

AUTUMN EXAMINATIONS 1999

3rd year B.Sc. Unit EP323: Nuclear and Astrophysics

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Time allowed TWO hours

Answer THREE questions

Q.1 Answer *all* parts.

- (i) List the properties of the *up* and *down* quarks. Explain how the quarks combine to produce mesons and baryons. Tabulate the properties of the mesons and baryons which can be produced from the *up* and *down* quarks.
- (ii) Give a *brief* discussion of three different types of nuclear track detectors.
- (iii) Describe the different components of the Weizsaecker formula as used in the liquid drop model of the nucleus.

Q.2 A Cobalt-60 gamma-ray source, sealed in a 3 mm thick stainless steel casing, is placed in a water pool. Cherenkov emission is observed from the water.

- (a) Explain the origin of the Cherenkov emission.
- (b) Derive an expression for the particle threshold energy for Cherenkov emission.
- (c) Calculate the threshold energy for an electron in water.
- (d) Show quantitatively that electrons, with energy exceeding the Cherenkov threshold energy, will be present in the water.

Refractive index of water = 1.33

Mass of electron = 0.511 MeV

Speed of light = $3.00 \times 10^8 \text{ m s}^{-1}$

Co-60 gamma decay energies = 1.17 MeV, 1.33 MeV

Compton scattering formula:

$$\frac{1}{E'} - \frac{1}{E} = \frac{1}{m_0 c^2} (1 - \cos \theta)$$

p.t.o.

Q.3 Give an account of the life-cycle of medium and high mass stars. Concentrate upon mass-dependent differences, and also ways in which the differences are observed.

Q.4 Discuss any *two* of the following:

- (a) cosmological distance measurements;
- (b) the 'unified scheme' for active galactic nuclei;
- (c) dark matter.

Q.5 Briefly describe

- (a) the "Cosmological Principles" upon which all cosmological models are based,
- (b) the "Perfect Cosmological Model", and,
- (c) the "Big-Bang Cosmological Model".