University of Bahrain, Department of Chemistry
Chemy 102, First Semester 2013-2014
2nd hour examination

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**Time : 75 min**

Name …… ID ……Sec ….

| Order | Concentration–Time Relation |
|---|---|
| 0 | $[A] = [A]_o - kt$ |
| 1 | $\ln \frac{[A]_o}{[A]} = kt$ |
| 2 | $\frac{1}{[A]} = \frac{1}{[A]_o} + kt$ |

Arrhenius equation: $k = Ae^{-Ea/RT}$

$R = 8.314\ J\ K^{-1}\ mol^{-1}$

**Q1.** (1 mark)

What volume of benzene ($C_6H_6$, density = 0.88 g/mL, molar mass = 78.11 g/mol) is required to produce $1.5 \times 10^3$ kJ of heat according to the following reaction?

$$2\ C_6H_6(l) + 15\ O_2(g) \rightarrow 12\ CO_2(g) + 6\ H_2O(g) \quad \Delta H° = -6278\ kJ$$

A) 75 mL B) 37 mL C) 21 mL D) 71 mL E) 42 mL

**Q2.** (1 mark)

Choose the reaction that illustrates $\Delta H°_f$ for $Ca(NO_3)_2$.

A) $Ca(s) + N_2(g) + 3O_2(g) \rightarrow Ca(NO_3)_2(s)$

B) $Ca^{2+}(aq) + 2\ NO_3^-(aq) \rightarrow Ca(NO_3)_2(aq)$

C) $Ca(s) + 2\ N(g) + 6\ O(g) \rightarrow Ca(NO_3)_2(s)$

D) $Ca(NO_3)_2(aq) \rightarrow Ca^{2+}(aq) + 2\ NO_3^-(aq)$

E) $Ca(NO_3)_2(s) \rightarrow Ca(s) + N_2(g) + 3O_2(g)$

**Q3.** (1 mark)

Using

| | |
|---|---|
| $C_3H_8\ (g) + 5\ O_2\ (g) \rightarrow 3\ CO_2\ (g) + 4\ H_2O\ (g)$ | $\Delta H = -2043$ kJ |
| $C\ (s) + O_2\ (g) \rightarrow CO_2\ (g)$ | $\Delta H = -393.5$ kJ |
| $2\ H_2\ (g) + O_2\ (g) \rightarrow 2\ H_2O\ (g)$ | $\Delta H = -483.6$ kJ |

Find $\Delta H$ for the following reaction

$$3\ C\ (s) + 4\ H_2\ (g) \rightarrow C_3H_8\ (g) \quad \Delta H = -105\ kJ$$

**Q4.** (1 mark)

Use the $\Delta H°_f$ and $\Delta H°$ information provided to calculate $\Delta H°_f$ for IF:

$$IF_7(g) + I_2(g) \rightarrow IF_5(g) + 2\,IF(g) \qquad \Delta H° = -89 \text{ kJ}$$

| | $\Delta H°_f$ (kJ/mol) |
|---|---|
| $IF_7(g)$ | –941 |
| $IF_5(g)$ | –840 |

A) 101 kJ/mol B) –146 kJ/mol C) –190 kJ/mol
D) –95 kJ/mol E) 24 kJ/mol

**Q5.** (2 marks)

Using

$H(g) + Br(g) \rightarrow HBr(g)$ $\Delta H = -368$ kJ
$2\,Br_2(g) \rightarrow 4\,Br(g)$ $\Delta H = +386$ kJ
$2\,H(g) \rightarrow H_2(g)$ $\Delta H = -436$ kJ

**(a)** Br–Br bond enthalpy = 193 kJ

**(b)** Arrange the following bonds from weakest to strongest:
H–H , Br–Br , H–Br

| Br–Br | H–Br | H–H |
|---|---|---|
| weakest | | strongest |

**Q6.** (1 mark)

Given w = 0, an endothermic reaction has the following.

A) $+\Delta H$ and $-\Delta E$ B) $-\Delta H$ and $+\Delta E$
C) $+\Delta H$ and $+\Delta E$ D) $-\Delta H$ and $-\Delta E$

**Q7.** (1 mark)

Given the balanced equation $2\,O_3(g) \rightarrow 3\,O_2(g)$.
If the rate of formation of $O_2$ is 0.694 mol/L·s, what is the rate of the loss of $O_3$?

A) 0.463 mol/L·s B) 1.04 mol/L·s C) 0.643 mol/L·s
D) 0.231 mol/L·s E) 4.16 mol/L·s

**Q8.** (1 mark)

Consider the following balanced chemical equation:

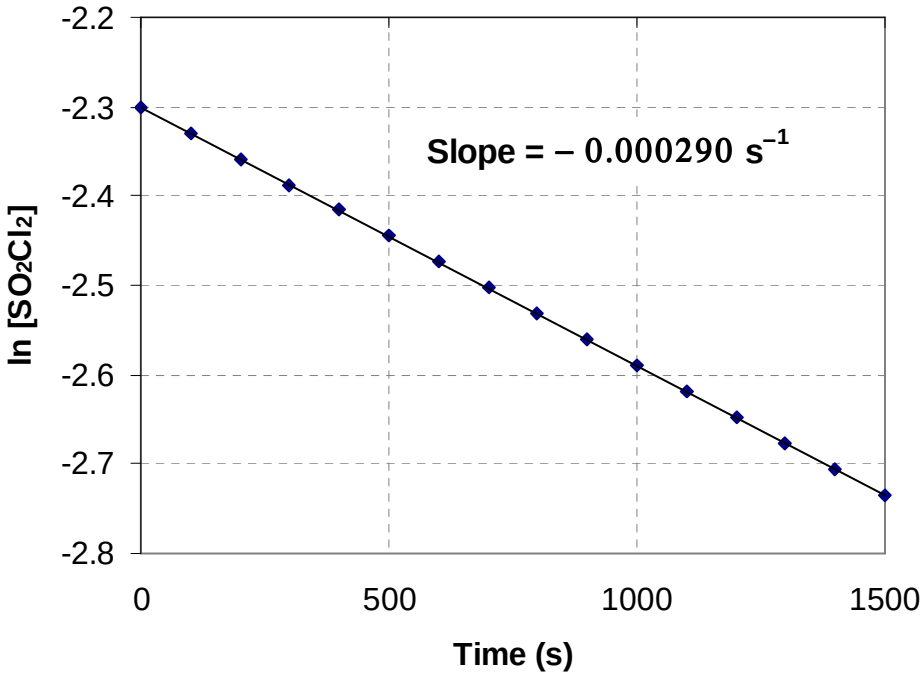
$H_2O_2\,(aq) + 3\,I^-\,(aq) + 2\,H^+\,(aq) \rightarrow I_3^-\,(aq) + 2\,H_2O\,(l)$

In the first 10.0 seconds of the reaction, the concentration of $I^-$ dropped from 1.000 M to 0.868 M. Calculate the average rate of this reaction in this time interval.

Rate = $4.40\times10^{-3}$ M/s

**Q9.** (2 marks)

The graph below is for the reaction $SO_2Cl_2\,(g) \rightarrow SO_2\,(g) + Cl_2\,(g)$




Determine

**a)** The order of reaction 1

**b)** The rate constant of the reaction 0.000290 $s^{-1}$

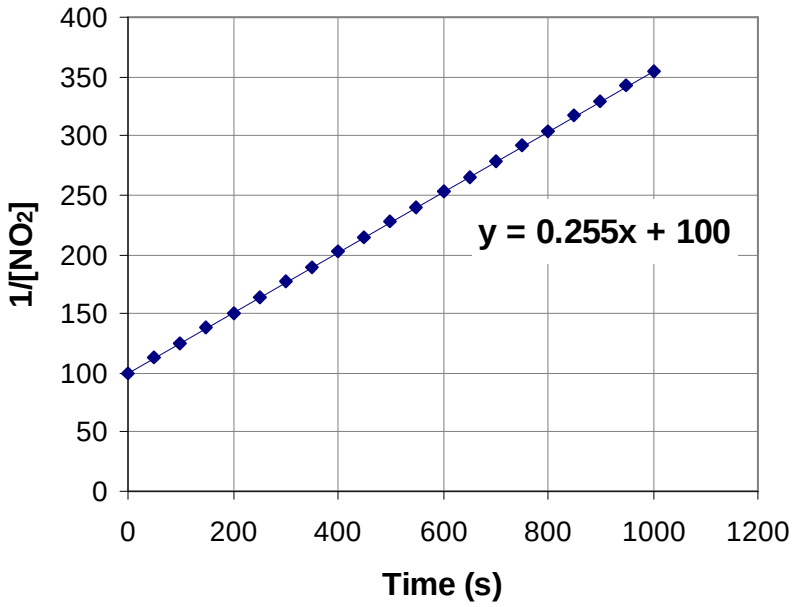
**c)** The initial concentration of $SO_2Cl_2$ 0.100 M

**d)** The rate of reaction when the concentration of $SO_2Cl_2$ is 0.0800 M.

$2.32\times10^{-5}$ M $s^{-1}$

**Q10.** (2 marks)

The graph below is for the reaction $NO_2\ (g) \rightarrow NO\ (g) + O\ (g)$




Determine:

**a)** The order of reaction. 2

**b)** The rate constant of the reaction. $0.255\ M^{-1}\ s^{-1}$

**c)** The initial concentration of $NO_2$. 0.0100 M

**d)** The concentration of $NO_2$ after 1300 s. $2.32\times10^{-3}$ M

**Q11.** (1 mark)

The reaction between nitrogen dioxide and carbon monoxide is given by the following equation: $NO_2\ (g) + CO\ (g) \rightarrow NO\ (g) + CO_2\ (g)$

The rate constant at 701 K was measured as 2.57 $M^{-1}s^{-1}$ and that at 895 K was measured as 567 $M^{-1}s^{-1}$. Find the activation energy for the reaction in kJ/mol.

$E_a$ = 150 kJ/mol

**Q12.** (1 mark)

Given the following rate law, how does the rate of reaction change if the concentration of Y is doubled?

$$\text{Rate} = k\,[X]^2\,[Y]^3$$

A) The rate of reaction will increase by a factor of 9.
B) The rate of reaction will increase by a factor of 2.
C) the rate of reaction will increase by a factor of 8.
D) The rate of reaction will increase by a factor of 4.
E) The rate of reaction will remain unchanged.

**Q13.** (1.5 marks)

The data below is for the reaction $CO(g) + Cl_2(g) \rightarrow COCl_2(g)$

| [CO] (M) | $[Cl_2]$ (M) | Initial Rate ($M^{-1}s^{-1}$) |
|---|---|---|
| 0.25 | 0.40 | 0.696 |
| 0.25 | 0.80 | 1.97 |
| 0.50 | 0.80 | 3.94 |

Determine

**a)** The order of reaction with respect to CO. 1

**b)** The order of reaction with respect to $Cl_2$ . 3/2

**c)** The unit of rate constant. $1/(M^{3/2}\ s)$

**Q14.** (0.5 mark)

How many half-lives are required for the concentration of reactant to decrease to 25% of its original value?

A) 1 B) 3 C) 1.5 D) 2.5 E) 2