Chemistry 1100 Practice Exam 1

Show all of your work and reasoning to receive credit. Include units as well. You may not share calculators.

1. A 24.4 L volume of ethane gas is heated from 19° C to 122° C at constant pressure. What is the final volume of the gas?

2. A sample of nitrogen gas kept in a container of volume 0.24 L and at a temperature of 12° C exerts a pressure of 11.2 atm. Calculate the number of moles of gas present.

3. A gas at 450 mm Hg and 14° C occupies a volume of 2.85 L. Calculate its volume at STP.

4. A 2.10 L vessel contains 4.44 g of a gas at 1.00 atm and 27.0 $^{\circ}$ C. Calculate the density of the gas in grams per liter. Then calculate the molar mass of the gas.

5. Consider the formation of nitrogen dioxide from nitric oxide and oxygen:
$2NO\,(g) + O_2\,(g) \rightarrow 2NO_2\,(g)$
If 4.5 L of NO are reacted with excess O_2 at STP, what is the volume in liters of the NO_2 produced?

6. The first step in the industrial recovery of zinc from the zinc sulfide ore is roasting, that is, conversion of ZnS to ZnO by heating:
$2ZnS(s) + 3O_2\,(g) \rightarrow 2ZnO\,(s) + 2SO_2\,(g) \quad \Delta H = -879$ kJ
Calculate the heat released (in kJ) per gram of ZnS roasted.

7. A 4.25 kg piece of gold metal is heated from 15.5 $^{\circ}$ C to 197.0 $^{\circ}$ C. Calculate the heat absorbed (in kJ and kJ/mol) by the metal.

8. A quantity of 2.5000 g of methanol (CH_3OH) was burned in a constant volume bomb calorimeter. Consequently, the temperature of the water rose by 2.40 $^{\circ}$ C. If the heat capacity of the bomb plus water was 10.4 kJ/$^{\circ}$ C, calculate the molar heat of combustion of methanol.

9. Calculate the heat of decomposition for the process below at constant pressure and 25 $^{\circ}$ C: $CaCO_3\,(s) \rightarrow CaO\,(s) + CO_2\,(g)$
Use the standard enthalpy of formation data given at the end of the exam.

10. Calculate the standard enthalpy change for the reaction:

$2Fe\ (s) + Al_2O_3\ (s) \rightarrow 2Al\ (s) + Fe_2O_3\ (s)$

given that:

$Al_2O_3\ (s) \rightarrow 2Al\ (s) + 3/2O_2\ (g)$ $\quad \Delta H = +1670$ kJ

$Fe_2O_3\ (s) \rightarrow 2Fe\ (s) + 3/2O_2\ (g)$ $\quad \Delta H = +822$ kJ

$PV = nRT$ STP = 1 atm and 0° C $T_K = T^\circ_C + 273.15$
760 mm Hg = 1atm 1 torr = 1 mm Hg 1.01 kPa =1 atm
R = 0.082057 Latm/Kmol = 8.31 J/Kmol $N_A = 6.022 \times 10^{23}$/mol
$MM = dRT/P$ $u_{rms} = \sqrt{3RT/MM}$ $r_1/r_2 = \sqrt{MM_2}/\sqrt{MM_1}$
$(P + an^2/V^2)(V-nb) = nRT$ $P_T = P_A + P_B + P_C + \ldots$
$\Delta E = q + w$ $w = -P \Delta V$ 1 Latm = 101.3 J $\Delta H = \Delta E + P \Delta V$
$\Delta E = \Delta H - RT \Delta n$ $C = ms$ $q = ms \Delta T = C \Delta T$
$\Delta H_{rxn} = \Sigma n \Delta H_f(\text{products}) - \Sigma n \Delta H_f(\text{reactants})$

substance	**specific heat (J/g$^\circ$ C)**
aluminum	0.900
gold	0.129
graphite	0.720
diamond	0.502
copper	0.385
iron	0.444
water (liquid)	4.184
ethanol	2.46

substance	ΔH_f (kJ/mol)
H_2O (l)	-286
H_2O (g)	-241.8
CaO (s)	-635.6
$CaCO_3$ (s)	-1206.9
CO_2 (g)	-393.5
HCl (g)	-92.3