CHEM 3530 - Exam 1 – February 9, 2018

Constants and Conversion Factors

$N_A = 6.02 \times 10^{23}$ mol^{-1}

R = 8.31 J/mol-K = 8.31 kPa-L/mol-K

1 bar = 100 kPa

1 kPa = 7.50 torr

1 J = 1 kPa-L

Molar Masses

$C_{10}H_{22}$ - 142.	CH_4 - 16.	He - 4.
CO_2 - 44.	H_2 - 2.0	F_2 - 38.
C_2H_6 - 30.	C_7H_8 - 92.	C_2H_2 - 26.

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Name_____

(88) **PART I. MULTIPLE CHOICE (Circle the ONE correct answer)**

1. A sample of decane, $C_{10}H_{22}$, contains 5.0×10^{24} atoms of Hydrogen. What is the mass of the sample?

   (A) 28.4 g (B) 53.6 g (C) 1180 g (D) 2.6×10^4 g

2. The volume of a sample of $N_2(g)$ at 600 torr and 200 ^oC is 400 mL. What is the volume of the N_2 at 350 torr and 100 ^oC?

   (A) 184 torr (B) 340 torr (C) 540 torr (D) 870 torr

3. At sea level, where the pressure is 100 kPa and the temperature is 20 ^oC, a sample of gas in a balloon occupies a volume of 350 cm^3. The balloon is raised to an altitude where the pressure is 35 kPa, and it's volume expands to 600 cm^3. What is the temperature (in ^oC) of the gas in the balloon?

   (A) -97 ^oC (B) +176 ^oC (C) -63 ^oC (D) +12 ^oC

4. A 20. L container contains 1.2×10^{24} molecules of CO_2 at a temperature of 150^o C. What is the pressure of the gas, **in bar**.

   (A) 1.2 bar (B) 350 bar (C) 28.4 bar (D) 3.5 bar

5. What is the approximate density, **in g/L**, of a sample of $CH_4(g)$ at 100 ^oC and 8. bar pressure?

   (A) 0.15 g/L (B) 4.1 g/L (C) 0.041 g/L (D) 15.4 g/L

6. A container has a gaseous mixture of 8.0 grams of He(g) and 96. grams of $CH_4(g)$. The partial pressure of He(g) in the mixture is 0.3 bar. What is the total pressure of both gases?

   (A) 3.9 bar (B) 2.4 bar (C) 1.2 bar (D) 0.9 bar

7. The RMS average speed of $C_2H_6(g)$ molecules at 800 ^oC is 940 m/s. What is the RMS average speed of $C_2H_6(g)$ molecules at 200 ^oC ?

   (A) 620 m/s (B) 410 m/s (C) 940 m/s (D) 1420 m/s

8. Consider the three gases (all at 1 bar pressure): CO_2 at 80 ^oC, He at 80 ^oC, CH_4 at 20 ^oC. Of these three gases, _____ has the **highest** rms average speed and _____ has the **lowest** molar kinetic energy.

   (A) CO_2 , CH_4 (B) CH_4 , He (C) He , CO_2 (D) He , CH_4

9. One mole of $H_2(g)$ effuses through a pinhole in 300 s. How long will it take for one mole of $F_2(g)$ to effuse through the pinhole under the same conditions?

   (A) 16 s (B) 70 s (C) 5700 s (D) 1310 s

10. The rate of effusion of $CO_2(g)$ through a pinhole in 8.0 mol/hr. Under the same conditions, the rate of effusion of an unknown gas through the pinhole is 6.5 mol/hr. The Molar Mass of the unknown gas is approximately:

    (A) 36 g/mol (B) 67 g/mol (C) 29 g/mol (D) 54 g/mol

11. The van der Waals equation for a non-ideal gas is given by:.

$$\left[P + a\left(\frac{n}{V}\right)^2\right][V - nb] = nRT]$$

    The pressure of a gas obeying the van der Waals equation is _____ than that of a Perfect Gas because of _____ forces between molecules.

