MULTIPLE CHOICE (2 pts each): Write the ONE letter corresponding to the correct answer on the line next to each question. The LETTER ASSOCIATED WITH THE CORRECT ANSWER MUST BE WRITTEN ON THE LINE NEXT TO THE QUESTION in order to receive full credit.

1) When 2 g sugar is dissolved in 100 g water, sugar is the 1) D
a) solvation b) solvent c) solution (d) solute

2) If temperature is doubled at constant pressure, what will happen to volume? 2) C
a) increases by half b) decreases by half
(c) doubles $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{1}{1} = \frac{2}{2}$ d) decreases by 2

3) What is oxidation number of manganese in MnO_4^- ? 3) A
(a) +7 b) +8 c) +4 d) +3
O = -2 $-2 \times 4 = -8 + Mn = -1$ Mn = +7

4) What volume would be occupied by 2.86 mol of gas at STP? 4) B
a) 7.83 L (b) 64.1 L c) 0.128 L d) 25.3 L
$2.86\,mol\left(\frac{22.4\,L}{1\,mol}\right) = 64.1\,L$

5) Which of the following would have the greatest conductivity in aqueous solution? 5) C
a) 4 M NaCl 8 ions b) 3 M $Ca_3(PO_4)_2$ insoluble
(c) 2 M $Al_2(SO_4)_3$ 10 ions d) 2 M $FeCl_3$ 8 ions

6) What type of experiment is most likely to be conducted in an ice bath to prevent a glass flask from overheating? 6) C
a) endomeric b) endothermic (c) exothermic d) exomeric

7) In order to measure the enthalpy of a chemical reaction, it is best to use a(n) 7) B
a) closed system (b) isolated system
c) open system d) buffered system

8)) What concentration of nitrate ions would be present in a 2 M solution of $Fe(NO_3)_3$? 8) D
a) 9 M b) 3 M c) 18 M (d) 6 M
$3\,NO_3 \times 2 = 6\,M$

9) What is the partial pressure of nitrogen in a balloon containing 0.34 mol N_2 and 0.28 mol CO_2. The total pressure in the balloon is 0.98 atm. 9) D
a) 0.33 atm b) 1.2 atm c) 0.44 atm (d) 0.54 atm
$X_{N_2} = \frac{0.34\,mol}{(0.34+0.28)\,mol} = \frac{0.34\,mol}{0.62\,mol} = 0.548$ $0.548(0.98\,atm) = 0.54\,atm$

10) How many liters of hydrogen gas are needed to produce 10 L of ammonia according in the following reaction: $3\,H_2\,(g) + N_2\,(g) \rightarrow 2\,NH_3\,(g)$ 10) B
a) 6.67 L (b) 15 L c) 20 L d) 30 L
$10\,L\,NH_3\left(\frac{3\,L\,H_2}{2\,L\,NH_3}\right) =$

SHORT ANSWER (10 pts each): Completely answer all of the following questions. Read all questions carefully!!! Show all work. Make sure to include units and report all mathematical answers to the correct number of significant figures. Write final answers in designated locations when indicated.

1) How many liters of nitrogen gas would be produced if 287.6 g TNT (227.132 g/mol) reacted with oxygen at 400. K and 1.00 atm according to the following equation?

$$4\ C_7H_5N_3O_6\ (s) + 21\ O_2\ (g) \rightarrow 28\ CO_2\ (g) + 10\ H_2O\ (g) + 6\ N_2\ (g)$$

↑ not a gas!

