STUDENT'S NAME:
STUDENT'S NUMBER:
Group Number:
Time allowed: **120 minutes.**

College of Science
Chemistry Department

Saturday 11/2/1435H

(CHEM 101) + (CHEM 103)
FIRST SEMISTER SECOND MID-TERM EXAM. 1434-1435H (2013-2014G)

IA	IIA											IIIA	IVA	VA	VIA	VIIA	VIIIA
							1 H 1.008										2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.30	IIIB	IVB	VB	VIB	VIIB		VIIIB		IB	IIB	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98.91	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127. 6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	La-Lu	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po 210. 0	85 At 210.0	86 Rn 222.0
87 Fr 223.0	88 Ra 226.0	Ac-Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub	113 Uut					

Hosny Yehia

Constants:

1 atm = 760 torr = 101.325 kPa

$R = 8.314\ kPa\ L\ mol^{-1}\ K^{-1} = 0.0821\ atm\ L\ mol^{-1}\ K^{-1} = 8.314\ J\ mol^{-1}\ K^{-1}$

N_A (Avogadro's Number) $= 6.022 \times 10^{23}\ mol^{-1}$

1 L atm = 101.325 J

CHEM 101 2ND MID TERM EXAM 1STSEM 1434-1435

First: Choose the correct answer:

(FOR CHEM 101 ***10 × 1 = 10 marks*****) (FOR CHEM 103** ***20 × 1 = 20 marks*****)**

1. The sign of ΔH for the process $CO_2(s) \rightleftharpoons CO_2(g)$ is: ((**The symbol "H" means enthalpy**))
   A) positive and $H_{CO_2(S)} > H_{CO_2(g)}$ B) positive and $H_{CO_2(g)} > H_{CO_2(s)}$
   C) negative and $H_{CO_2(S)} > H_{CO_2(g)}$ D) negative and $H_{CO_2(g)} > H_{CO_2(s)}$

2. Which of ΔH°_{rxn} of the following equations represents $\Delta H^\circ_{f,K_3PO_{4(s)}}$?
   A) $3K(s) + PO_2(s) + O_2(g) \rightarrow K_3PO_4(s)$ B) $K_3(s) + P(s) + O_4(g) \rightarrow K_3PO_4(s)$
   C) $K_3P(s) + 2O_2(g) \rightarrow K_3PO_4(s)$ D) $3K(s) + P(s) + 2O_2(g) \rightarrow K_3PO_4(s)$

3. A balanced chemical equation with specified value of ΔH and states of substances is called:
   A) a thermochemical equation. B) a combustion reaction.
   C) the first law of thermodynamics. D) Hess's law.

4. Change in internal energy (ΔE°), in kJ, of the following reaction is:
   $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$ $\Delta H^\circ_{rxn} = 129$ kJ
   A) 121.04 B) 134. 04 C) 124. 04 D) 114. 04

5. If 10.0 g of a metal (**C_s = 0.896 J/g K**) at 298 k is supplied with 313.5 J of heat, its final temperature, in K, will be:
   A) 353 B) 333 C) 323 D) 373

6. From table below, ΔH°_{rxn} of the following reaction, in kJ, is:
   $PCl_3(g) + 3HCl(g) \rightarrow 3Cl_2(g) + PH_3(g)$ $\Delta H^\circ_{rxn} = ?$

Compound	$PH_3(g)$	$PCl_3(g)$	$HCl(g)$
ΔH°_f/kJ mol^{-1}	+ 5.40	– 288.07	– 92.30

   A) 570.37 B) 507.37 C) 705.37 D) 750.37

7. Knowing that:
   $\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \rightarrow HCl(g)$ $\Delta H^\circ_{rxn} = -92.3$ kJ
   the number of kilojoules (kJ) released if 100 g of HCl(g) is produced, is:
   A) 235.17 B) 325.17 C) 523.17 D) 253.17

8. The process of surrounding solute particles by solvent particles is known as:
   A) dilution B) formation C) solvation D) osmosis

9. The solubility of -----?----- in liquid is highly affected by changing pressure.
   A) gases B) liquids C) solids D) salts

