



**University of Sri Jayewardenepura**  
**Faculty of Applied Sciences**  
**B.Sc. General Degree Examination**  
**Second year-Second Semester Examination June 2022**  
**PHY 208 1.0- Atomic & Nuclear Physics**  
**Time: One hour**

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Answer all questions.

Select and circle the most correct answer or appropriate statement on the exam paper.

Symbols have their usual meanings.

Total of 60 marks {Q1-Q20 (2 marks each), Q21-Q25 (4 marks each)}

Index #:
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Q1. Why has nuclear energy become an inevitable option for the development of the country?

- |   |  |
|---|--|
| (i) Because of the less pollution caused by nuclear plant | (ii) High efficiency of nuclear energy               |
| (iii) Due to acute shortage of other sources of energy    | (iv) High cost of energy production of other sources |

Q2. What is the most attractive part of nuclear energy?

- |                                     |   |
|-------------------------------------|---|
| (i) Supports countries development. | (ii) Has high efficiency of energy production |
| (iii) no pollution                  | (iv) is available in abundance                |

Q3. In which of the following process are Neutrons emitted?

- |                       |                            |
|-----------------------|----------------------------|
| (i) beta Decay        | (ii) nuclear fusion        |
| (iii) nuclear fission | (iv) none of these choices |

Q4. Who invented nuclear fission?

- |                |                 |                |                  |
|----------------|-----------------|----------------|------------------|
| (i) Rutherford | (ii) Hans Bethe | (iii) Otto Han | (iv) Marie Curie |
|----------------|-----------------|----------------|------------------|

Q5. Nucleus consists of two sub-particles known as.....

- |                 |               |                |                  |
|-----------------|---------------|----------------|------------------|
| (i) Nucleotides | (ii) Neutrons | (iii) Nucleons | (iv) Nucleosides |
|-----------------|---------------|----------------|------------------|

Q6. Atoms of different chemical elements that have the same number of nucleons are called as

.....

- |             |              |                |               |
|-------------|--------------|----------------|---------------|
| (i) isobars | (ii) isomers | (iii) isotones | (iv) isotopes |
|-------------|--------------|----------------|---------------|

Q7. Which of the following did Bohr use to explain his theory?

- (i) Conservation of linear momentum.                      (ii) The quantization of angular momentum.  
(iii) Conservation of quantum frequency.                      (iv) conservation of mass.

Q8. What is the valence electron in alkali metal?

- (i) f-electron                      (ii) p-electron                      (iii) s-electron                      (iv) d-electron

Q9. If an  $\alpha$ -particle collides head-on with a nucleus, what is its impact parameter?

- (i) Zero                      (ii) Infinite                      (iii)  $10^{-10}$  m.                      (iv)  $10^{-16}$  m.

Q10. Which pairs of species will have the same electronic configuration for both members?

- (i)  $\text{Li}^+$  and  $\text{Na}^+$ .                      (ii) He and  $\text{Ne}^+$ .                      (iii) H and Li.                      (iv) C and  $\text{N}^+$ .

Q 11. What is the naturally occurring isotope in a banana that gives it its radioactivity?

- (i) K-40                      (ii) H-1                      (iii) C-12                      (iv) O-16

Q12. What happens when a neutron is absorbed by a nucleus of an atom of  $\text{U}^{235}$ ?

- (i) mass number of atom increases.                      (ii) one electron is left out.  
(iii)  $\text{U}^{236}$  isotope is formed.                      (iv) nucleus becomes unstable.

Q13-14. In a muonic hydrogen atom, the electron is replaced by a negatively charged particle called a muon. The muon has the same charge as an electron, but its mass is 207 times the mass of an electron. Apply the Bohr model to a muonic hydrogen atom.

[ Bohr radius of the H-atom is 0.053 nm and the ground state energy is -13.6 eV.]

Q13. What is the radius of the orbit of the muon in ground state?

- (i)  $2.6 \times 10^{-13}$  m                      (ii)  $1.1 \times 10^{-10}$  m                      (iii)  $2.3 \times 10^{-12}$  m                      (iv)  $5.2 \times 10^{-13}$  m

Q14. What is the energy of the ground state?

