



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Supplementary Examination, July 2020

Programme: B.Sc. Chemistry/Mathematics
Course Name: Nuclear and Particle Physics
Course Code: PHYS 2012
No. of page/s: 7

Semester : IV
Max. Marks : 100
Attempt Duration : 3 Hrs.

Note:

1. Read the instruction carefully before attempting.
2. This question paper has two section, Section A and Section B.
3. There are total of six questions in this question paper. **One** in **Section A** and **five** in **Section B**
4. **Section A** consist of multiple choice based questions and has the total weightage of 60%.
5. **Section A** will be conducted online on BB Collaborate platform
6. **Section B** consist of long answer based questions and has the total weightage of 40%. The questions for section B shall also appear in BB Collaborate
7. **Section B** is to be submitted within 24 hrs from the scheduled time i.e. if the examination starts at 10:00 AM, the long answers must be submitted by 09:59:59 AM next day. Similarly, if the examination starts at 2:00 PM it must be submitted by 01:59:59 PM next day. (*Exceptional provision due extraordinary circumstance due to COVID-19 and due to internet connectivity issues in the far-flung areas*).
8. No submission of **Section B** shall be entertained after 24 Hrs.
9. **Section B** should be attempted after **Section A**
10. **Section B** should be attempted on blank white sheets (hand written) with all the details like programme, semester, course name, course code, name of the student, Sap id at the top (as in the format) and signature at the bottom (right hand side bottom corner)
11. Both section A & B should have questions from entire syllabus.
12. The COs mapping, internal choices within a section is same as earlier

Section – A (Attempt all the questions)
(60 marks. (2marks x 30))

Q1: Choose the correct answer:

(A) Quadrupole moment of spherical nucleus is

[CO2]

- a) Zero
- b) Positive

- c) Negative
- d) Half

(B) In case of Cerenkov radiation, the velocity of the charged particle in the transparent dielectric medium is [CO4]

- a) less than the velocity of light in that medium
- b) more than the velocity of light in the medium
- c) equal than the velocity of light in the medium
- d) none of the above

(C) Which of the following acts as quenching gas in Geiger Muller counter ? [CO1]

- a) Alcohol
- b) Argon gas
- c) Krypton
- d) Hydrogen

(D) The saturation current in the graph between voltage and current is called [CO1]

- a) Ionization region
- b) Proportional region
- c) Plateau region
- d) None of the above

(E) Redshift measurements of a galaxy yield a recession of 1700 km/s. Hubble's constant H is $23 \text{ km/s}/10^6 \text{ c.y.}$. The distance to the galaxy is approximately [CO4]

- a) $36 \times 10^6 \text{ c.y.}$
- b) $47 \times 10^6 \text{ c.y.}$
- c) $66 \times 10^6 \text{ c.y.}$
- d) $74 \times 10^6 \text{ c.y.}$

(F) A free neutron is [CO1]

- a) stable
- b) Unstable and decay into a proton, an electron and a neutrino
- c) Unstable and decay into a proton, an electron and an anti-neutrino
- d) Called neutrino

(G) The scintillator counter are highly suitable for detection of [CO4]

- a) alpha rays
- b) beta rays
- c) gamma rays

d) none of the above

(H) The isospin of π^+ is

[CO1]

- a) 0
- b) 1
- c) 1/2
- d) -1/2

(I) What is the typical voltage applied in a gaseous ionization detector?

[CO1]

- a) Between 1V and 100V
- b) Between 100V and 1500V
- c) Between 1500V and 2500V
- d) Between 2500V and 5000V

(J) The time during which the pulse are recorded but have smaller magnitude in G.M. counter is called

[CO2]

- a) Resolving time
- b) Dead Time
- c) Recovery Time
- d) None of the above

(K) The decay constant of end product of radioactive series is

[CO3]

- a) zero
- b) infinity
- c) uncertain
- d) may be zero or infinity

(L) In shell model

[CO2]

- a) Protons and neutrons interact with each other
- b) Protons and protons interact with each other
- c) Nucleons do not interact with each other
- d) None of these

(M) Semi empirical mass formula is useful for explaining

[CO2]

- a) Fission
- b) Fusion
- c) Nuclear binding energy
- d) Nuclear stability against alpha and beta decay

