مجلس الخدمة المدنية

مباراة على أساس الألقاب لوظيفة مهندس أو مهندس رئيس قسم في الفئة الثالثة الرتبة الثانية (أ) من السلك الفني في مؤسسة كهرباء لبنان

الاختصاص : الهندسة الكيميائية

مسابقة في الاختصاص المطلوب بإحدى اللغتين الفرنسية أو الإنكليزية وفق البرنامج المرفق بالقرار رقم ٢/١٦٥ تاريخ ٢٠١٠/٣/٢٧ : المدة : ثلاث ساعات

First exercise:

1 – Define or explain the following terms:

- a) Normal boiling point.
- b) Dalton's law for ideal gas.
- c) Adsorption.
- d) Steady state.
- e) Atomic weight.
- f) Mole.
- g) Batch process.
- h) Stoechiometric coefficients.
- i) Azeotrope.

2 – Give the standard conditions of temperature in the different temperature scales: Celsius (°C); Fahrenheit (°F); Kelvin (K); Rankin (°R).

Second exercise:

You are asked to prepare a batch of 18.63 % battery acid as follows: A tank of old weak sulfuric acid solution contains 12.43 % H_2SO_4 (The remainder is pure water). If 200 kg of 77.7 % H_2SO_4 is added to the tank, and the final solution is to be 18.63 % H_2SO_4 , how many kilograms of battery acid have been made?

Third exercise:

If you feed 10 grams of N₂ gas and 10 grams of H₂ gas into a reactor:

- a) Calculate the maximum extent of the reaction based on the complete reaction of N_2 and H_2 .
- b) What is the limiting reactant?
- c) Calculate the mass of the reactant remaining in excess and the mass of ammonia produced. N = 14; H = 1

Fourth exercise:

Hydro cracking is an important refinery process for converting low-valuable heavy hydrocarbons into more valuable lower molecular weight hydrocarbons by exposing the feed to a zeolite catalyst at high temperature and pressure in the presence of hydrogen gas.

Researches in this field study the hydro cracking of octane, the cracked products had the following composition in mole percent: $19.5 \% C_3H_8$; $59.4 \% C_4H_{10}$; and $21.1 \% C_5H_{12}$.

You are asked to determine the molar ratio of hydrogen consumed to octane reacted for this process.

(You will use element balances to solve this problem because the reactions involved in the process are not specified).

Fifth exercise:

Gas at 15°C and 105 KPa is flowing through an irregular duct. To determine the rate of flow of t gas, CO_2 from a tank is passed into the gas stream. The gas analyzes 1.2 % CO_2 by volume befor and 3.4 % CO_2 by volume after the addition.

As the CO₂ that was injected left the tank, it was passed through a rotameter and found to flow at the rate of 0.0917 m³/min at 7° C and 131 KPa.

What was the rate of flow of the entering gas in the duct in cubic meters per minute?

Sixth exercise:

Questions 1, 2 and 3 are independent:

1 - Explain the principle of gas chromatography and draw the apparatus used in this technique. What kind of detectors can be used in this method?

2 - What is the term that describes a gasoline's ability to resist detonation during the combustion in the engine? What does this term represent? Explain briefly.

3 - a) Describe the fractional distillation of crude oil petroleum.

b) Name the different oil refinery processes and explain the purpose of oil dewaxing and reforming processes.

Seventh exercise:

Public concern about the increase in the carbon dioxide in the atmosphere has led to numerous proposals to sequester or eliminate the carbon dioxide. An inventor believes he has developed a new catalyst that can make the gas phase reaction

 $CO_{2(g)} + 4 H_{2(g)} \rightarrow 2H_2O_{(g)} + CH_{4(g)}$

Proceed with 100 % conversion of CO_2 . The source of the hydrogen would be from the electrolysis of water using electricity generated from solar cells. Assume stoichiometric amounts of the reactants enter the reactor. Determine the heat of reaction if the gases enter and leave at 1 atm and 500° C.

	ΔH_{f}^{o} (KJ/mol)	ΔH^{500}_{25} (KJ/mol)
$CO_{2(g)}$	- 393.250	21.425
$H_{2(g)}$	0	13.834
$H_2O_{(g)}$	- 241.835	17.010
$CH_{4(g)}$	- 74.848	23.126

Eight exercise:

Fuels other than gasoline are being eyed for motor vehicles because they generate lower levels of pollutants than does gasoline.

Compressed propane is one such proposed fuel. Suppose that in a test 20 kg of C_3H_8 is burned with 400 kg of air to produce 44 kg of CO_2 and 12 kg of CO. What was the percent excess air? H = 1; C = 12; O = 16

Ninth exercise:

The figure below is a schematic of a process for the production of flake NaOH, which is used households to clear plugged drains in the plumbing.



The fresh feed to the process is 10.000 lb/hr of a 40 % aqueous NaOH solution. The fresh feed is combined with the recycled filtrate from the crystallizer, and fed to the evaporator where water is removed to produce a 50 % NaOH solution, Which in turn is fed to the crystallizer. The crystallizer produces a filter cake that is 95 % NaOH crystals and 5 % solution that itself consists of 45 % NaOH. The filtrate contains 45 % NaOH.

- a) You are asked to determine the flow rate of water removed by the evaporator, and the recycle rate for this process.
- b) Assume that the same production rate of NaOH flakes occurs, but the filtrate is not recycled. What would be the total feed rate of 40 % NaOH have to be then? Assume that the product solution from the evaporate still contains 50 % NaOH.

بيروت ، في ١٥/٥/١٠ ٢٠

اللجنية الفاحصية