10. If 0.1 mol of solid glucose ($C_6H_{12}O_6$) is dissolved in the same mass of each of the following solvents:

Solvent	Q	X	Y	Z
K_b/°C $molal^{-1}$	0.4	1.53	1.7	0.5

    the solvent which its boiling point is elevated more is:
    A) Q B) X C) Y D) Z

11. The magnitudes of the molal constant of boiling point elevation (K_b) depend on:
    A) temperature B) pressure C) nature of solute D) nature of solvent

12. The aqueous solution with the highest boiling point is:
    A) 0.1 M HI B) 0.1 M $(NH_4)_3PO_4$ C) 0.2 M C_2H_5OH D) 0.1 M NH_4Cl

13. If 1 L carbonated water is bottled under pressure of 2.4 atm of $CO_2(g)$, and Henry's law constant is 3.36×10^{-2} mol/L atm, the number of grams of dissolved $CO_2(g)$ is:

A) 5.35 B) 53.5 C) 35.5 D) 3.55

14. At 30 °C, the osmotic pressure, in torr, of 0.108 M aqueous solution of a salt that is assumed to be totally ionized into three ions is:

A) 3.16×10^3 B) 1.63×10^3 C) 6.13×10^3 D) 1.36×10^3

15. The minimum amount of energy required to overcome the energy barrier in a chemical reaction is the:

A) activation energy B) reaction's enthalpy
C) reactants' kinetic energy D) reactants' heat content

16. Increasing temperature increases reaction rate because it:

A) increases the activation energy B) decreases the activation energy
C) increases the number of collisions D) increases the reaction enthalpy

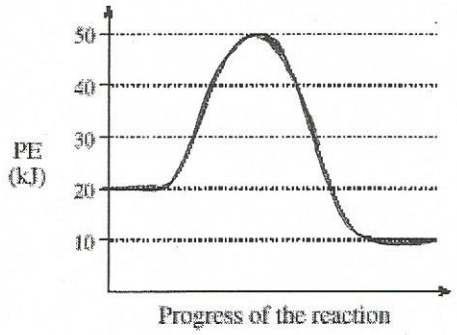
17. According to the following reaction:

$$N_2O_5(g) \rightarrow NO_2(g) + NO_3(g)$$

if 0.8 mol of N_2O_5 (g) is initially put in 2 L-reaction vessel and is found to be 0.0125 mol after 2 min, the rate of disappearance of $N_2O_5(g)$, in M/min, is:

A) 0.9169 B) 0.1969 C) 0.6919 D) 0.9961

18 From the following reaction potential energy (PE) diagram:



which of the following is correct for the forward reaction:

	ΔH/kJ	Activation energy, Ea/kJ	Type of reaction
A)	+ 10	40	exothermic
B)	+ 10	30	endothermic
C)	– 10	30	exothermic
D)	– 10	50	endothermic

19 In a first order reaction, if the concentration of the reactant changes from 0.1 M to 0.025 M in 40 minutes, the reaction rate, in M/min, when the initial concentration is 0.01 M is:

A) 6.634×10^{-4} B) 6.346×10^{-4} C) 4.366×10^{-4} D) 3.466×10^{-4}

20. For the reaction:

$$N_2O_5(g) \rightarrow 2NO_2(g) + \tfrac{1}{2}O_2(g)$$

if the value of the rate of disappearance of N_2O_5 is 6.25×10^{-3} mol L^{-1} s^{-1}, the rate of appearance of NO_2 is:

A) 2.15×10^{-2} B) 1.25×10^{-2} C) 2.51×10^{-2} D) 2.51×10^{-2}

Second: Solve, <u>in details</u>, the following problems:
(<u>FOR CHEM 101</u> *5 marks*) (<u>FOR CHEM 103</u> *10 marks*)

1. Given:

(1) $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H_1 = -393.5$ kJ
(2) $S(s) + O_2(g) \rightarrow SO_2(g)$ $\Delta H_2 = -296.8$ kJ
(3) $C(s) + 2S(s) \rightarrow CS_2(l)$ $\Delta H_3 = +\ 87.9$ kJ

calculate ΔH of the following reaction:

(4) $CS_2(l) + 3O_2(g) \rightarrow CO_2(g) + 2SO_2(g)$ $\Delta H_4 = ?$

2. If dissolving 28.5 g of a sugar in 13.88 mol of water lowers the vapor pressure of water from 17.540 torr to 17.435 torr, calculate the molar mass of the sugar.