- (i)  $-3.5 \times 10^{-16}$  J                      (ii)  $-1.1 \times 10^{-20}$  J                      (iii)  $-5.0 \times 10^{-17}$  J                      (iv)  $-4.5 \times 10^{-16}$  J

Q15. When a cool gas is placed between a glowing wire filament source and a diffraction grating, the resulting spectrum from the grating is which one of the following?

- (i) monochromatic                      (ii) line emission                      (iii) line absorption                      (iv) continuous

Q 16. Rutherford's experiments involving the use of alpha particle beams directed onto thin metal foils demonstrated the existence of which of the following?

- (i) proton                      (ii) neutron                      (iii) nucleus                      (iv) positron

Q 17. If a hydrogen atom, originally in its ground state of energy  $-13.6$  eV, absorbs a photon of energy  $30.0$  eV, what is the resulting kinetic energy of the electron if the proton has negligible kinetic energy?

- (i) Such a photon cannot be absorbed in this case.  
(ii)  $8.4$  eV  
(iii)  $16.4$  eV  
(iv)  $2.4$  eV

Q 18. A hydrogen gas discharge tube emitted various wavelengths of photons associated with transitions from higher levels down to the  $n = 2$  level. What type of spectra this produce?

- (i) a mixture of visible & infrared  
(ii) infrared  
(iii) visible  
(iv) ultraviolet

Q19. In the Bohr model of the atom, the orbits where electrons move slowest.....

- (i) have the least angular momentum.  
(ii) have the highest energy.  
(iii) have the lowest energy.  
(iv) have the least radius.

Q20. The restriction that no more than one electron may occupy a given quantum state in an atom was first stated by which of the following scientists?

- (i) de Broglie  
(ii) Heisenberg  
(iii) Bohr  
(iv) Pauli

Q 21-23. A Giger counter used for measuring the activity of a given radioactive sample shows 9750 counts at a particular instant and after 7 minutes later it shows 3000 counts.

Find correct answers for questions 21, 22, and 23.

Q 21. What is the decay constant of the radioactive sample?

- (i)  $0.0128 \text{ s}^{-1}$       (ii)  $0.168 \text{ s}^{-1}$       (iii)  $0.0228 \text{ s}^{-1}$       (iv)  $0.0028 \text{ s}^{-1}$

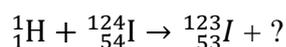
Q 22. What is the half-life of the substance?

- (i) 462.65 s      (ii) 247.5 s      (iii) 624.65 s      (iv) 264.65 s

Q 23. What is the mean-life of the radio-active element present in the sample?

- (i) 153.4 s      (ii) 135.4 s      (iii) 315.4 s      (iv) 357.1 s

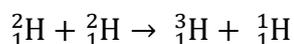
Q 24. The tracer  $^{123}_{53}\text{I}$  (iodine) is used to treat thyroid problems. This nucleus is produced by bombarding xenon with protons in the reaction



Assuming the question mark represents a single type of nucleus, what is that nucleus?

- (i)  $2^1_1\text{H}$       (ii)  $^4_2\text{He}$       (iii)  $^6_3\text{Li}$       (iv)  $^2_2\text{H}$

Q 25. A fusion reaction that might be used in a power reactor involves deuterium,  $^2_1\text{H}$ ;



In this reaction, what is the energy released in this reaction?

(mass [ $^1_1\text{H}$ ] = 1.007825 u, mass [ $^2_1\text{H}$ ] = 2.014102 u, mass [ $^3_1\text{H}$ ] = 3.016049 u, 1 u = 931.5 MeV/c<sup>2</sup>)

- (i) -4.033 MeV      (ii) 4.033 MeV      (iii) -4.648 eV      (iv) 4.648 eV

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Q1-Q4 covers ILO 3, 5

Q5-Q8 covers ILO 1, 2

Q9-Q12 covers ILO 2, 4

Q13-Q20 covers ILO 1, 4

Q21-Q25 covers ILO 4, 5