V PLUS U
IIT/PMT INSTITUTE

CHAPTER TEST

Subject : Physics **Topic : Atoms and Nuclei** **M.M. : 180**

Have patience all things are difficult before they become easy.

Marking Scheme:
(i) Each question is allotted 4 (four) marks for each correct response.
(ii) ¼ (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.

Q.1 The radius of the shortest orbit of a single electron system is 18 pm. This system may be
(A) H (B) D
(C) He^+ (D) Li^{++}

Q.2 Determine the ratio of area of circular orbits in doubly ionised lithium atom in 2nd & 3rd Bohr orbit
(A) 16 : 81 (B) 4 : 5
(C) 1 : 3 (D) 1 : 1

Q.3 Determine the ratio of perimeters in 2^{nd} & 3^{rd} Bohr orbit in He^+ atom.
(A) 1 : 2 (B) 2 : 3
(C) 1 : 4 (D) 4 : 9

Q.4 If the atom $_{100}Fm^{257}$ follows the Bohr model and the radius of $_{100}Fm^{257}$ is n times the Bohr radius, then find n.
(A) 100 (B) 200
(C) 4 (D) 1/4

Q.5 Determine the ratio of speed of electron in 3rd orbit of He^+ to 4th orbit of Li^{++} atom
(A) 1 : 2 (B) 8 : 9
(C) 1 : 3 (D) 4 : 9

Q.6 A hydrogen atom rises from its n = 1 state to the n = 4 state by absorbing energy. If the potential energy of the atom in the n = 1 state be –13.6eV, then potential energy in the n = 4 state will be -
(A) 3.4 eV (B) –1.54 eV
(C) 0.85 eV (D) – 0.85 eV

Q.7 In the nuclear reaction,
$_{92}U^{238} \rightarrow {}_{Z}Th^{A} + {}_{2}He^{4}$, the values of A and Z are-
(A) A = 234, Z = 94 (B) A = 234, Z = 90
(C) A = 238, Z = 94 (D) A = 238, Z = 90

Q.8 The energy released per fission of uranium 235 is about 200 MeV. A reactor using U-235 as fuel is producing 1000 kilowatts power. The number of U-235 nuclei undergoing fission per sec is, approximately-
(A) 10^6 (B) 2×10^8
(C) 3×10^{16} (D) 931

Q.9 A radioactive material decays by simultaneous emission of two particles with respective half lives 1620 and 810 years. The time (in years) after which one- fourth of the material remains is
(A) 1080 (B) 2430
(C) 3240 (D) 4860

Q.10 13.6 eV energy is required to ionize the hydrogen atom, then the energy required to remove an e^- from n = 2 is –
(A) 10.2 eV (B) 0 eV
(C) 3.4 eV (D) 6.8 eV

Q.11 The wavelengths involved in the spectrum of deuterium $({}_{1}^{2}D)$ are slightly different from that of hydrogen spectrum, because –
(A) The nuclear forces are different in the two cases.
(B) The masses of the two nuclei are different.
(C) The attraction between the electron and the nucleus is different in the two cases.
(D) The size of the two nuclei are different.

Q.12 If the binding energy of the electron in a hydrogen atom is 13.6 eV, the energy required to remove the electron from the first excited state of Li^{++} is –
(A) 13.6 eV (B) 3.4 eV
(C) 122.4 eV (D) 30.6 eV

Q.13 Suppose an electron is attracted towards the origin by a force (k/r)where k is a constant and r is the distance of the electron from the origin. By applying Bohr model to this system, the radius of the n^{th} orbital of the electron is found to be r_n and the kinetic energy of the electron to be T_n. Then which of the following is true?

(A) T_n independent of n, $r_n \propto n$
(B) $T_n \propto 1/n$, $r_n \propto n$
(C) $T_n \propto 1/n$, $r_n \propto n^2$
(D) $T_n \propto 1/n^2$, $r_n \propto n^2$

Q.14 The transition from the state n = 4 to n = 3 in a hydrogen like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition from -

(A) $2 \to 1$ (B) $3 \to 2$
(C) $4 \to 2$ (D) $5 \to 4$

Q.15 In the nuclear fusion reaction

${}_1^2H + {}_1^3H \to {}_2^4H + n$, given that the repulsive potential energy between the two nuclei is $\sim 7.7 \times 10^{-14}$ J, the temperature at which the gases must be heated to initiate the reaction is nearly (Boltzman constant $K = 1.38 \times 10^{-23}$ J/k)

(A) 10^5 K (B) 10^3 K
(C) 10^9 K (D) 10^7 K

Q.16 For uranium nucleus how does its mass vary with volume?

