50pts

1A Exam 2 VERSION 1 Name = Key
(Ch 4, 10, 5 thru Calorimetry)

****Relax & Good Luck. Please read carefully! ALL CALCULATIONS MUST BE SHOWN & INCLUDE UNITS.**

7pts 1. Calculate the volume (in mL) of a 4.25M $NaHCO_3$ aqueous solution that is needed to neutralize a 156mL spill of 5.95M H_2SO_4. Be sure to write a balanced equation to start!

(2) $2NaHCO_{3(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)} + 2CO_{2(g)}$

$$0.156\,L \times \frac{5.95\,mol\,H_2SO_4}{L} \times \frac{2\,mol\,NaHCO_3}{1\,mol\,H_2SO_4} \times \frac{L}{4.25\,mol} \times \frac{1\,mL}{10^{-3}\,L}$$

(1) (2) (1) (1)

$$= 437\,mL$$

6pts 2. Write the balanced NET IONIC reaction for the reaction above assuming the sodium product to be soluble. Label phases.

$$2HCO_3^- + 2H^+ \rightarrow 2H_2O + 2CO_2$$

or $HCO_{3(aq)}^- + H_{(aq)}^+ \rightarrow H_2O_{(l)} + CO_{2(g)}$

6pts 3. Complete the following single replacement reactions assuming they occur:

element + compound → element + compound

a. Chlorine reacts with potassium bromide

$$Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$$

b. Zinc reacts with silver nitrate

$$Zn + 2AgNO_3 \rightarrow 2Ag + Zn(NO_3)_2$$

6pts 4. Write the balanced reaction for the combustion of butane, C_4H_{10}. Then, assign oxidation states to each atom in the combustion reaction. Explain clearly which atom is the oxidizing agent.

$$\left(C_4H_{10} + 6.5O_2 \rightarrow 4CO_2 + 5H_2O\right) \times 2$$

4 C
10 H
13 O

4 C
10 H
13 O

$$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$$

-2.5 +1 ; 0 ; +4 -2 ; +1 -2

-10 / 4 = -2.5 ; +10 ; +4 ; -4

0 → -2

oxid agent = reduced = gains e⁻

6pts 5. A fixed amount of oxygen gas is held in a 2.500 L tank at a pressure of 15.68 atm. The tank is connected to an empty 5.50 L tank by a tube with a valve. After this valve has been opened and the oxygen is allowed to flow freely between the two tanks at a constant temperature, calculate the pressure of the gas now.

$V_1 = 2.500\,L$ * $V_2 = 2.500 + 5.50 = 8.00\,L$ ← 2pts!

$P_1 = 15.68\,atm$ $P_2 = ?$

$$\frac{P_1 V_1}{V_2} = \frac{P_2 V_2}{V_2}$$

$$\frac{(15.68\,atm)(2.500\,L)}{8.00\,L} = 4.9\,atm$$

P↓ as V↑

T P

6pts 6. Calculate the density, in g/L, of xenon gas at 182°C and 605 torr.

$\frac{131.29\,g}{mol}$

Other algebra possible!

$$\frac{131.29\,g}{mol} \times \frac{0.0213\,mol}{L} = \frac{2.80\,g}{L}$$

$$\frac{g}{mol} \times \frac{mol}{L} = \frac{g}{L}$$

(2)

solve for $\frac{n}{V}$

$T = 182 + 273.15$

(1) $= 455.15\,K$

$P = 605\,torr \times \frac{1\,atm}{760\,torr}$

(1) $= 0.796\,atm$

$\frac{PV}{RT} = \frac{n}{V}\frac{RT}{RT}$

(2) $\frac{0.0213\,mol}{L} = \frac{P}{RT} = \frac{n}{V} = \frac{0.796\,atm}{(0.08206\,\frac{atm\,L}{mol\,K})(455.15\,K)}$

7pts 7. When a 1.23 g sample of the rocket fuel hydrazine, N_2H_4, is burned in a bomb calorimeter, the temperature of the calorimeter rises from 24.62°C to 28.16°C. If the heat capacity for the bomb is 840 J/°C, calculate the enthalpy of combustion in kJ/mole. Label as endo- or exo-thermic.

N_2H_4 combusts

$1.23\,g \times \frac{mol}{32.05\,g}$

$\frac{kJ}{mol}$?

calorimeter

$T_i = 24.62°C$

$T_f = 28.16°C$

$C = 840\,J/°C$

$q = C\Delta T$

$q = \frac{840\,J}{°C} \times 3.54°C$

$= 2973.6\,J$ 2pts

Switch signs = 2 pts

$\ominus 2973.6\,J$

$= \ominus 2.9736\,kJ$

$\frac{\ominus 2.9736\,kJ}{0.0384\,mol} = \ominus 77.4\,\frac{kJ}{mol}$ 2

exothermic 1 (burning/combustion)

6pts 8. Calculate the number of times a 135lbs person must jump up 25cm in order to burn off the 299 Calorie hamburger they just ate. (2.21lbs/kg; 10^3 cal = 1Cal; 4/184J = 1cal)

$PE = mgh = 61.1\,kg \times 9.8\,m/s^2 \times 0.25\,m = 149.7\,J$ per jump

$135\,lbs \times \frac{kg}{2.21\,lbs} = 61.1\,kg$ (1)

$25\,cm \times \frac{10^{-2}\,m}{1\,cm} = 0.25\,m$ (1)

$299\,Cal \times \frac{1000\,cal}{1\,Cal} \times \frac{4.184\,J}{1\,cal} = 1251016\,J$ eaten (2)

$\frac{1251016\,J}{149.7\,J/jump} = 8357$ jumps

50pts

1A Exam 2 VERSION 2 (2)
(Ch 4, 10, 5 thru Calorimetry)

Name = key 2

****Relax & Good Luck. Please read carefully! ALL CALCULATIONS MUST BE SHOWN & INCLUDE UNITS.**

6pts 1. A fixed amount of oxygen gas is held in a 1.500 L tank at a pressure of 9.68 atm. The tank is connected to an empty 2.50 L tank by a tube with a valve. After this valve has been opened and the oxygen is allowed to flow freely between the two tanks at a constant temperature, calculate the pressure of the gas now.