    (A) higher,attractive (B) higher,repulsive

    (C) lower,attractive (D) lower,repulsive

12. The **constant volume** Molar heat capacity of ethane, $C_2H_6(g)$ is 44.3 J/mol-K. When 9.0 kJ of heat is removed at **constant volume** from 90 grams of ethane, the final temperature is 53 ^oC. What was the approximate initial temperature of the C_2H_6 before the heat is removed

    (A) +120 ^oC (B) +15 ^oC (C) -+68 ^oC (D) -68 ^oC

13. The **constant pressure** molar heat capacity of Ar(g) is 20.8 J/mol-K. What is the heat involved, **in kJ**, when 2.5 moles of Ar(g) is cooled from 200 ^oC to 50 ^oC **at constant volume**?.

    (A) -10.9 kJ (B) -4.7 kJ (C) -7.8 kJ (D) +10.9 kJ

14. For a process in which the internal energy change of a gas is **0 (zero),** which of the following processes is/are possible?

    (i) the gas is expanded and heated
    (ii) the gas is expanded and cooled
    (iii) the gas is compressed and cooled

    (A) i only (B) ii only (C) i and ii (D) i and iii

15. The deposition of gold vapor [Au(g)] onto the surface of a silicon wafer is

    (A) Endothermic and w > 0 (B) Endothermic and w < 0

    (C) Exothermic and w > 0 (D) Exothermic and w < 0

16. When a gas is compressed reversibly and adiabatically,

(A) q>0 & w>0 (B) q=0 & w>0 (C) q=0 & w<0 (D) q<0 & w>0

17. What are q and ΔH when 2 moles of a gas is expanded reversibly and isothermally from 5 L to 40 L at 25 ^{o}C?

(A) q= -10.3 kJ, ΔH= 0 (B) q= +10.3 kJ, ΔH=0
(C) q=0, ΔH= 0 (D) q=0, ΔH=+10.3 kJ

18, When a gas is cooled at constant volume,

(A) ΔU<0 & w<0 (B) ΔU<0 & w>0 (C) ΔU>0 & w=0 (D) ΔU<0 & w=0

19. For the combustion reaction, C_4H_8(gas) + 6 O_2(gas) $\rightarrow$ 4 CO_2(gas) + 4 H_2O(liq), at 25 ^{o}C, the enthalpy change is ΔH = -2630 kJ. What is ΔU for this reaction?

(A) -2622.6 kJ (B) -2637.4 kJ (C) -2627.6 kj (D) -2632.5 KJ

For #20-#22: The normal boiling point of toluene, C_7H_8 is 111 ^{o}C The enthalpy of vaporization of toluene, C_7H_8, is 32.6 kJ/mol.

20. What is the heat involved when 184 grams of toluene are vaporized to the gas phase at 1 bar pressure and 111 ^{c}C?

(A) +65.2 kJ (B) +71.6 kJ (C) +58.8 kJ

(D) Cannot be determined without the constant pressure molar heat capacity.

21. What is the work involved when 184 grams of toluene are vaporized to the gas phase at 1 bar pressure and 111 ^{o}C?

(A) -3.8 kJ (B) -6.4 kJ (C) +3.8 kJ (D) +6.4 kJ

22. What is ΔU when 184 grams of toluene are vaporized to the gas phase at 1 bar pressure and 111 ^{o}C?

(A) +65.2 kJ (B) +71.6 kJ (C) +58.8 kJ

(D) Cannot be determined without the constant volume molar heat capacity.

PART II. ONE (1) PROBLEM FOLLOWS
You MUST show your work for credit.

(12) 1. The **constant pressure** molar heat capacity of acetylene, $C_2H_2(g)$, is 43.9 J/mol-K. A sample of 65 g of $C_2H_2(g)$, is initially at a volume of 40 L and pressure of 2.0 bar.

Calculate q, w, ΔU and ΔH (**all in kJ**) when the gas is heated reversibly at **constant pressure** until the volume has increased to 90 L.