



Reg. No. :

Name :

Sixth Semester B.Sc. Degree Examination, April 2015

First Degree Programme under CBCSS

PHYSICS

Core Course – X

PY 1642 : Nuclear and Particle Physics

Time : 3 Hours

Max. Weight : 30

SECTION – A

This Section contains **four** bunches **each** of four questions. Answer **all** questions. **Each** bunch carries a weightage of **one**.

I. Choose the best from the options given.

1) These are positively charged particles emitted by some radioactive substances

- | | |
|--------------------|-------------|
| a) gamma rays | b) protons |
| c) alpha particles | d) neutrons |

2) Betatrons are used to accelerate

- | | |
|--------------------|--------------|
| a) protons | b) electrons |
| c) alpha particles | d) ions |

3) Tokamak is used for experiments related to

- | | |
|-------------------|--------------------|
| a) nuclear fusion | b) nuclear fission |
| c) radioactivity | d) cosmic rays |

4) These are produced by charged particles moving at a speed greater than that of light in the medium

- | | |
|------------------------|-------------------|
| a) Cyclotron radiation | b) Bremsstrahlung |
| c) Cerenkov radiation | d) Cosmic rays |

II. 5) Weakest of all fundamental forces

- | | |
|-----------------|--------------------------|
| a) strong force | b) electromagnetic force |
| c) weak force | d) gravity |

6) Isotopic nuclei have the same number of

- | | | | |
|-------------|-------------|------------|--------------|
| a) nucleons | b) neutrons | c) protons | d) electrons |
|-------------|-------------|------------|--------------|



- 7) A quark with charge $+ \frac{2}{3}$
- | | |
|-----------------|------------------|
| a) down quark | b) strange quark |
| c) bottom quark | d) up quark |
- 8) Scattering cross section has the same dimensions as that of
- | | |
|----------|-------------|
| a) area | b) pressure |
| c) force | d) energy |

III. Fill in the blanks appropriately.

- 9) Half life and mean life of a radioactive substance are related by the formula
- 10) Isotope with a nuclei having two protons and a neutron is known as
- 11) Primary cosmic rays consist mostly of _____ and alpha particles.
- 12) _____ radiation literally means braking radiation.

IV. State whether **true** or **false**.

- 13) The Koodankulam nuclear reactor works on the principle of nuclear fusion.
- 14) Gamma rays consist of very high energy photons.
- 15) Deuteron is an elementary particle.
- 16) Lepton number is conserved in all known interactions.

SECTION – B

Answer **any eight** questions. **Each** question carries a weightage of **one**.

- 17) Neutron is a neutral particle. But it has a small magnetic moment. How would you qualitatively explain that ?
- 18) What is a van de Graf generator ?
- 19) Write a brief note on neutrinos.
- 20) What do you mean by the Meson theory of nuclear forces ?
- 21) How does a synchrocyclotron differ from an ordinary cyclotron ?



- 22) Why do we have no nuclei with just two protons ?
- 23) Write a brief note on carbon dating.
- 24) What do you mean by a fast breeder reactor ?
- 25) What is the role of 'moderator' in a nuclear reactor ?
- 26) What is meant by latitude effect in the case of cosmic rays ? How would you explain it ?
- 27) What is 'strange' about strange particles ?
- 28) Explain why confinement is a big problem in the case of fusion reactors ?

SECTION – C

Answer **any five** questions. **Each** question carries a weightage of **two**.

- 29) Calculate the binding energy per nucleon for nitrogen (mass 14.003074 amu).
Given mass of proton and neutron to be 0.997593 and 1.006982 amu respectively.
(1 amu = 1.66×10^{-27} kg and $c = 3 \times 10^8$ m/s).
- 30) Assuming $\frac{1}{3}$ rd power law of atomic weight and $r_0 = 1.5 \times 10^{-15}$ m, find the radius of magnesium – 24 nucleus.
- 31) ${}_{92}\text{U}^{238}$ nucleus decays by emitting an alpha particle and this is followed by two electron beta emissions. Find Z and A of the final product.
- 32) How many years are needed to reduce the activity of carbon – 14 to 0.02 of its original activity ? The half life of carbon – 14 is 5730 years.
- 33) Half life of ${}^{40}\text{K}$ is 1.25 billion years. What percentage of ${}^{40}\text{K}$ in a sample will decay in 3.75 billion years ?



- 34) Check whether lepton number and baryon number are conserved in these reactions.
- a) $n \rightarrow p + e$
 - b) $e^+ + e^- \rightarrow 2\gamma$
 - c) $p + \pi^- \rightarrow n + \pi^0$
 - d) $p \rightarrow e^+ + \gamma$
- 35) What is the rate at which mass is converted into energy in the sun if the rate of production of energy is $3.9 \times 10^{26} \text{ W}$?
- 36) A cyclotron is operated at an oscillator frequency of 12 MHz and has a dee radius $R = 53 \text{ cm}$. What is the magnitude of the magnetic field needed for deuterons to be accelerated in the cyclotron ? Its mass = $3.34 \times 10^{-27} \text{ kg}$ and charge = $1.6 \times 10^{-19} \text{ C}$.

SECTION – D

Answer **any two** questions. **Each** question carries a weightage of **four**.

- 37) Discuss liquid drop model of nucleus. State its merits and demerits.
- 38) Write an essay on the elementary particles and their interactions.
- 39) Explain the working of GM counter and scintillation counter.