



(سموح باستخدام الجداول الكيميائية النسخة الخاصة بامتحانات الكيمياء الهندسية)

Answer the following questions

Total Marks 80

اجب عن الأسئلة الآتية:

**Question No. (1):**

(15 Marks)

- (a) Define the concept of partial pressure and derive the relationship between partial pressure, total pressure and mole fraction of a component gas in a gas mixture? (4 Marks)
- (b) List two conditions under which gas can deviate from ideal behaviour and show how you can obtain van der Waals equation of state by the modification of the ideal gas equation of state? (5 Marks)
- (c) Compute the molecular weight of gas mixture and its density at 27 °C and 750 torr, if the mixture of gases has the following composition by weight: CO<sub>2</sub>=0.44%, O<sub>2</sub>=22.4%, N<sub>2</sub>=75.36%, H<sub>2</sub>O=1.8%? (6 Marks)

**Question No. (2):**

(15 Marks)

- (a) Explain what is meant by enthalpy and show how it is related to the heat exchanged in a process carried out at constant pressure (Q<sub>p</sub>)? (4 Marks)
- (b) Derive the relationship between C<sub>p</sub> and C<sub>v</sub> for Real gases?  $\frac{C_p}{C_v} < \gamma$  (4 Marks)
- (c) Referring to the information in the table at 25°C: (7 Marks)

(1) Calculate  $\Delta S^\circ$ , at 25°C for the reaction:(2) Calculate  $\Delta S^\circ$  for CO<sub>(g)</sub> at 25°C.

(3) Discuss the effect of temperature on the spontaneity of the above reaction

Compound	$\Delta H^\circ_f$ kcal/mole	$\Delta G^\circ_f$ kcal/mole	S° cal/mole K
H <sub>2(g)</sub>	0.00	0.00	31.212
CO <sub>(g)</sub>	-26.415	-32.808	-----
CH <sub>3</sub> OH <sub>(l)</sub>	-57.036	-39.747	30.26

**Question No. (3):**

(15 Marks)

For the production of sulfuric acid by the contact process, iron pyrites, (FeS<sub>2</sub>), is burned with air in 100% excess of that required to oxidize all iron to Fe<sub>2</sub>O<sub>3</sub> and all sulfur to SO<sub>2</sub>. It may be assumed that the combustion of the pyrites is complete to form these products and that no SO<sub>3</sub> is formed in the burner. The gases from the burner are cleaned and then passed into a catalytic converter in which 70% of SO<sub>2</sub> is oxidized to SO<sub>3</sub> by combination with the oxygen present in the gases. The gases enter the converter at a temperature of 400°C. Assuming the converter is an adiabatic system. Calculate the temperature of the gases leaving the converter?

**Question No. (4):**

(15 Marks)

- (a) What is meant by colligative properties of solutions? (3 Marks)
- (b) Ethylene glycol C<sub>2</sub>H<sub>6</sub>O<sub>2</sub> is used as anti-coolant in vehicle's engine cooler (ردياتير السيارات), specially in cold climates. If the temperature in Moscow (موسكو) reached to -10°C, what weight of ethylene glycol C<sub>2</sub>H<sub>6</sub>O<sub>2</sub> must be added to 100 gm of water to prevent the formation of ice? (6 Marks)
- (c) What is the density at 17°C of aqueous solution containing 0.75 gm of sucrose, (C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>), per 2 litre of a solution developed a rise of 26.4 cm at osmotic equilibrium? (6 Marks)

**Question No. (5):**

(20 Marks)

- (a) Explain the main features of heating and cooling curves and interpret what happens in each portion? (4 Marks)
- (b) Study the effect of pressure on the melting point of water, starting from a pressure of 1 to 101 atm with an incremental change of 20 atm, where the density of liquid water at 0°C is given as 0.99 gm/cm<sup>3</sup> and that for ice at 0°C is 0.92 gm/cm<sup>3</sup>. Consider that both ( $\Delta H_{\text{fus}}$ ) for water and ( $\Delta S$ ) for phase change do not change with change in pressure? (8 Marks)
- (c) At 817°C, the equilibrium constant for reaction between pure CO<sub>2</sub> and excess hot graphite to form 2CO<sub>(g)</sub> is 10,  
(1) What is the analysis of the gases at equilibrium, at 817°C and at a total pressure of 4 atm? (3 Marks)  
(2) What is the total pressure when the gas mixture analyzes 94% CO by volume? (3 Marks)

**Question No. (6):**

(15 Marks)

- (a) In a simplified flow sheet diagram, explain the main steps of Portland cement manufacture? (3 Marks)
- (b) Explain the main features of the kiln used for burning the raw mix to produce Portland cement and explain the main reactions occurring inside it? (3 Mark)
- (c) Explain the main stages of setting and hardening of Portland cement according to modern theory? (3 Marks)
- (d) What are the main raw material resources for fertilizers industry? (3 Marks)
- (e) Explain the main reactions in acidulation process for the production of phosphoric acid from phosphate ore? What are the main problems facing this industry? (3 Marks)