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*chemistry 1*

*second exams*

عندما تطمح في شيء وتسعى جادا في الحصول  
عليه.. فإن العالم بأسره يكون في صفك  
باولو كويلو

13

General Chem. 101

Time: 60 min.

Second Exam

Date: 19/12/2009

Student's Name: .....

Reg. No: .....

Section No. ٤٠٣ ..... يوم الأحد ..... د. مالك القادري

Seat No. 51.....

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Physical constants and useful relations:

1 atm = 101.3 kPa = 1.013 x 10<sup>5</sup> Pa = 760. Torr; Planck's constant = 6.63x10<sup>-34</sup> J.s,

Speed of light = 3.00 x10<sup>8</sup> m/s; E<sub>n</sub> = - (2.18 x10<sup>-18</sup>/n<sup>2</sup>) J; E = hc/λ

R = 0.08206 L. atm/mol. K = 8.314 J / mol.K ; 1L. atm = 101.3 J; λ = h/mu

Av. No. = 6.022 x 10<sup>23</sup> mol<sup>-1</sup>, PV = n RT, [ P + a (n/V)<sup>2</sup> ] ( V - n b ) = nRT

u<sub>rms</sub> = (3RT/M)<sup>1/2</sup>; ΔE = q + w, ΔH = ΔE + P x ΔV, w = - P x ΔV

#####@@

ANSWER SHEET

- |                                    |                                     |
|------------------------------------|-------------------------------------|
| 1. a b c <del>d</del> e            | 9. a b c d <del>e</del>             |
| 2. a b <del>c</del> d e            | 10. a b <del>c</del> d e            |
| 3. a <del>b</del> c d e            | 11. a b c d <del>e</del>            |
| 4. <del>a</del> b c d e            | 12. a b c d <del>e</del>            |
| 5. a b <del>c</del> d e            | 13. a <del>b</del> <del>c</del> d e |
| 6. a b <del>c</del> d e            | 14. <del>a</del> b c d e            |
| 7. a <del>b</del> c <del>d</del> e | 15. a <del>b</del> c <del>d</del> e |
| 8. a b c <del>d</del> e            | 16. a b <del>c</del> d e            |



1. Which of the following statements concerning gases is *correct*?

- a) All gases behave ideally at high P and/or low T.
- b) No gases behave ideally at low P and/or high T.
- c) No gases behave ideally at high P and/or high T.
- d) All gases behave ideally at low P and/or high T
- e) Both *van der Waals* constants (a & b) are *the same* for all gases.

real  
T → low  
P → high

Ideal  
T → high  
P → low

2. Which of the following statements concerning *ideal* gases is *incorrect* (*not correct*)?

- a) At constant n and T,  $P_1 V_1 = P_2 V_2$ .
- b) The average molecular speed is higher for H<sub>2</sub> gas than for N<sub>2</sub> gas at same T.
- c) The average kinetic energy is higher for H<sub>2</sub> gas than for N<sub>2</sub> gas at same T.
- d) At constant n,  $P_1 V_1 / T_1 = P_2 V_2 / T_2$ .
- e) At constant n and V,  $P_1 / T_1 = P_2 / T_2$ .

3. According to Kinetic Molecular Theory of gases, the root-mean square speed ( $u_{rms}$ ) of N<sub>2</sub> gas (M = 28.0 g/mol) at 25°C is equal to

- a) 411 m/s
- b) 515 m/s
- c) 610. m/s
- d) 682 m/s
- e) 742 m/s

$$u_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3 \cdot 298 \cdot 8.314}{28 \cdot 10^{-3}}}$$

4. Given that the density for an ideal gas (d = 1.801 g/L) at 1.00 atm and 25°C, the molar mass (M in g/mol) of the gas is equal to

- a) 44.0 g/mol
- b) 30.0 g/mol
- c) 610. g/mol
- d) 58.0 g/mol
- e) 72.0 g/mol

$$M = \frac{dRT}{P}$$

$$M = \frac{1.801 \cdot 0.0821 \cdot 298}{1}$$

$$M = \frac{dRT}{P}$$

5. The nitrogen (N<sub>2</sub>) gas obtained from the decomposition of sodium azide (NaN<sub>3</sub>) according to the chemical reaction:  $2 \text{NaN}_3(\text{s}) \rightarrow 2 \text{Na}(\text{s}) + 3 \text{N}_2(\text{g})$  was collected over liquid water at a *total pressure* of 724 torr and 25°C where the vapor pressure of water was 24.0 torr. If the volume of the N<sub>2</sub> gas was 10.0 L, then the mass of N<sub>2</sub> gas is equal to.... (Molar mass of N<sub>2</sub> = 28.0 g/mole)

