



University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath

SEMESTER I EXAMINATION - 2008

CHEM 10030
Chemistry For Engineers

Professor Cole-Hamilton

Professor Wayne

Professor Waghorne

Dr. Sullivan *

Professor Sidebottom *

Time Allowed: 2 hours

Instructions for Candidates

All questions carry equal marks; the approximate assignment of marks to parts of a question is indicated (as a percentage) in parentheses.

Use a separate answer book provided for each question.

No loose rough work sheets are to be used. The rough work for each question should be included in the answer book for that question.

Instructions for Invigilators

The use of electronic calculators is permitted
A Periodic Table of the Elements is attached to these sheets
Graph paper should be provided

Answer *both* questions 1 and 2

Question 1

Answer any *three* of the following (a) – (e)

(a) Answer *all* sections (i) – (iii)

- (i) Explain what happens when an electric discharge is passed through hydrogen contained at low pressure in a transparent tube and discuss how the observations further developed atomic theory. (10)
- (ii) Why does the Bohr model of the atom not apply to any other related discharge experiment using Hg or Ne, or any other neutral atom? (10)
- (iii) Determine the wavelength of the light emitted when an electron makes a transition from the $n=4$ orbital to the $n=2$ orbital in a hydrogen atom. (13.3)

Planck's constant, $h = 6.626 \times 10^{-34}$ Js.

Rydberg constant, $R = 2.18 \times 10^{-18}$ J.

Speed of light, $c = 3 \times 10^8$ ms⁻¹.

(b) Answer *all* sections (i) – (iii)

- (i) Briefly discuss how isotopes differ from one another and name three areas where the isotopes have given diagnostic or historical information. (10)
- (ii) Charged particles are deflected as they move through a magnetic field. State the features that affect the extent of this deflection. (10)
- (iii) An element consists of two isotopes. The abundance of one isotope is 95.72% and its atomic mass is 114.9041 u. The atomic mass of the second isotope is 112.9043 u. What is the average atomic mass of the element? (13.3)

(c) Answer *all* sections (i) – (ii)

- (i) Why is the oxidation of hydrocarbon fuels always an exothermic process? (20)
- (ii) Determine the number of moles of CO₂ and the mass of H₂O formed following the combustion of 500kg of C₃H₈. (13.3)

(d) Answer *all* sections

Draw Lewis structures and predict the shapes of the following molecules:

N ₂	(5)
CO ₂	(5)
CH ₄	(5)
C ₂ H ₆	(5)
C ₂ H ₄	(7)
C ₂ H ₂	(7.3)

(e) Answer *all* sections (i) – (iii)

- (i) Explain, with examples, ionic bonding. (5)
- (ii) Explain covalent bonding in terms of the attractions and repulsions that components of an atom experience as two atoms approach one another. (8.3)
- (iii) Given the following data, roughly sketch (on one plot) the potential energy curves for the formation C–C, C=C and C≡C bonds (carbon-carbon single, double and triple bonds).

	Bond length / pm	Bond strength / kJ mol ⁻¹
C–C	154	346
C=C	134	610
C≡C	120	835

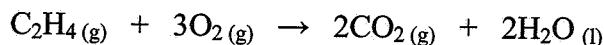
Comment on the relative magnitudes of the bond lengths and energies as a function of bond order and explain each part of one of the energy profiles in terms of the changes in the extents of the attractive and repulsive forces experienced by the components of the atoms as a function of the inter-nuclear distance. (20)

Question 2 is on the next page.....

Question 2

Answer *all* sections (a)-(d)

- (a) The molar enthalpy for the combustion of ethene, (25)



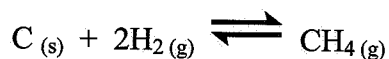
is $-1411 \text{ kJ mol}^{-1}$ at 298 K. Calculate the standard enthalpy of formation of ethene from the following data:

$$\Delta H_f^\circ(\text{CO}_2(\text{g})) = -394 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\circ(\text{H}_2\text{O}(\text{l})) = -286 \text{ kJ mol}^{-1}$$

Sketch the enthalpy diagram for the combustion of ethene including the elements in their standard states.

- (b) Write an expression for the equilibrium constant for the exothermic reaction : (25)



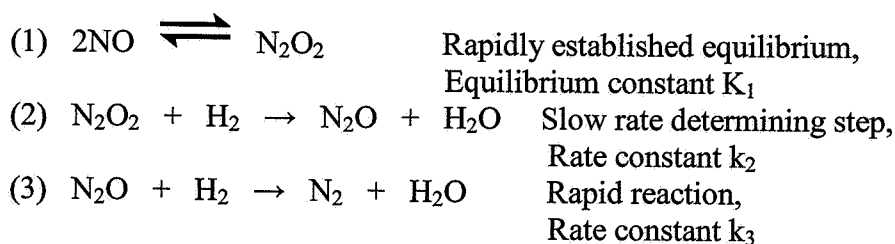
Predict the effect on the amount of CH_4 in the system if:

- (i) the reaction volume is decreased
- (ii) the temperature is increased

- (c) The reaction of hydrogen with nitric oxide in the gas phase,



is complex and takes place by the three elementary reactions:



Show that the rate equation for the formation of N_2 is of the form:

$$\frac{d[\text{N}_2]}{dt} = k[\text{NO}]^2[\text{O}_2]$$

Section (d) is on the following page.....

- (d) Explain in terms of chemical kinetics why each of the following increases the rate of a chemical reaction: (25)
- (i) the presence of a catalyst
 - (ii) an increase in temperature
 - (iii) an increase in reactant concentrations.

oOo

[illegible]