(A) $m \propto V$ (B) $m \propto 1/V$
(C) $m \propto \sqrt{V}$ (D) $m \propto V^2$

Q.17 A nucleus with mass number 220 initially at rest emits an α-particle. If the Q value of the reaction is 5.5 MeV, calculate the kinetic energy of the α-particle.

(A) 4.4 MeV (B) 5.4 MeV
(C) 5.6 MeV (D) 6.5 MeV

Q.18 If M_0 is the mass of an oxygen isotope ${}_8O^{17}$, Mp and M_N are the masses of a proton and a neutron respectively, the nuclear binding energy of the isotope is

(A) $(M_0 - 8M_P)\,C^2$
(B) $(8M_P + 9M_N - M_O)\,C^2$
(C) M_0C^2
(D) $(M_0 - 17\,M_N)\,C^2$

Q.19 In gamma ray emission from a nucleus

(A) both the neutron number and the proton number changes.
(B) there is no change in the proton number and the neutron number.
(C) only the neutron number changes.
(D) only the proton number changes.

Q.20 The half-life of ^{215}At is 100 μs. The time taken for the radioactivity of a sample of ^{215}At to decay to $1/16^{th}$ of its initial value is

(A) 400 μs (B) 63 μs
(C) 40 μs (D) 300 μs

Q.21 In N_0 is the original mass of the substance of half-life period $t_{1/2}$ = 5 years, then the amount of substance left after 15 years is–

(A) $N_0/8$ (B) $N_0/16$
(C) $N_0/2$ (D) $N_0/4$

Q.22 A radioactive sample at any instant has its disintegration rate 5000 disintegrations per minute. After 5 minutes, the rate is 1250 disintegrations per minute. Then, the decay constant (per minute) is –

(A) 0.2 ln 2 (B) 0.1 ln 2
(C) 0.8 ln 2 (D) 0.4 ln 2

Q.23 Which of the following cannot be emitted by radioactive substances during their decay ?

(A) Neutrinos (B) Helium nuclei
(C) Electrons (D) Protons

Q.24 When a U^{238} nucleus originally at rest, decay by emitting an alpha particle having a speed 'u' the recoil speed of the residual nucleus is –

(A) $-\frac{4u}{232}$ (B) $\frac{4u}{234}$
(C) $-\frac{4u}{238}$ (D) $\frac{4u}{238}$

Q.25 Which of the following processes represent a γ-decay?

(A) ${}^AX_Z + \gamma \to {}^AX_{Z-1} + a + b$
(B) ${}^AX_Z + {}^1n_0 \to {}^{A-3}X_{Z-2} + c$
(C) ${}^AX_Z \to {}^AX_Z + f$
(D) ${}^AX_Z + e_{-1} \to {}^AX_{Z-1} + g$

Q.26 Energy required for the electron excitation in Li^{++} from the first to the third Bohr orbit is :

(A) 12.1 eV (B) 36.3 eV
(C) 108.8 eV (D) 122.4 eV

Q.27 Two H atoms in the ground state collide inelastically. The maximum amount by which their combined kinetic energy is reduced is

(A) 10.20 eV (B) 20.40 eV
(C) 13.6 eV (D) 27.2 eV

Q.28 The fission properties of ${}^{239}_{94}Pu$ are very similar to those of ${}^{235}_{92}U$. The average energy released per fission is 180 MeV. If all the atoms in 1 kg of pure ${}^{239}_{94}Pu$ undergo fission, then the total energy released in MeV is –
(A) 4.53×10^{26} MeV (B) 2.21×10^{14} MeV
(C) 1×10^{13} MeV (D) 6.33×10^{24} MeV

Q.29 M_x and M_y denote the atomic masses of the parent and the daughter atom respectively in a radioactive decay. The Q-value for a β^- decay is Q_1 and that for a β^+ decay is Q_2. If m_e denotes the mass of an electron, then which of the following statements is correct?
(A) $Q_1 = (M_x - M_y)\,c^2$ and $Q_2 = (M_x - M_y - 2m_e)\,c^2$
(B) $Q_1 = (M_x - M_y)\,c^2$ and $Q_2 = (M_x - M_y)c^2$
(C) $Q_1 = (M_x - M_y - 2m_e)\,c^2$ and $Q_2 = (M_x - M_y + 2m_e)\,c^2$
(D) $Q_1 = (M_x - M_y + 2m_e)\,c^2$ and $Q_2 = (M_x - M_y + 2m_e)\,c^2$