0.95 atm

- a) 5.27 g
- b) 15.8. g
- c) 10.5 g
- d) 21.1 g
- e) 38.7 g

$$m = \frac{P \cdot V \cdot M}{R \cdot T} = \frac{0.95 \cdot 10 \cdot 28}{0.0821 \cdot 298}$$

$$P = \frac{nRT}{V}$$

$$\frac{m}{M}$$

$$0.952 - 0.03$$

10.5

$$P = \frac{nRT}{V} \rightarrow \frac{298 \times 0.082 \times 7.7}{25}$$

6. Given that 4.00 g of CH<sub>4</sub> gas (M = 16.0 g/mol) and 22.0 g of C<sub>3</sub>H<sub>8</sub> gas (M = 44.0 g/mol) were placed in a 25.0 L container at 25°C, then the total pressure (P in kPa) of the gas mixture would be equal to

$$P = \frac{nRT}{V} = \frac{1.75 \times 0.082 \times 298}{25} = 1.7 \text{ atm}$$

1.7 atm  $\times \frac{101.3 \text{ kPa}}{1 \text{ atm}}$

- a) 92.9 kPa      b) 61.9 kPa      **c) 74.3 kPa**      d) 53.1 kPa      e) 40.8 kPa

7- The combustion (oxidation) of propane (M = 44.0 g/mole) is described by the balanced equation  
 $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l) \quad \Delta H = -2220 \text{ kJ}$   
 Calculate the mass of propane (in gram) must be burned to produce 175.5 kJ of heat.

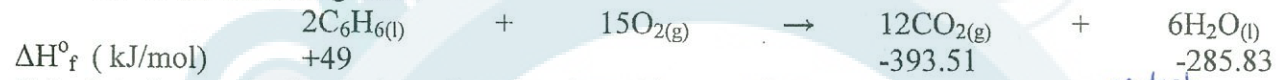
- a- 6.96      ~~b- 13.9~~      c- 20.9      d- 3.48      e- 4.40

$$\frac{2220}{n} = 175.5$$

$$n = \frac{2220}{175.5} = 12.6$$

$$12.6 \times 44 = 554.4 \text{ g}$$

8- Given the following data:



Calculate the standard enthalpy of combustion of benzene in (kJ/mole benzene)

- a) -3135.5      b) 6535.2      c) -6270.9      **d) -3267.6**      ~~e) -6535.2~~

product - reactant

$$(12 \times -393.51 + 6 \times -285.83) - (2 \times 49)$$

$$-4722.12 - 98 = -4820.12$$

product - reactant

$$6 \times -285.83 + 12 \times -393.51 - 2 \times 49$$

$$-1714.98 - 4722.12 - 98 = -6535.2$$

9- A gas is allowed to expand, at constant temperature, from a volume of 1.0 L to 10.1 L against an external pressure of 0.50 atm. If the gas absorbs 250 J of heat from the surroundings, what is the value of q, w, and ΔE?

	q	w	ΔE
a)	250 J	-4.55 J	245 J
b)	-250 J	-460 J	-710 J
c)	250 J	460 J	710 J
d)	-250 J	460 J	210 J
<b>e)</b>	<b>250 J</b>	<b>-460 J</b>	<b>-210 J</b>

$w = -P\Delta V$

$$w = -0.5 \times (10.1 - 1.0) \text{ atm} \times 101.3$$

$$w = -460.9 \text{ J}$$

q = +250 J

$$\Delta E = q + w = 250 - 460.9 = -210.9 \text{ J}$$

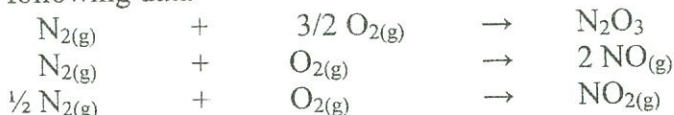
10- A 100.0 ml of 0.200 M aqueous hydrochloric acid, is added to 100.0 ml of 0.200 M aqueous ammonia (NH<sub>3</sub>) in a constant pressure calorimeter of negligible heat capacity. The initial temperature of both solutions is the same at 25.00 °C. The final temperature after mixing is 26.20 °C. Assuming the density of the solution = 1.00 g/ml and its specific heat = 4.18 J/g.°C, calculate ΔH per mole of the reaction:



$$q = m s \Delta T$$

$$q = 200 \times 4.18 \times (1.20)$$

11- given the following data



$\Delta H(\text{kJ})$
83.7
180.4
33.2

Find  $\Delta H(\text{kJ})$  for the reaction



- a) -19.7      b) -59.7      c) 49.7      d) -29.7      e) -39.7

$\frac{-33.2}{2} = -16.6$   
 $\frac{-180.4}{2} = -90.2$   
 $83.7$

12 What is the wavelength ( $\lambda$  in nm) of a photon whose energy is  $1.2 \times 10^{-14} \text{ J}$

$$\lambda = \frac{hc}{E}$$

- a)  $1.7 \times 10^{-12}$       b) 17      c)  $1.7 \times 10^{-1}$       d)  $1.7 \times 10^{-3}$       e)  $1.7 \times 10^{-2}$

$$E = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E}$$

$\frac{6.63 \times 10^{-34} \times 3 \times 10^8}{1.2 \times 10^{-14}} = 16.575 \times 10^{-2} = 1.6575 \times 10^{-1} \text{ m} = 165.75 \text{ nm}$

$\frac{-34+8}{-14} = \frac{-26}{-14} = 1.857$

13 An electron transition of hydrogen atoms is accompanied with emission of light at 2165 nm. If the value of  $n_f$  for lower level involved in this emission is 4, what is the value of  $n_i$  for the higher level from which the electron falls back?

- a) 5      b) 7      c) 3      d) 6

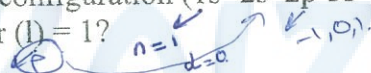
$$\frac{6.63 \times 10^{-34} \times 3 \times 10^8}{2165 \times 10^{-9}}$$

$9, 18^{-20} = 2.18 \times 10^{-18} \left( \frac{1}{n_i^2} - \frac{1}{16} \right)$

$E = \frac{hc}{\lambda} = 9.18 \times 10^{-19} \text{ J}$

14 For the electron configuration  $(1s^2 2s^2 2p^4 3s^1)$ , how many electrons have the angular momentum quantum number ( $l = 1$ )?

- a) 4      b) 1      c) 3      d) 2      e) 5



15 Calculate the wavelength ( $\lambda$  in meters) associated with an atom moving at a velocity of  $1.0 \times 10^5 \text{ m/s}$ , given that the molar mass is  $19.992 \text{ g/mol}$ .  $\times$  avogadro num

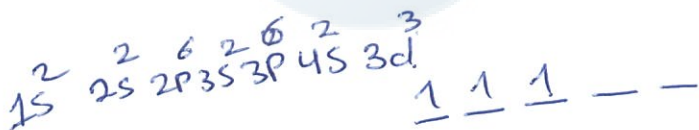
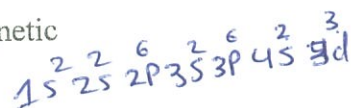
- a)  $1.0 \times 10^{-12}$       b)  $2.0 \times 10^{-13}$       c)  $1.0 \times 10^{-14}$       d)  $9.7 \times 10^{-13}$       e)  $2.0 \times 10^{-14}$

$$\lambda = \frac{h}{m \cdot v} = \frac{6.63 \times 10^{-34}}{1.0 \times 10^5 \times 19.992 \times 10^{-3}}$$

$$\lambda = \frac{h}{m \cdot v} = \frac{6.63 \times 10^{-34}}{1 \times 10^5 \times 19.992}$$

16- An atom with 23 electrons in its ground state will have..... unpaired electrons and is .....

- a) 0, diamagnetic      b) 2, diamagnetic      c) 3, paramagnetic  
 d) 5, paramagnetic      e) 7, paramagnetic



11/16

The University of Jordan  
Date: 12/12/2010

General Chemistry 101  
Second Exam

Chemistry Department  
Time: 60 min.