Answer: 62.4 L

$$287.6\text{ g TNT}\left(\frac{1\text{ mol}}{227.132\text{ g}}\right) = 1.266\text{ mol TNT}\left(\frac{6\text{ mol N}_2}{4\text{ mol TNT}}\right) = 1.899\text{ mol N}_2$$

$$PV = nRT$$

$$\frac{(1.00\text{ atm})(V)}{1.00\text{ atm}} = \frac{(1.899\text{ mol})\left(0.0821\ \frac{\text{L atm}}{\text{mol K}}\right)(400.\text{ K})}{1.00\text{ atm}}$$

$$V = 62.374\text{ L} \rightarrow 62.4\text{ L}$$

2) What is the concentration (molarity) of an HCl solution if 24.8 mL of 1.50 M $Ba(OH)_2$ is needed to neutralize 39.8 mL of the solution?

$$Ba(OH)_2 + 2\ HCl \rightarrow 2\ H_2O + BaCl_2$$

$$24.8\text{ mL}\left(\frac{1\text{ L}}{1000\text{ mL}}\right) = 0.0248\text{ L}$$

$$39.8\text{ mL}\left(\frac{1\text{ L}}{1000\text{ mL}}\right) = 0.0398\text{ L}$$

Answer: 1.87 M

$$0.0248\text{ L Ba(OH)}_2\left(\frac{1.50\text{ mol}}{\text{L}}\right) = 0.0372\text{ mol Ba(OH)}_2\left(\frac{2\text{ mol HCl}}{1\text{ mol Ba(OH)}_2}\right) =$$

$$= 0.0744\text{ mol HCl}$$

$$\frac{0.0744\text{ mol HCl}}{0.0398\text{ L}} = 1.8693\ \frac{\text{mol}}{\text{L}} \rightarrow 1.87\text{ M}$$

3) a.) What mass of Potassium Permanganate ($KMnO_4$, 158.0339 g/mol) would be needed to make 500.0 mL of a 2.500 M stock solution?

$500.0\ mL \left(\frac{1\ L}{1000\ mL}\right) = 0.5000\ L$

Answer a: 197.5 g

$0.5000\ L \left(\frac{2.500\ mol}{L}\right) = 1.25\ mol \left(\frac{158.0339\ g}{mol}\right) = 197.54\ g$

$\downarrow$

$197.5\ g$

b.) How much of the stock solution in part a would be needed to make 250.0 mL of a 0.550 M solution?

$M_1V_1 = M_2V_2$

$(2.500\ M)(V_1) = (0.550\ M)(250.0\ mL)$

Answer b: 55.0 mL

$V_1 = \frac{(0.550\ M)(250.0\ mL)}{2.500\ M} = 55.0\ mL$

4) a.) Write the products of the following reaction, the total ionic equation, and the net ionic equation.

$\overset{+2\ -1}{SnCl_2}\ (aq) + 2\overset{+1\ -1}{NaOH}\ (aq) \rightarrow Sn(OH)_2\ (s) + 2\ NaCl\ (aq)$

Total Ionic:

$Sn^{2+}(aq) + 2Cl^-(aq) + 2Na^+(aq) + 2OH^-(aq) \rightarrow Sn(OH)_2(s) + 2Na^+(aq) + 2Cl^-(aq)$

Net Ionic:

$Sn^{2+}(aq) + 2OH^-(aq) \rightarrow Sn(OH)_2(s)$

b.) Write the products of the following reaction, the oxidation half reaction, and the reduction half reaction.

$\overset{0}{Fe} + \overset{+2\ -1}{CuBr_2} \rightarrow \overset{+2\ -1}{FeBr_2} + \overset{0}{Cu}$

Oxidation: $Fe \rightarrow Fe^{2+} + 2e^-$

Reduction: $Cu^{2+} + 2e^- \rightarrow Cu$

c.) What is the oxidizing agent in part b?

copper 2+ ion
Cu^{2+}
$CuBr_2$

} any of these answers would be accepted just Cu or copper would not, because copper metal is a product not a reactant

5) If 5.63 mol of gas in a 25.0 L cylinder at 1.56 atm and 25.0 °C is moved to a new 20.0 L cylinder at 20.0 °C, what is the pressure in the new cylinder? Assume no gas is lost in the transfer.

