CHEM 11 Exam 2 Fall 2007 Section D01BG Lloyd

You have 120 minutes to complete this exam. Answer all questions. To receive credit you must show your reasoning and all calculations in the bluebook. Report numerical answers with the correct number of significant figures and with correct units. No speaking is allowed during the exam. You must use the calculator you have. Once you complete the exam you may leave the room. Each question is valued at 5 points for a total of 100 points.

1. Convert 623 mm Hg to atmospheres and kilopacscals.

2. Calculate the volume (in liters) occupied by 0.512 moles of nitrous oxide gas (N_2O) at 6.54 atm and 112 °C.

3. A sample of fluorine gas occupies a volume of 623 mL at a pressure of 623 mm Hg. Calculate the pressure of the gas (in mmHg) if the volume is increased at constant temperature to 905 mL.

4. A gas initially at 2.44 L, 1.00 atm, and 34 °C undergoes a change so that its final volume and temperature are 1.44 L and 23 °C. What is its final pressure? Assume the number of moles is unchanged.

5. What is the density of uranium hexafluoride (UF_6) at 2110 mm Hg and 97 °C?

6. The density of a gaseous organic compound is 2.55 g/L at 60 °C and 2.11 atm. What is its molar mass?

7. The equation for the breakdown of glucose ($C_6H_{12}O_6$) is:

$$C_6H_{12}O_6\ (s) + 6O_2\ (g) \rightarrow 6CO_2\ (g) + 6H_2O\ (l)$$

Calculate the volume of CO_2 produced at 37 °C and 1.00 atm when 2.15 g of glucose is used in the reaction.

8. A sample of natural gas contains 8.2 moles of methane (CH_4), 0.42 moles of ethane (C_2H_6), and 0.116 moles of propane (C_3H_8). If the total pressure of the gases is 2.15 atm, what are the partial pressures of the gases?

9. It takes 222 s for an unknown gas to effuse through a porous hole and 84 s for the same volume of O_2 gas to effuse at the same temperature and pressure. What is the molar mass of the unknown gas?

10. Calculate the heat evolved when 166 g of white phosphorus (P_4) burns in air according to the equation:

$$P_4\ (s) + 5O_2\ (g) \rightarrow P_4O_{10}\ (s) \quad \Delta H = -3010\ \text{kJ/mol}$$

11. A gold bar of mass 869 g cools from 92 °C to 5 °C. Calculate the heat released (in kilojoules) by the metal.

12. Hydrazine, (N_2H_4), decomposes according to the equation

$$3N_2H_4\,(l) \rightarrow 4NH_3\,(g) + N_2\,(g)$$

The standard heat of formation of hydrazine is 50.4 kJ/mol. What is the heat of reaction for the decomposition of hydrazine?

13. Calculate the standard enthalpy change for the reaction

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

Given that

$$2Al\,(s) + 3/2O_2\,(g) \rightarrow Al_2O_3\,(s) \qquad \Delta H° = -1670 \text{ kJ/mol}$$
$$2Fe\,(s) + 3/2\,O_2\,(g) \rightarrow Fe_2O_3\,(s) \qquad \Delta H° = -822 \text{ kJ/mol}$$

14. Calculate the frequency of a photon of light with a wavelength of 4.5×10^{-11} m.

15. The energy of a photon is 5.87×10^{-19} J. What is its wavelength (in meters)?

16. What is the wavelength (in meters) of a photon emitted during a transition from $n_i = 6$ to $n_f = 2$ in a hydrogen atom?

17. What is the total number of orbitals associated with the principal quantum number n = 3?

18. Write the 4 quantum numbers for an electron in a 3d orbital.

19. Calculate the total number of electrons that can be present in the principal level for which n = 2.

20. Write the ground-state electron configuration for arsenic (As).

Constants and Equations

$N_A = 6.022 \times 10^{23}/\text{mol}$ $\quad R = 0.08206 \frac{\text{L atm}}{\text{mol K}} = 8.31 \frac{\text{J}}{\text{mol K}}$

$T_K = T_{°C} + 273.15$

$m_e = 9.11 \times 10^{-31}$ kg $\quad m_p = 1.67 \times 10^{-27}$ kg $\quad q = 1.602 \times 10^{-19}$ coulombs

$\Delta E = q + w$ $\quad \Delta H = q$ $\quad q = -ms\Delta T$ $\quad C = ms$

$\Delta H^\circ_{rxn} = \sum n_p \Delta H^\circ_p - \sum n_r \Delta H^\circ_r$ $\quad T_K = T_C + 273$ $\quad V_M = 22.41$ L/mol at STP

$h = 6.626 \times 10^{-34}$ Js $\quad c = 3.00 \times 10^8$ m/s

$E = h\nu = hc/\lambda$ $\quad E = \frac{-b}{n^2}$ $\quad \Delta E = R_H \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right)$ $\quad R_H = 2.178 \times 10^{-18}$ J

1 atm = 760 torr = 760 mm Hg = 1.01×10^5 N/m^2 = 101 kPa

$PV = nRT$ $\quad P_T = P_a + P_b + P_c + \ldots P_n$

$\frac{\text{rate } 2}{\text{rate } 1} = \frac{\sqrt{M_1}}{\sqrt{M_2}}$ $\quad d = MM\frac{P}{RT}$

Metric Prefixes

atto (a) = 10^{-18}	femto (f) = 10^{-15}	pico (p) = 10^{-12}	nano (n)= 10^{-9}
micro (μ)= 10^{-6}	milli (m) = 10^{-3}	centi (c)= 10^{-2}	kilo (k) = 10^3
mega (M) = 10^6	giga (G) = 10^9	tera (T) = 10^{12}	peta (P) = 10^{15}

specific heat capacities

substance	**s** $\frac{\text{J}}{\text{g°C}}$
graphite	0.711
copper	0.387
ethyl alcohol	2.45
gold	0.129
granite	0.803
iron	0.445
lead	0.128
water (l)	4.18

Heats of formation (kJ/mol)

CO(g)	–110	CO_2(g)	–394
CH_4(g)	–74.9	C_2H_2 (g)	+227
C_2H_4(g)	+51.9	C_2H_6(g)	–84.5
C_3H_8(g)	–104	C_4H_{10}(g)	–126
H_2O(g)	–241.8	H_2O(l)	–285.9
H_2O_2(l)	–187.8	NH_3 (g)	–46.3