Name: \_\_\_\_\_ Registration Number \_\_\_\_\_

Instructor \_\_\_\_\_ Seat No. \_\_\_\_\_ Day/Time \_\_\_\_\_

Answer Sheet

$K = ^\circ\text{C} + 273$ ,  $1 \text{ atm} = 760 \text{ mmHg}$ ,  $R = 0.082057 \text{ L}\cdot\text{atm}/(\text{K}\cdot\text{mol}) = 8.314 \text{ J}/(\text{K}\cdot\text{mol})$ ,  $L\cdot\text{atm} = 101.3 \text{ J}$ ,  $N_A = 6.022 \times 10^{23}$ ,  $h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}$ ,  $R_H = 2.18 \times 10^{-18} \text{ J}$ ,

$c = 3 \times 10^8 \text{ m/s}$ ,  $PV = nRT$ ,  $u_{\text{rms}} = \sqrt{u^2} = \sqrt{\frac{3RT}{M}}$ ,  $KE = \frac{3}{2}RT = N_A(\frac{1}{2}mu^2)$ ,  $\Delta E = \Delta H - P\Delta V$

$\Delta E = q + w$ ,  $c = \lambda\nu$ ,  $E = h\nu$ ,  $E_n = -R_H(1/n^2)$ ,  $\lambda = h/(mu)$ ,

1. a b  c d e      9. a  b c ~~d~~ e

2. a  b c d e      10. a  b c d e

3. a b c  d e      11. a b  c d e

4. a b c d  e      12. a  b c d e

5. a ~~b~~ c  d e      13. a b  c ~~d~~ e

6.  a b c d e      14. ~~a~~ b  c d e

7. a b c  d ~~e~~      15. a b  c d e

8. a b  c d e      16. a b  c d e

$$P = \frac{nRT}{V}$$

$$n = \frac{m}{MM}$$

$$n = 0.018$$

$$n = \frac{PV}{RT} = \frac{1 \times 0.401}{0.082057 \times 273.15}$$

1] Determine the molar mass of a gas if 0.401 L weighs 1.55g at STP?

- a) 69.3 g/mol    b) 94.5 g/mol    **c) 86.6 g/mol**    d) 53.3 g/mol    e) 43.3 g/mol

$$P_t = P_{H_2} + P_{H_2O} \rightarrow P_{H_2} = 988 - 118 = 870 \text{ mm Hg}$$

2] In a reaction of calcium metal with water, the volume of hydrogen gas collected at 50°C and pressure of 988 mmHg is 441 mL. What is the mass (in grams) of the hydrogen gas obtained? The vapor pressure of water at 50°C is 118 mmHg. (Molar mass of H<sub>2</sub> = 2.016 g/mol)

- a) 0.0436g    **b) 0.0384g**    c) 0.0190g    d) 0.0242g    e) 0.0488g

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

3] Calculate the mass of calcium (in g) that must be dissolved in sulfuric acid in order to obtain 500ml of hydrogen gas at 20°C and 770 mmHg? (Molar mass of Ca = 40.08 g/mol)

- ~~$P_{H_2} = P_t - P_{H_2O}$~~  a) 1.38 g    **b) 0.0425 g**    c) 1.24 g    **d) 0.84 g**    e) 1.18 g

$$n = \frac{PV}{RT} = \frac{770 \times 0.500}{0.082057 \times (20 + 273)}$$

4] What is the kinetic energy of a mole of CO<sub>2</sub> at 200K (in kJ)?

- a) 200 kJ    b) 4.14x10<sup>-24</sup> kJ    c) 2.5x10<sup>-2</sup> kJ    d) 0.200 kJ    **e) 2.49 kJ**

~~$\frac{3RT}{2} = \frac{3 \times 8.314 \times 200}{2} = 2494.2 \text{ J} = 2.4942 \text{ kJ}$~~

~~$\frac{3RT}{2} = \frac{3 \times 8.314 \times 200}{2} = 2494.2 \text{ J} = 2.4942 \text{ kJ}$~~

$KE = \frac{1}{2} m v^2$

$\frac{3}{2} R T \text{ K}$   
K. mol.  
L. atm

5] Which of the following is a wrong statement?

- a) H<sub>2</sub> gas behaves more ideally than CO<sub>2</sub> gas  
 b) CO<sub>2</sub> (44 g/mol) effuses faster than N<sub>2</sub>(g) (28 g/mol) at STP  
 c) At the same temperature molecules of a gas with low molar mass have higher average velocity than heavier molecules  
**d) Average kinetic energy depends only on temperature.**  
 e) Real gases behaves as ideal gases at low pressure and high temperature

$$P_1 V_1 = P_2 V_2$$

$$u_{rms} = \sqrt{\frac{3RT}{MM}} = \sqrt{\quad}$$

6] Calculate the root mean square velocity ( $u_{rms}$ ) in (m/s) of  $CO_2$  molecules in a sample of  $CO_2$  gas at  $1.0^\circ C$  [molar mass of  $CO_2 = 44.0 \text{ g/mol}$ ]