Q.30 The electron emitted in beta radiation originates from
(A) inner orbits of atom
(B) free electrons existing in nuclei
(C) decay of a neutron in a nucleus
(D) photon escaping from the nucleus

Q.31 The decay constant, for a given radioactive sample, is 0.3465 day^{-1}. What percentage of this sample will get decayed in a period of 4 days?
(A) 100% (B) 50%
(C) 75% (D) 10%

Q.32 If in a nuclear fusion reaction, mass defect is 0.3%, then energy released in fusion of 1 kg mass
(A) 27×10^{10} J (B) 27×10^{11} J
(C) 27×10^{12} J (D) 27×10^{13} J

Q.33 Half life of ${}^{238}_{92}U$ is 4.5×10^9 yr. The activity of 1g sample of ${}^{238}_{92}U$ is
(A) 1.0 Bq (B) 1.23×10^4 Bq
(C) 0.98×10^{-17} Bq (D) 1.23×10^{10} Bq

Q.34 Reaction rate in a nuclear reactor is controlled through control rods. Control rods reduces reaction rate by
(A) accelerating neutrons to high speeds.
(B) showing neutrons to nearly zero velocity.
(C) reducing temperature of the core.
(D) absorbing neutrons so that they are not available for chain reaction.

Q.35 The simple Bohr model is not applicable to He^4 atom as it was applied to a H-atom, because
(I) He^4 is an inert gas.
(II) He^4 has neutrons in the nucleus.
(III) He^4 has one more electron.
(IV) electrons are not subject to central force.
Correct reasons are –
(A) III and IV (B) I and II
(C) II and III (D) II and IV

Q.36 Taking the Bohr radius as a_0 = 53pm, the radius of Li^{++} ion in its ground state, on the basis of Bohr's model, will be about
(A) 53 pm (B) 27 pm
(C) 18 pm (D) 13 pm

Q.37 The moment of momentum for an electron in second orbit of hydrogen atom as per Bohr's model is –
(A) h/π (B) $2\pi h$
(C) $2h/\pi$ (D) π/h

Q.38 A set of atoms in an excited state decays.
(A) in general to any of the states with lower energy.
(B) into a lower state only when excited by an external electric field.
(C) all together simultaneously into a lower state.
(D) to emit photons only when they collide.

Q.39 An electron emitted in beta radiation originates from
(A) inner orbits of atom
(B) free electrons existing in the nuclei
(C) decay of a neutron in a nuclei
(D) photon escaping from the nucleus

Q.40 Nuclear force is a strong attractive force which
I. is responsible for high value of binding energy per nucleon.
II. overcomes the repulsive force of proton and proton.
III. binds protons and neutrons into the nucleus.
IV. is very short range.
Which of the above statements are correct?
(A) I and II (B) II and IV
(C) II, III and IV (D) I, II, III and IV

Q.41 Heavy stable nuclei have more neutrons than protons. This is because of the fact that

(A) neutrons are heavier than protons.

(B) electrostatic force between protons are repulsive.

(C) neutrons decay into protons through beta decay.

(D) nuclear forces between neutrons are weaker than that between protons.

Q.42 In a sample of radioactive material, what fraction of the initial number of active nuclei will remain undisintegrated after half of the half life of the sample?

(A) 1/4 (B) $1/2\sqrt{2}$

(C) $1/\sqrt{2}$ (D) $\sqrt{2}-1$

Q.43 Suppose we consider a large number of containers each containing initially 10000 atoms of a radioactive material with a half life of 1 year. After 1 year,

(A) all the containers will have 5000 atoms of the material.

(B) all the containers will contain the same number of atoms of the material but that number will only be approximately 5000.

(C) the containers will in general have different numbers of the atoms of the material but their average will be close to 5000.

(D) none of the containers can have more than 5000 atoms.

Q.44 The half life period of a radioactive element X is same as the mean life time of another radioactive element Y. Initially, they have the same number of atoms. Then

(A) X and Y decay at same rate always.

(B) X will decay faster than Y.

(C) Y will decay faster than X.

(D) X and Yhave same decay rate initially.

Q.45 Fusion processes like combining two deuterons to form a 'He' nucleus are impossible at ordinary temperatures and pressures. The reason for this can be traced to the fact that –

(A) nuclear forces are lone-range.

(B) nuclei are positively charged.

(C) the original nuclei must be completely ionised before fusion can takes place.

(D) the original nuclei must break up from combining with each other.