PHY 208 1.0 - Atomic & Nuclear Physics

Time: One (01) hour	No. of questions: 25	No. of pages: 04	Total marks: 100

Answer ALL questions

Select and circle the most correct answer or
Fill in the blanks with appropriate words or statement <u>on</u> the exam paper.

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Symbols have their usual meanings.

Q1. According to Bohr's theory of the hydrogen atom, electrons starting in the 4th energy level and eventually ending in the ground state could produce a total of how many different spectral lines?

(i) 3   (ii) 4   (iii) 6   (iv) 9

Q2. 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

Q3. What is the valence electron in alkali metal?

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

Q4. Which pairs of species will have the same electronic configuration for both members?

(i) Li+ and Na+   (ii) He and Ne+   (iii) H and Li   (iv) C and N+

Q5. 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

Q6. What happens when a neutron is absorbed by a nucleus of an atom of U235?

(i) mass number of atom increases   (ii) one electron is let out

(iii) U236 isotope is formed   (iv) nucleus becomes unstable

Q7-10. Fill in the blanks by selecting suitable words from the list given below.

(positive, negative, zero, mass number, mass defect, atomic mass, packing fraction)

Q7. The mass defect of the atom is the difference of it atomic mass and its……...

Q8. The packing fraction is the ………..per elementary particle in the nucleus.

Q9. The packing fraction is ………. for elements having mass number below 20.

Q10. The packing fraction is ……… for elements having mass numbers between 20 and 200.

Q11. 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 12. 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 13. What is the energy E, released when two deutron nuclei fuse to form Helium nucleus, given that binding energies per nucleon of ^2_1H and ^4_2He are 1.1 and 7 MeV respectively?

$$^2_1H + ^2_1H \rightarrow ^4_2He + E$$
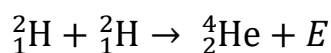
(i) 4.8 MeV   (ii) 4.033 MeV   (iii) -4.8 MeV   (iv) -4.033 MeV

Q 14. Rutherford's "Scattering α–particles by a gold foil" experiment disproved which of the following?

(i) Plum-pudding model of the atom
(ii) Planetary model of the atom
(iii) De Broglie hypothesis
(iv) Wave nature of light

Q15. Which of the following statement(s) can be associated with Bohr's theory of the atom? (Select 2 answers)

(i) An electron orbiting the nucleus can change its energy continuously

(ii) An electron orbiting the nucleus emits energy and falls on the nucleus

(iii) An electron can change its energy only by a certain portion when it jumps between the orbits

(iv) The angular momentum of an electron around the nucleus is equal an integer times $h/2\pi$

Q16. 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

Q17. 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

Q18. Who invented nuclear fission?

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

Q19-20. When an atom of U235 undergoes fission in a reactor 200 MeV energy is liberated. Suppose that the power out is 800 MW and reactor is 25% efficient.

Q19. How many uranium atoms does it consume in one day?

(i) 9.64×10^{26} (ii)) 4.82×10^{26} (iii) 6.94×10^{26} (iv) 3.47×10^{26}

Q20. What mass of uranium does it consume in one day?

(i) 376.31 kg   (ii)) 300.21 kg   (iii) 763.11 kg   (iv) 147.23 kg

Q 21-23. A Giger counter used for measuring the activity of a given radioactive sample shows 4750 counts at a particular instant and after 5 minutes later it shows 2700 counts.

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

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

(i) 0.0188 per second   (ii) 0.188 per second   (iii) 0.0218 per second   (iv) 0.00188 per second

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

(i) 0.3682 s   (ii) 36.82 s   (iii) 3.682 s   (iv) 368.2 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) 531.4 s

Q 24-25. A photon is emitted by a hydrogen atom when an electron makes a transition from n = 2 to n = 1 state. Given that the ionization potential = 13.6 eV.

Q 24. What is the energy of the photon emitted?

(i) 18.6 eV   (ii) 10.2 eV   (iii) 16.32 eV   (iv) 1.02 eV

Q 25. What is the wavelength of the photon emitted? (Hint: find the momentum)

(i) 1218 Å   (ii) 1318 Å   (iii) 2218 Å   (iv) 2318 Å

Bonus Question: (05 points)-Optional

Briefly discuss one of the medical applications given below under atomic or nuclear physics.

   (i) LASIK (Laser-assisted in situ keratomileusis) eye surgery
   (ii) Diagnostic techniques

******End of the Paper******