- a) 394      b) 44.0      c) 1.24      d) 39.2      e) 12.5

7] A gas is allowed to expand, at constant temperature, from a volume of 3.0 L to 8.0 L against external pressure of 1.10 atm. If the gas absorbs 350 J of heat from the surroundings, then  $\Delta E$  in J:

- a) -345      b) +207      c) -907      d) +345      e) -207

$$\Delta E = \Delta H - P\Delta V$$

$$\Delta E = q + w$$

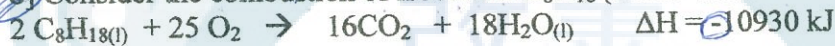
$$w = -P\Delta V$$

$$w = -1.10 \times (8 - 3)$$

$$\Delta V > 0$$

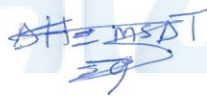
$$w = -$$

8] Consider the combustion of isooctane  $C_8H_{18}$  (Molar mass = 114 g/mol):



Calculate the energy released when 105 g of isooctane are combusted in excess oxygen?

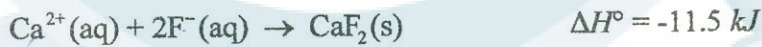
- a)  $2.19 \times 10^4 \text{ kJ}$     b)  $1.01 \times 10^4 \text{ kJ}$     c)  $5.03 \times 10^3 \text{ kJ}$     d)  $2.52 \times 10^3 \text{ kJ}$     e)  $2.01 \times 10^4 \text{ kJ}$



$$\Delta E = q + w$$

$$\Delta H = H_f$$

9] When 500.0 mL of 0.400 M  $Ca(NO_3)_2$  is added to 500.0 mL of 0.800 M NaF,  $CaF_2$  precipitates, as shown in the net ionic equation below. The initial temperature of both solutions is  $20.00^\circ C$ . Assuming that the resulting solution has a mass of 1000.00 g and a specific heat of  $4.18 \text{ J/(g}\cdot^\circ C)$  calculate the final temperature of the solution.



- a)  $18.90^\circ C$       b)  $20.00^\circ C$       c)  $19.45^\circ C$       d)  $20.55^\circ C$       e)  $21.10^\circ C$

$Ca(NO_3)_2$   
500 mL  
0.400 M  
 $20^\circ C$

+ NaF  
500 mL  
0.8 M

$m_{sol} = 1000 \text{ g}$   
 $S = 4.18$

$$q = m s \Delta T$$

$$2.395 \times 10^{-3} = \Delta T$$

$$TF = 20$$

$$11.5 = 1000 \times 4.18 \times (TF - 20)$$



10] When 3.50 g of sucrose undergoes combustion in a constant-volume calorimeter, the temperature rises from 25.00 °C to 29.00 °C. Calculate  $\Delta H$  for the combustion of sucrose in (kJ/mol) sucrose. The heat capacity of the calorimeter is 3.7 kJ/°C. The molar mass of sucrose is 342.3 g/mol.

Bomb

$\Delta H = -$

- $C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(l)$
- a)  $-5.07 \times 10^3$     b)  $-1.45 \times 10^3$     c)  $+1.45 \times 10^3$     d)  $-1.48 \times 10^1$     e)  $+1.48 \times 10^1$

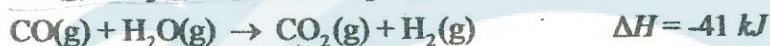
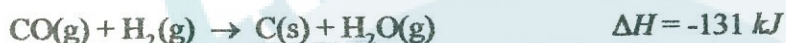
$$q = C \Delta T$$

$$= 3.7 \times (29 - 25)$$

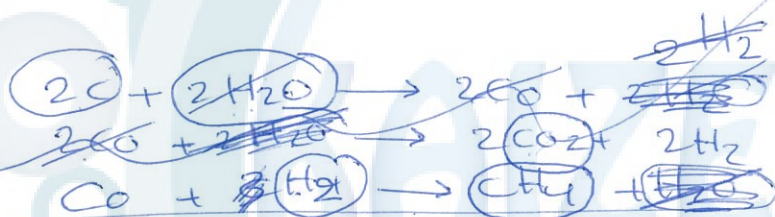
$$= 14.8 \text{ kJ}$$

11] For the following reaction:  $2C(s) + 2H_2O(g) \rightarrow CH_4(g) + CO_2(g)$   $\Delta H = ?$

Use the following information to find  $\Delta H$  for the reaction above.



