

Ollscoil na hÉireann, Gaillimh
THE NATIONAL UNIVERSITY OF IRELAND, GALWAY

SUMMER EXAMINATIONS, 1999

FIRST UNIVERSITY EXAMINATION
in
BIOMEDICAL SCIENCE, BIOTECHNOLOGY,
ENVIRONMENTAL SCIENCE, MARINE SCIENCE

CHEMISTRY

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Time allowed: *Three* hours

Answer *five* questions of which no more than two may be from any one section.
All questions carry *equal* marks. For a question with a choice between parts, all parts of that question carry equal marks.

Atomic masses (a.m.u.): H = 1.008, C=12.001, N =14.006, O = 15.999.

Section A

1

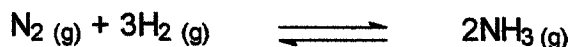
- (a) The alkaloid nicotine, a component of tobacco, contains 74.1% C, 8.6% H, and 17.3% N. Determine the empirical formula of nicotine.
- (b) If the molecular weight of nicotine is 162 gmol^{-1} , determine the molecular formula.
- (c) Draw a structure for nicotine. (Hint: it contains a pyridine ring and a heterocyclic five-membered ring).
- (d) Is nicotine considered to be an acid or a base? Explain your answer.

2

- (a) Outline the main points of the kinetic-molecular theory of gases.
- (b) Discuss *either* Boyle's Law *or* Charles' Law in terms of this theory.
- (c) An unknown gas composed of homonuclear diatomic molecules effuses at a rate that is only 0.355 times that of O_2 at the same temperature. What is the identity of the unknown gas?
- (d) Write a chemical equation for any reaction which this gas might undergo.

3

- Write a note on Gibbs Free Energy
- Discuss the effect of temperature on reaction spontaneity
- Predict the direction in which ΔG^0 will change with an increase in temperature for the equilibrium



- Calculate ΔG^0 at 500°C, assuming that ΔH^0 and ΔS^0 do not change with temperature.
- Discuss your answers in relation to the industrial production of ammonia.
Given: $\Delta H^0 = -92.38 \text{ kJ}$, $\Delta S^0 = -198.3 \text{ JK}^{-1}$

4

- "Some physical properties of solutions differ in important ways from those of pure solvent". Discuss.
- The average osmotic pressure of blood is 780 kPa at 25°C. What concentration of glucose will be isotonic with blood?
- Arrange the following aqueous solutions in order of their expected freezing points:
(i) 0.050 m calcium nitrate, (ii) 0.15 m sodium chloride, (iii) 0.10 m hydrochloric acid, (iv) 0.050 m acetic acid, (v) 0.10 m sucrose

Section B

5 Complete each of the following nuclear equations:

- $^{14}\text{C} \rightarrow ^{14}\text{N} + \quad t_{1/2} = 5570 \text{ y}$
- $^{212}\text{Po} \rightarrow ^{208}\text{Pb} + \quad t_{1/2} = 3 \times 10^{-7} \text{ s}$
- $^{90}\text{Mo} \rightarrow ^{90}\text{Nb} + \quad t_{1/2} = 5.7 \text{ h}$
- $^{239}\text{Np} \rightarrow ^{239}\text{Pu} + \quad t_{1/2} = 2.3 \text{ d}$
- $^{235}\text{U} + ^1_0\text{n} \rightarrow$
- $^3_1\text{H} + ^2_1\text{H} \rightarrow$

Discuss each reaction with respect to

- Stability of parent radionuclide,
- particle(s) produced,
- significance of the reaction, and
- biological effects, if any, of the reaction.