3. If a reaction rate constant is $8.9 \times 10^{-3}\ M^{-1}\ s^{-1}$ at 3 °C and $7.1 \times 10^{-2}\ M^{-1}\ s^{-1}$ at 35 °C, calculate its activation energy in kJ/mol?

بسم الله الرحمن الرحيم

الاسم :- عبدالله غازي عبدالله بن سعدون

الرقم الجامعي :-

First : Choose the correct answer :-

(Q1) :- (B) :- positive and $H_{co_2(g)} > H_{co_2(s)}$.

(Q2) :- (D) :- $3K_{(s)} + P_{(s)} + 2O_{2(g)} \longrightarrow K_3PO_{4(s)}$

(Q3) :- (A) :- a thermochemical equation.

(Q4) :- الحل :-

$R = 8,314\ J\ mol^{-1}k^{-1}$

$\Delta H^\circ_{rxn} = 129\ KJ$, $\Delta E^\circ = ?$, $T = 25\,C^\circ = 298\ K$

$$2NaHCO_{3(s)} \longrightarrow Na_2CO_{3(s)} + H_2O_{(g)} + CO_{2(g)}$$

$$\Delta E^\circ = \Delta H_{rxn} - \Delta nRT$$

Δn ← الفرق في عدد مولات الغازات

$$\Delta nRT = (n_f - n_i)RT = (2-0) \times 8,314 \times 298 = 4955,144\ J$$

$$\therefore \Delta nRT = 4,955\ KJ$$

$$\therefore \Delta E^\circ = 129 - 4,955 = \boxed{124,04\ KJ}$$

(Q5) :- الحل :-

- mass of metal (m) = 10 g
- Specific heat (C_s) = 0,896 J/g k
- heat (q) = 313,5 J
- T_i = 298 K
- T_f = ?

$\because q = m \times C_s \times (T_f - T_i)$

$\therefore T_f = \frac{q}{m \times C_s} + T_i = \frac{313,5}{10 \times 0,896} + 298 = 332,98 \simeq \underline{333\ k}$

$\therefore T_f = \boxed{333\ k}$

↙ final temperatur

(Q6) :- الحل :-

$$PCl_3 + 3\,HCl \longrightarrow 3\,Cl_2 + PH_3 \qquad \Delta H^\circ_{rxn} = ?\ kJ$$

$\Delta H^\circ_f\ (PH_3) = +5,40\ kJ\ mol^{-1}$

$\Delta H^\circ_f\ (PCl_3) = -288,07\ kJ\ mol^{-1}$

$\Delta H^\circ_f\ (HCl) = -92,30\ kJ\ mol^{-1}$

$\Delta H^\circ_f\ (Cl_2) = 0\ kJ\ mol^{-1}$

$$\Delta H^\circ_{rxn} = \sum n\ \Delta H^\circ_{f\ products} - \sum m\ \Delta H^\circ_{f\ reactants}$$

$$= [(3\times 0) + (1 \times 5,40)] - [(1 \times -288,07) + (3 \times -92,30)]$$

$$= 5,40 + 564,97 = \underline{570,37\ kJ}$$

$\therefore \Delta H^\circ_{rxn} = \boxed{570,37\ kJ}$

(Q7) :- الحل :- $\frac{1}{2} H_2 + \frac{1}{2} Cl_2 \longrightarrow HCl$ $\quad \Delta H^\circ_{rxn} = -92,3\ kJ$

$\Delta H^\circ_{rxn} = -92,3\ kJ$ ⟵ هي حرارة تكوين مول واحد من (HCl)

∵ 1 mol (HCl) ⟶ 36,45 g/mol

∵ 1 mol (HCl) ⟶ −92,3 kJ

∴ 36,45 g ⟶ −92,3 kJ

100 g ⟶ −X

$\therefore X = \frac{100 \times 92,3}{36,45} = \boxed{253,17\ kJ}$

(C)

(Q8) :- Solvation .