- a) -378 kJ    b) 116 kJ    c) 15 kJ    d) -116 kJ    e) -372 kJ



$$\Delta H = 2(131)$$

$$\Delta H = 2(-41)$$

$$\Delta H = -206$$

12] Using the information below, calculate  $\Delta H_f^\circ$  for PbO(s) in kJ/mol.

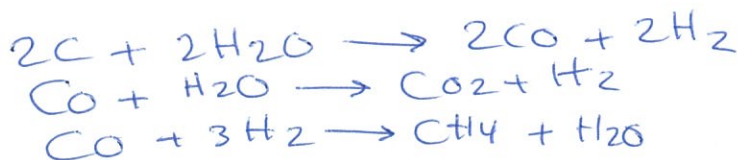
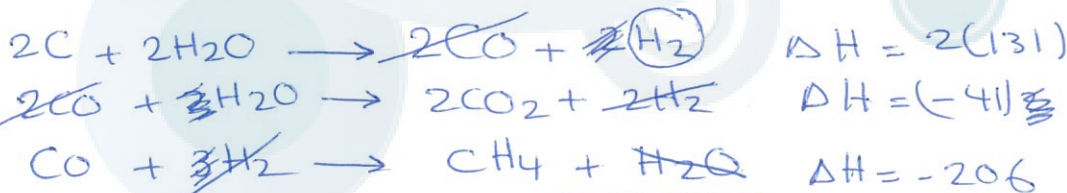


Molecules	$\Delta H_f^\circ$ (kJ/mol)
CO(g)	-110.5
CO <sub>2</sub> (g)	-393.5

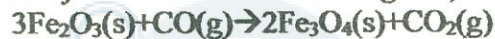
$$\Delta H_{rxn}^\circ = 1 \times \Delta H_f^\circ(CO_2) - \Delta H_f^\circ(CO) - \Delta H_f^\circ(PbO)$$

$$-131.4 = -393.5 + 110.5 - \Delta H_f^\circ(PbO)$$

- a) -413.9 kJ    b) -151.6 kJ    c) +372.1 kJ    d) +413.9 kJ    e) -372.1 kJ



13] Use the given standard enthalpies of formation to calculate the heat released per gram Fe<sub>2</sub>O<sub>3</sub>(s). (molar mass of O=16.00 and Fe=55.85g/mol)



Molecules	$\Delta H_f^\circ$ (kJ/mol)
Fe <sub>2</sub> O <sub>3</sub> (s)	-824.2
Fe <sub>3</sub> O <sub>4</sub> (s)	-1118.4
CO(g)	-110.5
CO <sub>2</sub> (g)	-393.5

- a) -98.5 kJ/g    b) 98.5 kJ/mol    **c) -101.9 J/g**    d) -98.5 J/g    e) +101.9 J/g

14] Calculate the energy (in joules) of 1 mole of photons with a wavelength of  $10.00 \times 10^{-2}$  nm (X ray region).

- a)  $1.20 \times 10^9$  J    b)  $1.99 \times 10^{-24}$  J    **c)  $1.99 \times 10^{-15}$  J**    d)  $3.30 \times 10^{-39}$  J    e) 1.20 J

$$\Delta E = h \nu = h \frac{c}{\lambda}$$

$$c = \nu \lambda$$

15] Calculate the wavelength ( $\lambda$ ) of the light emitted by a hydrogen atom during a transition of its electron from the energy level with  $n=2$  to the level with  $n=1$ .

- a)  $1.0 \times 10^{-9}$  nm    b) 95.0 nm    **c) 122 nm**    d) 97.3 nm    e) 103 nm

$$\Delta E = -2.18 \times 10^{-18} \left( \frac{1}{1^2} - \frac{1}{2^2} \right)$$

$$\Delta E = -1.635 \times 10^{-18}$$

$$\lambda = \frac{hc}{\Delta E}$$

16] Calculate the frequency of a particle with mass =  $1.00 \times 10^{-26}$  kg that is moving with a speed of  $9.5 \times 10^2$  cm/s.

- a)  $1.4 \times 10^{12}$  s<sup>-1</sup>    b)  $4.3 \times 10^{19}$  s<sup>-1</sup>    **c)  $4.3 \times 10^{16}$  s<sup>-1</sup>**    d)  $4.3 \times 10^{14}$  s<sup>-1</sup>    e)  $1.4 \times 10^9$  s<sup>-1</sup>

$$\lambda = \frac{h}{mv}$$

$$\lambda = 6.978 \times 10^{-11}$$

$$\Delta E = h \nu$$