

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

SUMMER EXAMINATIONS, 2000

FIRST UNIVERSITY EXAMINATION
in
BIOMEDICAL SCIENCE, BIOTECHNOLOGY,
ENVIRONMENTAL SCIENCE

CHEMISTRY CH101

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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.

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

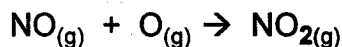
Section A

1

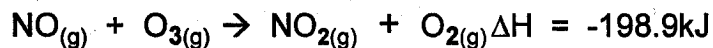
- (a) Vanillin, an aromatic compound containing hydroxyl, aldehyde and methoxyl groups, is the dominant flavour in vanilla and contains three elements: C, H and O. When 1.05g of this substance is completely combusted, 2.43g of CO₂ and 0.50g of H₂O are produced. What is the empirical formula of vanillin?
- (b) Draw the structure of vanillin (the empirical formula is the molecular formula).
- (c) Write any chemical reaction which vanillin might undergo.

2

- (a) Discuss briefly the first law of thermodynamics
- (b) Show using appropriate diagrams what is meant by the terms
(i) enthalpy change, (ii) endothermic reaction and (iii) exothermic reaction
- (c) State Hess's Law
- (d) Calculate ΔH for the reaction



given the following information:



3

(a) Write notes on each of the following:

- (i) Kinetic-molecular theory of gases
- (ii) Non-ideality of gases.

(b) If 1.000 mol of an ideal gas were confined to 22.4 dm³ at 0.0°C, it would exert a pressure of 101.325 kPa. Use the Van der Waals equation to estimate the pressure exerted by 1.000 mol of Cl₂ (g) in 22.4 dm³ at 0.0°C.

For Cl₂, $a = 657.6 \text{ kPa dm}^6 \text{ mol}^{-1}$, $b = 0.0562 \text{ dm}^3 \text{ mol}^{-1}$.

4

(a) Describe with the aid of a sketch the structure of any one crystal which has an ionic lattice. Show how the ratio of ions in the unit cell is related to the molecular formula.

(b) Crystals of metallic copper have a cubic unit cell which contains four copper atoms. By X-ray diffraction, the length of the side of this unit cell is found to be $3.61 \times 10^{-10} \text{ m}$. The density of copper is $8,920 \text{ kg m}^{-3}$ and its relative atomic mass is 63.5. Use these data to calculate the Avogadro constant.

Section B

5

(a) Write notes on each of the following including nuclear equations where appropriate:

- (i) Radiocarbon dating
- (ii) Radon gas in the environment
- (iii) Nuclear fission
- (iv) Nuclear fallout

(b) If a 1.000 g sample of ⁹⁰Sr decays, 0.953 g will remain after 2.00 years.

(i) What is the half-life of ⁹⁰Sr? (ii) How much ⁹⁰Sr will remain after 5.00 years?

6

(a) Compare the molecular structures of CF₄, SF₄, and XeF₄ using both valence shell electron pair repulsion theory and orbital hybridisation theory.

(b) Write the orbital configuration and four quantum numbers for the electrons in an atom of Cu.

7 Write an essay on the concerns of environmentalists with regard to the role of gases in atmospheric pollution. In your answer pay particular attention to

- (i) the greenhouse effect,
- (ii) ozone in the ozonosphere and in smog, and
- (iii) the oxides of nitrogen.

8 Answer *each* of the following:

- (a) Explain concisely what is meant by (i) oxidation, (ii) reduction and (iii) standard cell potential E°_{cell} .
- (b) Describe concisely any biological redox reaction.
- (c) Discuss the usefulness of the Nernst equation.
- (d) What is the emf of the following cell at 25°C?
 $\text{Zn(s)} \mid \text{Zn}^{2+} (0.0010\text{M}) \parallel \text{Cu}^{2+} (0.100\text{M}) \mid \text{Cu(s)}$
The standard emf of this cell is 1.10 V.

Section C

9 Discuss *each* of the following:

- (a) The electronic structure of alkenes
- (b) Any one method for the preparation of an alkene
- (c) Any three reactions of alkenes

10 Discuss *each* of the following:

- (a) structure of an α -amino acid at different pH values
- (b) titration curve and pI of any α -amino acid
- (c) peptide linkage
- (d) secondary structure of protein
- (e) tertiary structure of protein
- (f) quaternary structure of protein

11 Write an essay on the chemical structure of DNA.