$V_1 = 1.500\,L$ $V_2 = 1.500\,L + 2.50\,L = 4.00\,L$ (2 pts)

$P_1 = 9.68\,atm$ $P_2 = ?$

$$\frac{P_1V_1}{V_2} = \frac{P_2V_2}{V_2} \qquad \frac{(9.68\,atm)(1.500\,L)}{4.00\,L} = 3.63\,atm$$

P↓ as V↑

T P

6pts 2. Calculate the density, in g/L, of argon gas at 282°C and 505 torr.

(2) $\frac{39.948\,g}{mol} \times \frac{0.0146\,mol}{L} = 0.583\,\frac{g}{L}$

$\frac{g}{mol} \times \frac{mol}{L} = \frac{g}{L}$

find from $PV = nRT \rightarrow \frac{n}{V} = \frac{P}{RT}$

$\frac{39.948\,g}{mol}$

other algebra possible

$T = 282^\circ C + 273.15 = 555.15\,K$ (1)

$P = 505\,torr \times \frac{1\,atm}{760\,torr} = 0.664\,atm$ (1)

(2) $= \frac{0.664\,atm}{(0.0820\,\frac{atm \cdot L}{mol\,K})(555.15\,K)} = 0.0146\,\frac{mol}{L}$

7pts 3. When a 2.23 g sample of the rocket fuel hydrazine, N_2H_4, is burned in a bomb calorimeter, the temperature of the calorimeter rises from 24.62°C to 35.16°C. If the heat capacity for the bomb is 840 J/°C, calculate the enthalpy of combustion in kJ/mole. Label as endo- or exo-thermic.

N_2H_4 burns

$2.23\,g \times \frac{mol}{32.05\,g} = 0.0696\,mol$

$\frac{kJ}{mol}$?

Calorimeter

$T_i = 24.62°C$

$T_f = 35.16°C$

$C = \frac{840\,J}{°C}$

$q = C\Delta T$

$q_{calorim.} = \frac{840\,J}{°C} \times 10.54°C$ 2pts

$= 8853.6\,J$

switch signs 2pts

$-8853.6\,J$

$= -8.8536\,kJ$ 2

$\frac{-8.8536\,kJ}{0.0696\,mol} = -127\,\frac{kJ}{mol}$ exothermic 1

6pts 4. Calculate the number of times a 255lbs person must jump up 45cm in order to burn off the 299 Calorie hamburger they just ate. (2.21lbs/kg; 10^3 cal = 1Cal; 4/184J = 1cal)

$PE = mgh$

$255\,lbs \times \frac{1\,kg}{2.21\,lbs} = 115.4\,kg$ (1)

$45\,cm \times \frac{10^{-2}\,m}{1\,cm} = 0.45\,m$ (1)

$PE = 115.4\,kg \times \frac{9.8\,m}{s^2} \times 0.45\,m$

$= 508.9\,J_{per\ jump}$

$299\,Cal \times \frac{1000\,cal}{1\,Cal} \times \frac{4.184\,J}{1\,cal} = 1251016\,J$ eaten (2)

$1251016\,J / 508.9\,J_{per\ jump} = 2458$ jumps (2)

7pts 5. Calculate the volume (in mL) of a 7.35M $NaHCO_3$ aqueous solution that is needed to neutralize a 356mL spill of 4.95M H_2SO_4. Be sure to write a balanced equation to start!

(2)
$2NaHCO_{3(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)} + 2CO_{2(g)}$

$$0.356\,L \times \frac{4.95\,mol\,H_2SO_4}{L} \times \frac{2\,mol\,NaHCO_3}{1\,mol\,H_2SO_4} \times \frac{L}{7.35\,mol} \times \frac{1\,mL}{10^{-3}\,L}$$

$= \boxed{480.\,mL}$

6pts 6. Write the balanced TOTAL IONIC reaction for the reaction above assuming the sodium product to be soluble. Label phases.

$2Na^+_{(aq)} + 2HCO_3^-{}_{(aq)} + 2H^+_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow 2Na^+_{(aq)} + SO_4^{2-}{}_{(aq)} + 2H_2O_{(l)} + 2CO_{2(g)}$

6pts 7. Complete the following single replacement reactions assuming they occur:

element + compound → element + compound

a. Fluorine reacts with potassium bromide

$F_2 + 2KBr \rightarrow Br_2 + 2KF$

b. Cadmium reacts with silver nitrate

$Cd + 2AgNO_3 \rightarrow 2Ag + Cd(NO_3)_2$

6pts 8. Write the balanced reaction for the combustion of propane, C_3H_8. Then, assign oxidation states to each atom in the combustion reaction. Explain clearly which atom is the reducing agent.

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

-2.7 +1 0 +4 -2 +1 -2

-8/3 | +8

+4 | -4 = 0

+2 | -2 = 0

-2.7 → +4

reducing agent = oxidized = lose e-