(Q9) :- (A) :- gases .

(Q10) :- (Q/X/Y/Z) ⊛ بما أنَّ المولالية (m) متساوية في جميع المذيبات لأنَّ لهم نفس الكتلة .

⊛ k_b ⟵ ثابت للجميع

⊛ إذاً ترتفع درجة الغليان عندما يكون (ΔT_b) هو الأكبر

∴ boiling point is elevated more is (Y) = 1,7

∴ الجواب هو : (C) ⇐ $\boxed{Y}$

(Q11) :- (D) :- nature of Solvent .

(Q12) :- الحل :- $C_2H_5OH \longrightarrow$ nonelectrolyte $\Longrightarrow \boxed{i = 1}$

$HI \longrightarrow$ electrolyte $\longrightarrow HI \longrightarrow H^+ + I^- \Longrightarrow \boxed{i = 2}$

$(NH_4)_3PO_4 \longrightarrow$ electrolyte $\longrightarrow (NH_4)_3PO_4 \rightarrow 3NH_4^+ + PO_4^- \Longrightarrow \boxed{i = 4}$

$NH_4CL \longrightarrow$ electrolyte $\longrightarrow NH_4Cl \rightarrow NH_4^+ + Cl_2^- \Longrightarrow \boxed{i = 2}$

⊛ (تم تفع درجة الغليان عندما يكون (i) هو الأكبر) .

∴ الجواب الصحيح هو :- (B) $\longrightarrow \boxed{0,1M\ (NH_4)_3PO_4}$

(Q13) :- الحل :- نطلع ذوبانية الغاز (S_g)

$$S_g = k\,P_g = 3,36 \times 10^{-2} \times 2,4 = 0,08064\ M \text{ or } mol/L$$

⊛ بما أن ذوبانية الغاز (S_g) يعبر عنها بوحدات التركيز (M)

$\therefore S_g = \text{Molarity (M)}$

$$\therefore M = \frac{\text{Number of solute}}{\text{Volume of Solution in (Litter)}}$$

$$\therefore n = M \times V = 0,08064 \times 1 = 0,08064 \text{ mole}$$

$$\therefore n = \frac{m}{Mut} \Longrightarrow m = n \times Mut = 0,08064 \times 44 = 3,55\ g$$

∴ the number of grams (m) of dissolved CO_2 is = $\boxed{3,55g}$

(Q14) :- الحل :- $T = 30\,^{\circ}C = 303\ K$, $M = 0,108\ M$

$i = 3$ ions , $R = 0,0821\ atm\ L\ mol^{-1}\ k^{-1}$

$R = 0,0821 \times 760 = 62,396$

$\pi = MRTi = 0,108 \times 62,396 \times 303 \times 3$

$= 6,13 \times 10^{3}$ torr

∴ the osmotic pressure (π) = $\boxed{6,13 \times 10^{3}\ torr}$

(Q15) :- (A) :- activation energy.

(Q16) :- (C) :- increases the number of collisions .

(Q17) :- الحل :- $n_i = 0,8\ mol$, $n_f = 0,0125\ mol$

$V = 2L$, $\Delta t = 2\ min$

∴ $Rate = \frac{\Delta [M]}{\Delta t}$ ← مقدار التغير في التركيز / مقدار التغير في الزمن

∴ نوجد $\Delta[M]$

$M_i = \frac{n_i}{V} = \frac{0,8}{2} = 0,4\ M$

$M_f = \frac{n_f}{V} = \frac{0,0125}{2} = 0,00625\ M$

∴ $\Delta[M] = 0,4 - 0,00625 = 0,39375\ M$

∴ $Rate = \frac{\Delta[M]}{\Delta t} = \frac{0,39375}{2} = \boxed{0,1969\ M/min}$

(Q 18) :- إذا كان التفاعل في الاتجاه الأمامي (forward) فإن قيمة (ΔH) تكون (-) لأن التفاعل طارد للحرارة (exothermic) .

