

Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

SUMMER EXAMINATIONS 2000

**FIRST YEAR ENGINEERING
 CHEMISTRY CH103**

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Time allowed: Three Hours

Answer Five questions

Answer five questions of which not more than two may be chosen from any one section. All questions carry equal marks.

Section A

1. Explain what is meant by ΔH and, using an example, explain why it is of importance from a practical point of view.

Use the data below to estimate the enthalpy of formation (ΔH°_f) of propane, $C_3H_8(g)$:

$$\Delta H^\circ_f C(g) = 716.7 \text{ kJ mol}^{-1}$$

$$\Delta H^\circ_f H(g) = 218.0 \text{ kJ mol}^{-1}$$

$$DH_{av} C-H = 414.0 \text{ kJ mol}^{-1}$$

$$DH_{av} C-C = 347.0 \text{ kJ mol}^{-1}$$

2. (a) The active agent in many commercial bleaches is potassium hypochlorite (KOCl). It can be manufactured in a two-stage process which involves making chlorine and then passing it into a hot solution of potassium hydroxide:



- (i) What weight of MnO_2 is required to prepare sufficient chlorine to produce 25kg of potassium hypochlorite?
- (ii) What weight of KOH would be required to make this amount of KOCl?

(b) One of the major irritants in smog is formaldehyde (CH_2O), which may be formed by the reaction of ozone (O_3) with ethene (C_2H_2). This is known to be first order in both ozone and ethene and has a rate constant (k) of $2 \times 10^3 \text{ l mol}^{-1} \text{ s}^{-1}$.

(i) Write down the rate equation for this reaction and if the concentrations of ozone and ethane in heavily polluted air are 5×10^{-8} and $1 \times 10^{-8} \text{ mol l}^{-1}$, respectively, what is the rate of production of formaldehyde under these conditions?

(ii) How long will it take for the concentration of formaldehyde to build up to $1 \times 10^{-8} \text{ mol l}^{-1}$, the threshold above which eye irritation becomes noticeable?

3. (a) Explain, using examples, what information is provided by each of the four quantum numbers.

(b) Briefly describe any technique that can be used to separate a mixture of liquids.

(c) Draw a diagram of a micelle and explain how it is involved in "dissolving" oil in water.

(d) Explain what is meant by ionization energy (IE) and why the following values are obtained as electrons are removed successively from a magnesium atom:

1^{st} IE: 737.7 ; 2^{nd} IE: 1450.6 ; 3^{rd} IE: $7732.6 \text{ kJ mol}^{-1}$

4. Explain what is meant by osmosis and outline any practical consequence of this phenomenon.

A solution of polystyrene (4.0g) in 0.001m^3 of the solvent benzene was found to have an osmotic pressure of 65.7 Nm^{-2} at 25°C . Calculate the molecular weight of the polystyrene.

$$[R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}]$$

Suggest another method by which the molecular weight of this polymer might be determined.

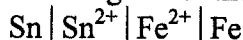
Section B

5. The oxides of sulfur, nitrogen and carbon play a major role in air pollution. Outline the role played by each and suggest methods by which the amounts entering the atmosphere could be reduced in each case.
6. (a) Explain how the Band Theory of solids accounts for the differences between conductors, insulators and semi-conductors.
- (b) Give an account of the bonding that exists in metals and how it accounts for their electrical properties.
- (c) Explain in detail how the Electron Pair Repulsion Theory accounts for the structure of ammonia (NH_3).
- (d) The boiling point of the hydrogen halides are as follows:

Hydrogen Halide	HF	HCl	HBr	HI
Boiling Point ($^{\circ}\text{C}$)	19.5	-84.9	-67.0	-35.4

Give a detailed explanation of the trends shown by these data.

7. (a) Explain the difference between the “strength” and “concentration” of an acid.
- (b) Explain how the corrosion of a piece of iron can be kept to a minimum.
- (c) Briefly describe a hydrogen/oxygen fuel cell and explain how it works. What are the advantages and disadvantages of these fuel cells?
- (e) Give the cell reaction and draw a diagram of the following cell:

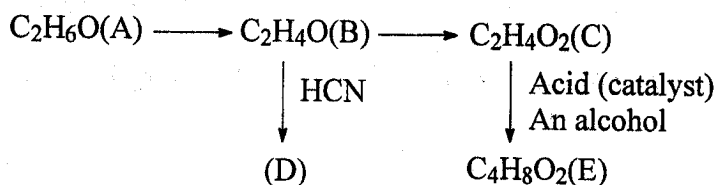


Calculate the EMF of the cell given the following standard electrode potentials:



Section C

8. Discuss the chemistry of aldehydes and ketones under the following headings:
- structure and physical properties
 - methods of preparation
 - reactions
- 9.
- Using examples explain the difference between structural isomerism and geometric (cis/trans) isomerism.
 - Provide two examples of what you consider to be the most important reaction of benzene and give a simple mechanism for one of them.
 - Using examples explain the difference between an addition reaction and a substitution reaction.
 - Explain giving two examples what you consider to be the most important reaction of alkenes and provide a simple mechanism for one of them.
- 10.



B: gives a yellow precipitate with 2,4-dinitrophenylhydrazine

C: reacts with magnesium metal to give a gas which burns in air

E: has a pleasant smell

- Provide structures for the compounds (A) – (E). The functional group should be clearly labeled and named in each case.
- Suggest reagents which could be used to carry out the reaction where these are not given.
- Suggest two other reactions for (C) and provide reaction equations for them.