UNIVERSITY OF NOTTINGHAM

FACULTIES OF PURE SCIENCE AND APPLIED SCIENCE

FIRST YEAR PART I EXAMINATION, 1966

PHYSICS (ii)

THURSDAY *June 2nd* 9.45--12.45

Answer SIX *questions: not more than* FOUR *from Section* A *and not less than* TWO from *either Section B or Section* C sub*ject to the following restrictions.*

Section B may only be answered by those candidates reading HONOURS IN PHYSICS, JOINT HONOURS *where* PHYSICS is ***one*** *of two named subjects, or* HONOURS MATHEMATICS.

Section C may only be answered by those candidates reading HONOURS CHEMISTRY, HONOURS GEOLOGY, HONOIJRS GEOGRAPHY, HONOURS METALLURGY, *or remaininq* JOINT HONOURS.

SECTION A

1. Give a full account of Millikan's method of measuring the charge *e* on the electron.

Explain without giving experimental details another method for finding *e.*

2. Summarize the evidence for believing that the energy of electromagnetic radiation is quantized.

How can the value of Planck's constant *h* be determined.?

[Turn over

3. Stating clearly your assumptions, derive an expression for the decay of a radioactive element.

A specimen of radium contains 10^{20} nuclei initially. The half-life of ^{226}Ra is 1590 years. Calculate to three significant figures the number of nuclei which disintegrate in (*a*) the first 1000 years and (*b*) the firstday.

4. Explain how the fission of some heavy nuclei liberates energy.

Describe the construction and principles of operation of a nuclear reactor based on this process.

5. Classify all forms of matter on the basis of their ability to conduct electricity. Give a brief indication of the mechanism of conduction in each case.

Find the average drift velocity of the charge carriers in an electricity distribution cable of cross sectional area 1 cm^2, having 10^{22} free electrons per cm^3, carrying a current of 10^3 A. Explain why the charge carriers do not continue accelerating under the influence of the potential gradient existing in the wire.

(Electronic charge = 1.6×10^{-19} coulomb.)

6. Show in general how a knowledge of the laws governing the magnetic fields produced by current elements and the forces acting on them may be combined to give a consistent definition of unit current.

Find the tension in a current carrying circular loop placed with its plane perpendicular to a uniform magnetic induction B. Consider the forces acting on an element of the loop and ignore the field produced by the current itself.

7. State carefully the laws of electromagnetic induction.

Show how the e.m.f. developed in a short straight conductor moving in a magnetic field may he calculated by (*a*) using the above laws and (*b*) considering the force on the electrons in the conductor.

SECTION B

8B. A large electromagnet of inductance 100 H and resistance 2 ohm is connected to a generator of e.m..f. 100 V and internal resistance 3 ohm. Describe fully the behaviour of the current after switching on the generator. If a break occurs in the circuit and the current is observed to decrease from its maximum value to zero in 1 sec, estimate the average vo1tage which appears across the break and calculate the energy liberated during this process.

9B.Find the relationship between the current and charge senitivities of a galvanometer. The current sensitivity of a galvanometer is 10 cm μA^{-1} and its period in a circuit 1 sec. In addition it is known that a charge of 1 μC passed through the galvanometer in the same circuit in 0.01 sec causes a first deflection of 18π cm. Calculate the logarithmic decrement λ**.**

l0B. Show that, at angular frequencies ω near the resonance frequency ω_o , the complex impedance of a series *LCR* circuit of high *Q* may he written

$$Z = R\left[1 + 2jQ(\Delta\omega / \omega_0)\right], \text{ where } \Delta\omega = \omega_0 - \omega \ .$$

If *L* = 1 H, C = 1μF and *R* = 10 ohm, show that the values of $|Z|$ found by this approximation and, by the exact formula do not differ by more than 6% in the range $0 < (\Delta\omega / \omega_0) < 0.1$.

SECTION C

11C. An inductance *L* is placed in series with a resistor *R* and the combination connected in parallel with a capacitor *C.* Derive an expression for the impedance of this circuit at resonance.

Putting *L* = 100 mH, *R* = 30 ohm and *C* = 100 μμF, calculate the resonant frequency and the Q factor of the circuit.

[Turn over

12C. Explain in detail the action of *either* a thermionic diode *or* a solid state diode.

Describe a power supply circuit, using either device, which will run off alternating mains voltage and will provide direct current with very little ripple content. What parameters actually determine the ripple content?

13C. Explain the principle of operation of the junction transistor showing how it gives rise to voltage amplification.

Draw a circuit diagram of a two stage transistor amplifier employing grounded emitter stages naming the function of each component.