sub>2</sub> CO <sub>3(s)</sub>	-1130.9
H <sub>2</sub> O <sub>(g)</sub>	-241.8
CO <sub>2(g)</sub>	-393.5

ABBREVIATIONS AND SYMBOLS					
ampere	A	Faraday constant	<i>F</i>	molal	<i>m</i>
atmosphere	atm	formula molar mass	<i>M</i>	molar	<i>M</i>
atomic mass unit	u	free energy	<i>G</i>	molar mass	<i>M</i>
atomic molar mass	<i>A</i>	frequency	<i>v</i>	mole	mol
Avogadro constant	<i>N<sub>A</sub></i>	gas constant	<i>R</i>	Planck's constant	<i>h</i>
Celsius temperature	°C	gram	g	pressure	<i>P</i>
centi- prefix	c	heat capacity	<i>C<sub>p</sub></i>	rate constant	<i>k</i>
coulomb	C	hour	h	retention factor	<i>R<sub>f</sub></i>
electromotive force	<i>E</i>	joule	J	second	<i>s</i>
energy of activation	<i>E<sub>a</sub></i>	kelvin	K	temperature, K	<i>T</i>
enthalpy	<i>H</i>	kilo- prefix	k	time	<i>t</i>
entropy	<i>S</i>	liter	L	volt	V
equilibrium constant	<i>K</i>	milli- prefix	m		

CONSTANTS
$R = 8.314 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$
$R = 0.0821 \text{ L}\cdot\text{atm}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$
$1 F = 96,500 \text{ C}\cdot\text{mol}^{-1}$
$1 F = 96,500 \text{ J}\cdot\text{V}^{-1}\cdot\text{mol}^{-1}$
$N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$
$h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$
$c = 2.998 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
$0^\circ\text{C} = 273.15 \text{ K}$
$1 \text{ atm} = 760 \text{ mmHg}$

EQUATIONS		
$E = E^\circ - \frac{RT}{nF} \ln Q$	$\ln K = \left( \frac{-\Delta H}{R} \right) \left( \frac{1}{T} \right) + \text{constant}$	$\ln \left( \frac{k_2}{k_1} \right) = \frac{E_a}{R} \left( \frac{1}{T_1} - \frac{1}{T_2} \right)$

## PERIODIC TABLE OF THE ELEMENTS

1 1A												13 3A					14 4A	15 5A	16 6A	17 7A	18 8A
1 H 1.008	2 He 4.003											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18				
3 Li 6.941	4 Be 9.012											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95				
11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80				
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3				
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)				
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	114 (277)									
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (277)										

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Exit Exam (Written Portion)

Name EXIT EXAM #4

Get at least 3/5 correct to pass.

1) A saturated aqueous solution of sucrose,  $C_{12}H_{22}O_{11}$  contains 525g of sucrose (MW = 342) per 100g of water. What is the molecular ratio of  $C_{12}H_{22}O_{11} : H_2O$  in this solution?

$$525g \text{ of sucrose} = \frac{525}{342} = 1.535 \text{ moles}$$

$$100g \text{ of water} = \frac{100}{18} = 5.55 \text{ moles.}$$

$$C_{12}H_{22}O_{11} : H_2O \text{ ratio is } 1.535 : 5.55 \\ = \underline{\underline{1 : 3.62}} \text{ (or } \underline{\underline{0.277 : 1}})$$

2) What is the mass of 1 molecule of water in grams?

$$\text{MW of } H_2O = 18 \text{ g/mol}$$

$$\text{Avogadro's Number} = 6.02 \times 10^{23} \text{ per mole}$$

$$1 \text{ mole of } H_2O = 18 \text{ g} = 6.02 \times 10^{23} \text{ molecules}$$

$$\text{So } 1 \text{ molecule} = \frac{18}{6.02 \times 10^{23}} = \underline{\underline{3.0 \times 10^{-23} \text{ g}}}$$

3) A 100 mL portion of 0.250 M Calcium Nitrate is mixed with 400 mL of 0.100 M Nitric acid solution. What is the final concentration of the Nitrate ion?

$$\text{Moles } \text{Ca}(\text{NO}_3)_2 = 0.25 \times \frac{100}{1000} = 0.025$$

$$\text{Moles of } \text{NO}_3^- \text{ from above} = 2 \times 0.025 = 0.050 \text{ moles.}$$

$$\text{Moles } \text{HNO}_3 = 0.1 \times \frac{400}{1000} = 0.04 \text{ moles.}$$

$$\text{Total } \text{NO}_3^- : 0.05 + 0.04 = 0.09 \text{ moles}$$

$$\text{Total volume} = 100 \text{ mL} + 400 \text{ mL} = 500 \text{ mL.}$$

$$[\text{NO}_3^-] = 0.09 \times \frac{1000}{500}$$

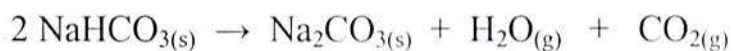
$$= \underline{\underline{0.180 \text{ moles. l}^{-1}}} \quad (3 \text{ sig figs})$$

4) At 20.0°C water has  $K_w = 6.807 \times 10^{-15}$ . What is the pH of pure water at this temperature?

$$\begin{aligned}K_w &= [\text{H}^+][\text{OH}^-] \\&= 6.807 \times 10^{-15} = [\text{H}^+]^2 \\ \therefore [\text{H}^+] &= 8.2 \times 10^{-8} \text{ Moles.L}^{-1}\end{aligned}$$

$$\begin{aligned}\text{pH} &= -\log_{10} [\text{H}^+] \\&= \underline{\underline{7.08}}\end{aligned}$$

5) Calculate the change in enthalpy (in kJ per mole of CO<sub>2</sub>) for the decomposition of sodium hydrogen carbonate according to the below equation and provided standard enthalpies of formation.



	$\Delta H_f^\circ$ (in kJ.mol <sup>-1</sup> )
NaHCO <sub>3(s)</sub>	-947.7
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$$\Delta H_{\text{reaction}} = (\Delta H_f^\circ \text{ products}) - (\Delta H_f^\circ \text{ reagents})$$

$$= (-1130.9 - 241.8 - 393.5) - (2 \times -947.7)$$

$$= -1766.2 + 1895.4$$

$$= \underline{\underline{129.2 \text{ kJ/mol}}}$$