(N) In an accelerator the particle energy is increased by [CO3]

- a) the electric field of a radio frequency wave
- b) the magnetic field of a dipole
- c) the magnetic field of a quadrupole
- d) none of these

(O) A photon can disappear producing an electron and positron. What is this phenomenon called? [CO2]

- a) X-ray diffraction
- b) Electron scattering
- c) Pair annihilation
- d) Pair production

(P) Half life of a radioelement depends on [CO2]

- a) Temperature
- b) Pressure
- c) amount of substance present
- d) amount of substance disintegrated

(Q) A meson is a bound state of [CO2]

- a) 3-quarks
- b) 5-quarks
- c) 2-quarks
- d) a quark and an antiquark

(R) Angular velocity of a charged particle moving in a circular orbit under the influence of magnetic field is given by [CO2]

- a) qm/B
- b) qm^2/B
- c) em/B^2
- d) eB/m

(S) The charge on up quark is [CO1]

- a) $e/2$
- b) $2e/3$
- c) $-e/3$
- d) $-2e/3$

(T) Nuclear forces are [CO1]

- a) long range forces
- b) short range forces
- c) Electromagnetic forces
- d) gravitational forces

(U) The size of the atomic nucleus is: [CO1]

- a) 10^{-3}cm
- b) 10^{-10}cm
- c) 10^{-13}cm
- d) 10^{-15}cm

(V) A semiconductor detector... [CO3]

- a) produces a slow electrical signal
- b) produces an electrical signal independent of dE/dx
- c) produces a pair of charges with less deposited energy than the gaseous detector
- d) none is true

(W) In a transmutation reaction, the target and the product nuclei are [CO2]

- a) Totally unrelated to each other
- b) Close neighbors in the periodic table
- c) Temporary stable
- d) Mirror images of each other

(X) The Compton Shift corresponding to 180° value of photon scattering angle will be- [CO3]

- a) 0.242 \AA
- b) 0.0484 \AA
- c) 0.0242 \AA
- d) 2.42 \AA

(Y) Which of the following acts as quenching gas in Geiger Muller counter? [CO1]

- a) Alcohol
- b) Argon gas
- c) Krypton
- d) Hydrogen

(Z) Quarks are [CO1]

- a) Bosons

- b) Fermions
- c) atoms
- d) molecules

(AA) Photoelectric effect can take place only when photons strike bound electrons or electrons embedded in the metal surface, since it is impossible for a photon to give up all its energy and momentum to a free electron. This is in accordance with the law of conservation of- [CO2]

- a) Energy
- b) mass
- c) momentum
- d) All of these

(AB) The conservation law violated by the reaction $p \rightarrow \pi^0 + e^+$ is the conservation of [CO3]

- a) charge
- b) energy
- c) lepton number and Baryon number
- d) linear momentum

(AC) An astronomical unit (AU) is _____. [CO1]

- a) the average distance between any two planets
- b) the average distance between the Sun and Earth
- c) any very large unit, such as a light-year
- d) the average distance between the Sun and Pluto

(AD) If the kinetic energy of incident particles passing through matter is comparable to rest mass energy, then the energy loss by the emission of electromagnetic radiations is called as [CO3]

- a) Compton effect
- b) Bremsstrahlung
- c) Cerenkov radiation
- d) None of these

PART B Total Marks 40

Q2	Calculate the time required to disintegrate pure sample of ${}_{90}\text{Th}^{232}$ to 10% of its initial value. The half life of ${}_{90}\text{Th}^{232}$ is 1.4×10^{10} years. [CO3]	08
Q3	Derive the Bethe- Bloch formula for the energy loss of a heavy charged particle moving through matter. [CO2]	08

Q4	Explain the principle, working and use of a G.M. counter. How does it differ from ionization chamber? [CO1]	08
Q5	What is Compton effect? Derive an expression for change in wavelength when a gamma ray photon undergoes Compton scattering [CO2]	08
Q6	Which of the following reaction are allowed and forbidden: (i) $\pi^+n \rightarrow \pi^0 + k^+$ (ii) $\pi^+n \rightarrow k^0 + k^+$ (iii) $\pi^0n \rightarrow k^- + \Sigma^0$ (iv) $p \rightarrow e^+ + \gamma$ [CO4]	08