2018

M.Sc. 4th Semester Examination

PHYSICS

PAPER—PHS-402

Subject Code—33

Full Marks : 40

Time : 2 Hours

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

Use separate Answer-scripts for Group-A & Group-B

Group-A

[Marks : 20]

Answer Q. No. *1* and any *one* from the rest.

1. Answer any *five* bits : 2×5

(a) Consider the reaction ${}_1H^3(d, n) \rightarrow {}_2He^4 + 17.6$ Mev

If $(R_d + R_t) \simeq 4$ fm.

Calculate the height of the coulomb barrier of ${}_1H^3$ nucleus in Kev.

(Turn Over)

(b) If internucleon potential in deuteron to be of rectangular well type with depth V_0, range r_0 and B.E. (E_B), prove

that radius of the deuteron is $\frac{2r_0}{\pi}\sqrt{\frac{V_0 - E_B}{E_B}}$.

(c) (i) $\pi^- + p \rightarrow \Sigma^+ + k^-$

(ii) $\Omega^- \rightarrow \Xi^\circ + \pi^-$

Which of the above reactions is allowed ? Give reasons.

(d) Plot potential vs 'separation of fission fragments' for $_{92}U^{235}$ and yield Y(A) vs A.

(e) Draw the energy level diagram for the following reaction :

$$U^{235} + n^1 \rightarrow Ba^{143} + Kr^{90} + 3n^1.$$

(f) In case of an elastic collision, use the Q equation to find the K.E. of the outgoing projectile.

(g) Calculate the cross-section for n–p scattering at neutron energy 2 Mev (lab),

$a_t = 5.38$ fm, $a_s = -23.7$ fm,

$r_{ot} = 1.70$ fm, $r_{os} = 2.40$fm.

(h) Calculate the magnetic moment and quadrupole moment of ${}_{29}Cu^{63}$.

2. (a) Deduce an expression for scattering length and effective range for n–p scattering.

(b) Plot $\frac{d\sigma}{d\Omega}$ vs θ for n–p scattering.

(4+4)+2

3. (a) Calculate the magnetic moment of deuteron.

(b) When F^{19} is bounbarded with protons in (p, n) reaction with subsequent α-emission occurs. Calculate the excitation energy of the compound nucleus that corresponds to the resonance with a proton energy of 4.99 Mev.

(c) Why the Breit-Wigner formula is called dispersion formula ?

4+4+2

Group-B

[Marks : 20]

Answer Q. No. *1* and any *one* from the rest.

1. Answer any *five* bits : 2×5

(a) Find the Euler-Lagrange equation for the Lagrangian density $\mathcal{L} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \frac{1}{2}m^2 A_\mu A^\mu$

where $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$.

(b) Prove that the equations of motion remain unchanged if the divergence of an arbitrary field function is added to the Lagrangian density.

(c) Find the Canonical Hamiltonian for free scalar field.

(d) Prove that Lagrangian density

$$\mathcal{L} = \overline{\psi}(i\phi - m)\psi$$

is invariant under phase transformation

$$\psi' = e^{i\theta}\psi.$$

(e) For free e.m. field, prove that

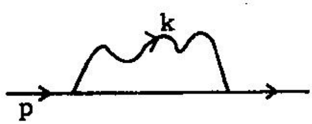
$$T_{00} = \frac{1}{2}\left(\left|\vec{E}\right|^2 + \left|\vec{B}\right|^2\right)$$

where T_{00} is the component of energy momentum tensor.

(f) Draw the Feynman diagram for compton scattering $e^-\gamma \rightarrow e^-\gamma$.

(g) Prove that $(\not{p} + m)\gamma^\mu u(p) = 2p^\mu u(p)$.

(h) Write the expression for Feynman amplitude for the figure



2. (a) For Dirac field

$$\psi(x) = \frac{1}{(2\pi)^{3/2}} \sum_{r=1}^{2} \int d^3\vec{p} \sqrt{\frac{m}{E_{\vec{p}}}} \left(u_r(\vec{p})c_r(\vec{p})e^{-ip.x} + v_r(\vec{p})d_r^+(\vec{p})e^{+ip.x}\right)$$

Express Hamiltonian in terms of creation and anihilation operators.

(b) Evaluate $\left[\hat{H}, C_r^+(\vec{p})\, C_r(\vec{p})\right]$.

(c) Evaluate momentum $\vec{p}$. 4+3+3

3. (a) For e.m. field, prove that

$$\left[\hat{H}, A^{\mu}(x)\right] = -i\, \partial^{\circ} A^{\mu}.$$

(b) $\left[p^{i}, A^{\mu}(x)\right] = -i\, \partial^{i} A^{\mu}(x)$.

(c) Calculate the cross-section per unit volume for the creation of electron-positron pairs by the e.m. potential $A^{\mu} = (0, 0, ae^{-i\omega t}, 0)$ where ω and 'a' are constants.

2+2+6