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

Answer : 1.92 atm

$P_1 = 1.56$ atm
$V_1 = 25.0$ L
$n_1 = n/a$
$T_1 = 25.0°C + 273.15 = 298.15$ K

$P_2 = ?$
$V_2 = 20.0$ L
$n_2 = n/a$
$T_2 = 20.0°C + 273.15 = 293.15$ K

$$\frac{(1.56\text{ atm})(25.0\text{ L})}{298.15\text{ K}} = \frac{(P_2)(20.0\text{ L})}{293.15\text{ K}}$$

$$0.130807\ \frac{\text{atm}\cdot\text{L}}{\text{K}} = \frac{(P_2)(20.0\text{ L})}{293.15\text{ K}} \times 293.15\text{ K}$$

$$\frac{38.3416\text{ atm}\cdot\text{L}}{20.0\text{ L}} = \frac{(P_2)(20.0\text{ L})}{20.0\text{ L}}$$

$P_2 = 1.9173$ atm → 1.92 atm

6) A 0.550 mole sample of a sugar is burned in a calorimeter, increasing the temperature of 100.0 g of water from 20.0 °C to 35.5 °C.

a.) What is the heat released during this experiment? Answer : 6490 J or 6.49 kJ

$q = mc\Delta T$ (15.5°C)
$= (100.0\text{ g})(4.184\text{ J/g°C})(35.5°C - 20.0°C)$
$= 6485.2$ J → 6490 J or 6.49 kJ

b.) What would be the enthalpy per mole of sugar burned? Answer : 11.8 kJ/mol

$$\frac{-6.49\text{ kJ}}{0.550\text{ mol}} = 11.79\text{ kJ/mol} \rightarrow 11.8\text{ kJ/mol}$$

7) a.) What is the enthalpy of the following reaction?

$$2\,C_2H_6 + 7\,O_2 \rightarrow 6\,H_2O + 4\,CO_2$$

The standard enthalpies of formation for the compounds involved are:

C_2H_6: ΔH_f° = - 82.8 kJ/mol H_2O: ΔH_f° = - 285.83 kJ/mol

O_2: ΔH_f° = 0.000 kJ/mol CO_2: ΔH_f° = - 393.5 kJ/mol

Answer a: $-3123\ kJ$

$\Delta H = H_{products} - H_{reactants}$

$= [(-285.83\ kJ/mol \times 6) + (-393.5\ kJ/mol \times 4)] - [(-82.8\ kJ/mol \times 2) + (0\ kJ/mol \times 7)]$

$= [-1714.98 + (-1574)] - [-165.6 + 0]$

$= -3288.98\ kJ + 165.6\ kJ = -3123.38\ kJ$

b.) How much heat would be releasd from burning 5.5 mol of ethane?

Answer b: $-8600\ kJ$

$\frac{-3123\ kJ}{2\ mol\ ethane} \times 5.5\ mol\ ethane$

$= -8589\ kJ \rightarrow -8600\ kJ$

8) a.) A reaction producing 2.48 mol CO_2 gas was conducted that increased the volume in a piston controlled chamber from 0.00 to 3.42 L. The reaction was run at 56.8 °C. $+273.15 =$

a.) What was the pressure in the system?

Answer a: $19.6\ atm$

$PV = nRT$

$\frac{(P)(3.42L)}{3.42L} = \frac{(2.48\ mol)(0.0821\ \frac{L\cdot atm}{mol\cdot K})(329.95K)}{3.42L}$

$P = 19.6\ atm$

b.) How much work was done by the CO_2 to move the piston?

Answer b: $-6810\ J$

$w = -P\Delta V$

$= -(19.6\ atm)(3.42L - 0.00L) = -67.18\ L\cdot atm\left(\frac{101.32\ J}{L\cdot atm}\right) = -6806.7\ J$

c.) If the heat required for the reaction was 123.7 J, what was the change in internal energy?

Answer c: $-6680\ J$

$\Delta U = q + w$

$= 123.7\ J + (-6806.7\ J) = -6683\ J$