

*Ollscoil na hÉireann, Gaillimh*  
*National University of Ireland, Galway*

GX 917

**Semester II Examinations, 2002/2003**

Exam Code(s)	<u>4BS2, 4EL3, 4EL4, 4BS9</u>
Exam(s)	<u>4<sup>th</sup> Science</u>
Module Code(s)	<u>4BS-EP448, 4BS2-AX410, 4EL3-EP441-7, 4EL4-AX402-7, 4BS9-EP436</u>
Module(s)	<u>EP436 : Thermodynamics</u>
Paper No.	<u>                    </u>
Repeat Paper	<u>                    </u> Special Paper <u>                    </u>
External Examiner(s)	<u>Professor E. Kennedy</u>
Internal Examiner(s)	<u>Professor S. G. Jennings</u>
	<u>Dr. A. Ó Rodaighe</u>

**Instructions:**      Answer TWO questions.

Duration	<u>1½ hrs</u>
No. of Answer Books	<u>1</u>

**Requirements:**

Handout	<u>                    </u>
MCQ	<u>                    </u>
Statistical Tables	<u>                    </u>
Graph Paper	<u>                    </u>
Log Graph Paper	<u>                    </u>
Other Material	<u>                    </u>

No. of Pages	<u>2</u>
Department(s)	<u>Experimental Physics</u>

## EP436: Thermodynamics

- Q.1 Write down Van der Waals equation for a real gas and explain how, and on what basis, it differs from the ideal gas equation. [3 marks]

Write a brief note on PV diagrams in the case of (a) an ideal gas, and (b) a real gas. Explain what the critical constants (pressure, temperature, molar volume) represent. [3 marks]

Show how the constants of the Van der Waals equation can be expressed in terms of the critical constants of a gas. Hence, or otherwise, show how the law of corresponding states can be deduced and write a brief note on that law. [4 marks]

- Q.2 Define the Gibbs free energy and comment briefly on its usefulness as a criterion of spontaneity. [2 marks]

For a reversible process, taking place at constant temperature and pressure, show that the decrease in the Gibbs free energy, during the process, is equal to the useful work that might in principle be obtained from the process. [3 marks]

Derive an expression for the change in the Gibbs free energy when  $n$  moles of an ideal gas expand from an initial volume  $P_1$  to a final volume  $P_2$ . Obtain a numerical value for the change in Gibbs free energy when 3 moles of an ideal gas expand from an initial pressure  $1.2 \times 10^5$  Pa to a final pressure  $1.0 \times 10^5$  Pa at a temperature of  $20^\circ\text{C}$ . [5 marks]  
(Gas constant  $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$ )

- Q.3 There are several alternative statements of the third law of thermodynamics. Give two such statements and explain them briefly in your own words. [3 marks]

Give an account of zero point energy, including an explanation of the theoretical basis for it and the evidence for its existence. [7 marks]