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NATIONAL UNIVERSITY OF IRELAND
GALWAY

SUMMER EXAMINATIONS 1999

Second Science Examination
Experimental Physics - (EP 214)

Experimental Physics

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Time allowed : TWO hours.
Answer three questions.

Q.1 Explain what are meant by the following: the triple point of water, the Kelvin temperature.

At what temperature is the numerical value the same using:
(a) the Celsius and Fahrenheit scales ?
(b) the Fahrenheit and Kelvin scales ?

State Newton's Law of cooling and show that $\Delta T = \Delta T_0 e^{-At}$ where ΔT and ΔT_0 are the temperature differences between an object and its surroundings at time t and time $t = 0$ respectively.

The source of heat breaks down inside a house early in the morning. The outside temperature is + 2 °C. As a result, the inside temperature falls from 22 °C to 18 °C in 45 minutes. How much longer does it take for the inside temperature to fall by another 4 °C, assuming that the outside temperature remains the same. Assume that Newton's law of cooling applies.

Q.2 Explain the following terms: equipartition principle, internal energy of a system, adiabatic process, molar specific heat capacity C, ideal gas.

Show that $T\,V^{\gamma-1} = constant$ for an adiabatic process for an ideal gas where T is the temperature, V is the volume and γ is the ratio of the specific heat capacity at constant pressure to that at constant volume.

A monatomic ideal gas initially at 21.0 °C is suddenly compressed to 80% of its original volume. What is its temperature after compression ?

Q.3 Explain briefly what are meant by the following: reversible change, efficiency of a heat engine, coefficient of performance of a refrigerator, 2nd law of thermodynamics.

Describe briefly the four stages of the Carnot cycle involving the isothermal expansion and compression stages and the adiabatic expansion and compression stages of the cycle.

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Q.4 Explain in words and through mathematical expression, what is meant by entropy.

Show that the change in entropy for a Carnot cycle is zero. Using that result, show that the entropy for any reversible cycle is also zero.

1 kg of ice at 0 °C is melted and converted to water at 0 °C. It is then heated to 100 °C. Calculate the total change in entropy for the two processes.

Heat of fusion of water = 3.35×10^5 J kg^{-1}
Specific heat capacity of water = 4180 J kg^{-1} K^{-1}

Q.5 Answer (A) or (B)

(A) Define the following: gauge pressure, hectopascal, millibar, Pascal's principle.

Show that the change in pressure, dp with height dy is given by

$$dp = -\rho g \, dy$$

where g is the acceleration due to gravity, and ρ is the fluid density.

A simple U-tube contains mercury under normal atmospheric pressure. When 11.2 cm of water is poured into the right arm of the U-tube how high does the mercury rise in the left arm from its initial level ?

Density of mercury = 13.595×10^3 kg m^{-3}

(B) Explain the following terms: flow streamline, mass flux, incompressible fluid, volume flow rate, coefficient of viscosity, Reynolds number.

Discuss the theoretical basis, and an experimental method, for the measurement of the coefficient of viscosity of a viscous liquid.