Exit Exam (Written Portion)

Name _____

Get at least 3/5 correct to pass.

1) The oxidation of ammonia produces nitrogen and water according to the equation:

$$4NH_{3(g)} + 3O_{2(g)} \rightarrow 2N_{2(g)} + 6H_2O_{(g)}$$

If the rate of formation of N_2 at a certain temperature is 3.0 $mol.L^{-1}.s^{-1}$, what is the rate of disappearance of O_2 ?

2) The mineral *Beryl* contains 5.03% Beryllium by mass, and contains three Beryllium atoms per formula unit. What is the formula mass (molecular weight) of *Beryl* ?

3) What is the maximum mass (in grams) of NO that could be obtained from 15.5g of N_2O_4 and 4.68g of N_2H_4 when they react according to the following equation ?

$$2N_2O_4 + N_2H_4 \rightarrow 6NO + 2H_2O$$

(MW of N_2O_4 = 92.0 $g.mol^{-1}$; N_2H_4 = 32.0 $g.mol^{-1}$)

4) What is the pH of a 0.0015 M solution of HNO_3 ?

5) A 2.00 liter evacuated container has a mass of 1050.0g. When the container is filled with an unknown gas at 800 mmHg pressure and 25.0°C, the mass is 1052.4g. What is the molar mass of the gas in $g.mol^{-1}$?

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

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

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

PERIODIC TABLE OF THE ELEMENTS

1 1A																	18 8A
1 H 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	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 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	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
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	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
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	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
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	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
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)		114 (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 #1

Get at least 3/5 correct to pass.

1) The oxidation of ammonia produces nitrogen and water according to the equation:

$$4NH_{3(g)} + 3O_{2(g)} \rightarrow 2N_{2(g)} + 6H_2O_{(g)}$$

If the rate of formation of N_2 at a certain temperature is 3.0 $mol.L^{-1}.s^{-1}$, what is the rate of disappearance of O_2 ?

stoichiometry of $N_2 : O_2$ is 2:3

So rate of disappearance of O_2 is $\frac{3}{2} \times 3.0 = 4.5\ mol.L^{-1}.s^{-1}$.

2) The mineral *Beryl* contains 5.03% Beryllium by mass, and contains three Beryllium atoms per formula unit. What is the formula mass (molecular weight) of *Beryl* ?

Mass of Be = 9.012 $\frac{g}{mol}$

So 3 Be atoms = $3 \times 9.012 = 27.036\ \frac{g}{mol}$.

The 3Be are 5.03% of the total mass, so $\frac{5.03}{100} = \frac{27.036}{MW}$

$\Rightarrow MW = 538\ \frac{g}{mol}$ (3 sig figs)

3) What is the maximum mass (in grams) of NO that could be obtained from 15.5g of N_2O_4 and 4.68g of N_2H_4 when they react according to the following equation ?

$$2N_2O_4 + N_2H_4 \rightarrow 6NO + 2H_2O$$

(MW of N_2O_4 = 92.0 g.mol^{-1}; N_2H_4 = 32.0 g.mol^{-1})

Moles of N_2O_4 : $\frac{15.5}{92.0}$ = 0.168 moles

Moles of N_2H_4 = $\frac{4.68}{32.0}$ = 0.146 moles

Stoichiometry is 2 N_2O_4 reacts with 1 N_2H_4 so the limiting reagent is therefore N_2O_4. (Would need 2×0.146 = 0.292 moles of N_2O_4 to fully react with the N_2H_4).

2 N_2O_4 produces 6 NO

So 0.168 N_2O_4 produces $\left(\frac{6}{2} \times 0.168\right)$ NO = 0.504 moles.

MW of NO = 30.01, so 0.504 moles = 30.01 × 0.504

= 15.1 g of NO (3 sig figs)

4) What is the pH of a 0.0015 M solution of HNO_3 ?

$HNO_3 \rightleftharpoons H^{\oplus}_{(aq)} + NO_3^{\ominus}{}_{(aq)}$ (Nitric Acid is a strong acid, which we assume fully dissociates in aqueous solution).

$pH = -\log_{10}[H^{\oplus}]$

$= -\log_{10}[0.0015]$

$= 2.8$

5) A 2.00 liter evacuated container has a mass of 1050.0g. When the container is filled with an unknown gas at 800 mmHg pressure and 25.0°C, the mass is 1052.4g. What is the molar mass of the gas in $g.mol^{-1}$?

Mass of gas = 1052.4 − 1050.0
= 2.4g

$PV = nRT$

P in atms = $\frac{800}{760}$

Rearranges to $n = \frac{PV}{RT}$

V in L = 2

R = 0.0821 $L.atm.k^{-1}mol^{-1}$

T in K = 25.0 + 273.15
= 298.15K.

So $n = \frac{\left(\frac{800}{760} \times 2\right)}{0.0821 \times 298.15}$ = 0.086 Moles.

If 2.4g = 0.086 moles, then $MW = \frac{2.4}{0.086}$ = 28 g/mol (2 sig figs)