∴ الجواب الصحيح هو :- (C)

	ΔH / KJ	Activation energy , E_a / KJ	Type of reaction
C)	-10	30	exothermic

(Q19) :- الحل :-

$[A]^{\circ} = 0,1\ M$, $[A]_t = 0,025\ M$

$t = 40$ minutes

نطلع (k) ثابت سرعة التفاعل :-

$$\ln \frac{[A]_t}{[A]_{\circ}} = -kt \implies \ln\left(\frac{0,025}{0,1}\right) = -k \times 40$$

$$\therefore k = 0,03466\ min^{-1}$$

$$\therefore \text{Rate} = k[A] = 0,03466 \times 0,01 = \boxed{3,466 \times 10^{-4}\ M/min}$$

(Q20) :- الحل :-

Rate of $N_2O_5 = 6,25 \times 10^{-3}\ mol\ L^{-1} s^{-1}$

$$N_2O_5 \longrightarrow 2NO_2 + 1/2\ O_2$$

$$\text{Rate} = -\frac{\Delta[N_2O_5]}{\Delta t} = \frac{1}{2}\frac{\Delta[NO_2]}{\Delta t}$$

$$\because \frac{\Delta[N_2O_5]}{\Delta t} = 6,25 \times 10^{-3}$$

$$\therefore \frac{1}{2}\frac{\Delta[NO_2]}{\Delta t} = 6,25 \times 10^{-3}$$

$$\therefore \text{Rate of } NO_2 = 6,25 \times 10^{-3} \times 2 = \boxed{1,25 \times 10^{-2}\ mol\ L^{-1} s^{-1}}$$

Second :- Solve :-

(Q1) :- الحل :- نعكس المعادلة (2) في (2) ونعكس المعادلة (3) ثم نجمع المعادلات الثلاث :-

① $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\quad \Delta H_1 = -393,5$ KJ

② $2S_{(s)} + 2O_{2(g)} \longrightarrow 2SO_{2(g)}$ $\quad \Delta H_2 = -593,6$ KJ

③ $CS_{2(l)} \longrightarrow C_{(s)} + 2S_{(s)}$ $\quad \Delta H_3 = -87,9$ KJ

④ $CS_{2(l)} + 3O_{2(g)} \longrightarrow CO_{2(g)} + 2SO_{2(g)}$ $\quad \boxed{\Delta H_4 = -1075 \text{ KJ}}$

(Q2) :- الحل :-

- mass of sugar = 28,5 g
- No. mole of water = 13,88 mol
- vapor pressure of water (P_w) = 17,435 torr
- vapor pressure of pure water (P_w°) = 17,540 torr

$\because P_w = X_w P_w^\circ$

$\therefore P_w = \left(\frac{n_w}{n_w + n_s}\right) P_w^\circ$

(n_w عدد مولات الماء ، n_s عدد مولات السكر)

$17,435 = \left(\frac{13,88}{13,88 + n_s}\right) \times 17,540$

$\therefore n_s = \frac{13,88}{0,99401} - 13,88 = 0,0836$ mol

$\because n_s = \frac{m}{Mut} \Longrightarrow Mut = \frac{m}{n_s} = \frac{28,5}{0,0836} = \underline{340,91} \simeq \underline{341 \text{ g/mol}}$

$\therefore$ the molar mass of the sugar $\simeq \boxed{341 \text{ g/mol}}$

(Q3) :- الحل :-

$k_1 = 8,9 \times 10^{-3}\ M^{-1} s^{-1}$

$T_1 = 3\,C^\circ = 276\,K$

$k_2 = 7,1 \times 10^{-2}\ M^{-1} s^{-1}$

$T_2 = 35\,C^\circ = 308\,K$

$E_a = ?$, $R = 8,314\ J\ mol^{-1} K^{-1}$

$$\therefore \ln\left(\frac{K_2}{K_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\therefore E_a = \frac{R \ln\left(\frac{k_2}{k_1}\right)}{\frac{1}{T_1} - \frac{1}{T_2}}$$

$$= \frac{8,314 \ln\left(\frac{7,1 \times 10^{-2}}{8,9 \times 10^{-3}}\right)}{\frac{1}{276} - \frac{1}{308}} = \frac{17,26509}{3,7643 \times 10^{-4}}$$

$$= 45865,34\ J/mol$$

$$\therefore E_a = \boxed{45,86\ KJ/mol}$$