SOLVED EXAMPLES

Example 1.

The two highest wavelengths of the radiation emitted when hydrogen atoms make transitions from higher states to n = 2 state are

(1) 654 nm & 487 nm (2) 487 nm & 326 nm

(3) 654 nm & 326 nm (4) 487 nm & 256 nm

Solution

(1) The highest wavelength corresponds to the lowest energy of transition. this will be the case for the transition n = 3 to n = 2. The second highest wavelength corresponds to the transition n = 4 to n = 2.

$E_2 = -3.4\,eV$, $E_3 = -1.5\,eV$ and $E_4 = -0.85\,eV$

The highest wavelength is $\lambda_1 = \dfrac{hc}{\Delta E} = \dfrac{1242\,eV - nm}{(3.4\,eV - 1.5\,eV)} = 654\,nm$

The second highest wavelength is $\lambda_2 = \dfrac{1242\,eV - nm}{(3.4\,eV - 0.85\,eV)} = 487\,nm$

Example 2.

Monochromatic radiation of wavelength λ is incident on a hydrogen sample in ground state. Hydrogen atoms absorb a fraction of light and subsequently emit radiation of six different wavelengths. The value of λ is

(1) 117 nm (2) 97.5 nm (3) 88.34 nm (4) 66.25 nm

Solution

(2) As the hydrogen atoms emit radiation of six different wavelengths, that must have been excited to n = 4. The energy in n = 4 state is

$$E_4 = \frac{E_1}{4^2} = -\frac{13.6\,eV}{16} = -0.85\,eV$$

The energy needed to take a hydrogen atom from its ground state to n = 4 is

$$13.6\text{ eV} - 0.85\text{ eV} = 12.75\text{ eV}$$

The photons of the incident radiation should have 12.75 eV of energy. So

or, $\lambda = \dfrac{hc}{12.75\,eV} = \dfrac{1242\,eV - nm}{12.75\,eV} = 97.5\,nm$

Example 3.

The energy needed to detach the electron of a hydrogen-like ion in ground state is 4 Rydberg. The wavelength of the radiation emitted when the electron jumps from the first excited state to the ground state is

(1) 16.2 nm (2) 45.6 nm (3) 30.4 nm (4) 91.3 nm

Solution

(3) In energy units, 1 rydberg = 13.6 eV. The energy needed to detach the electron is 4 × 13.6 eV. The energy in the ground state is, therefore, $E_1 = -4 \times 13.6$ eV. The energy of the first excited state (n = 2) is $E_2 = \dfrac{E_1}{4} = -13.6$ eV.

The energy difference is $E_2 - E_1 = 3 \times 13.6$ eV = 40.8 eV. The wavelength of the radiation emitted is

$$\lambda = \frac{hc}{\Delta E} = \frac{1242\,eV - nm}{40.8\,eV} = 30.4\,nm$$

Example 4.	A lithium atom has three electrons. Assume the following simple picture of the atom. Two electrons move close to the nucleus making up a spherical cloud around it and the third moves outside this cloud in a circular orbit. Bohr's model can be used for the motion of this third electron but n = 1 state is not available to it. The ionization energy of lithium in ground state using the above picture is (1) 40.8 eV (2) 27.2 eV (3) 13.6 eV (4) 3.4 eV
Solution	**(4)** In this picture, the third electron moves in the field of a total charge + 3e – 2e = + e. Thus, the energies are the same as that of hydrogen atoms. The lowest energy is $$E_2 = \frac{E_1}{4} = \frac{-13.6\text{ eV}}{4} = -3.4\text{ eV}$$ Thus, the ionization energy of the atom in this picture is 3.4 eV.
Example 5.	A small particle of mass m moves in such a way that the potential energy $U = \frac{1}{2}m^2\omega^2r^2$ where ω is a constant and r is the distance of the particle from the origin. Assuming Bohr's model of quantization of angular momentum and circular orbits, the radius of the nth allowed orbit is proportional to (1) n (2) $\sqrt{n}$ (3) $\frac{1}{n}$ (4) $\frac{1}{\sqrt{n}}$
Solution	**(2)** $F = -\frac{dU}{dr} = -m\omega^2r \Rightarrow \frac{mv^2}{r} = m\omega^2r \Rightarrow v = \omega r$ ...(i) The quantization of angular momentum gives $mvr = \frac{nh}{2\pi mr}$ ...(ii) From (i) and (ii), $r = \left(\frac{nh}{2\pi m\omega}\right)^{1/2}$
Example 6.	The electric potential energy due to the electric repulsion between two nuclei ^{12}C when they 'touch' each other at the surface is (1) 40.8 MeV (2) 20.4 MeV (3) 10.0 MeV (4) 5.4 MeV
Solution	**(3)** The radius of a ^{12}C nucleus is $R = R_0A^{1/3} = (1.1\text{ fm})(12)^{1/3} = 2.52\text{ fm}$ The separation between the centres of the nuclei is 2R = 5.04 fm. The potential energy of the pair is $U = \frac{q_1q_2}{4\pi\varepsilon_0 r} = (9\times10^9)\frac{(6\times1.6\times10^{-19}C)^2}{5.14\times10^{-15}m} = 1.64\times10^{-12}\text{ J} = 10.2\text{ MeV}$
Example 7.	The binding energy of $^{56}_{26}Fe$ is (Atomic mass of ^{56}Fe is 55.9349 u and that ^{1}H is 1.00783 u. Mass of neutron = 1.00867 u) (1) 492 MeV (2) 312 MeV (3) 280 MeV (4) 672 MeV

Solution	**(1)** The number of protons in ${}^{56}_{26}\text{Fe}$ = 26 and the number of neutrons = 56 – 30. The binding energy of ${}^{56}_{26}\text{Fe}$ is = [26 × 1.00783 u + 30 × 1.00867 u – 55.9349 u]c^2 = (0.52878 u)c^2 = (0.52878 u)(931 MeV/u) = 492 MeV
Example 8.	The activity of a radioactive sample falls from 600 s^{-1} to 500 s^{-1} in 40 minutes. Its half-life is (1) 38 min (2) 76 min (3) 108 min (4) 152 min
Solution	**(4)** $A = A_0\, e^{-\lambda t} \Rightarrow 500\ s^{-1} = (600\ s^{-1})\, e^{-\lambda t} \Rightarrow e^{-\lambda t} = 5/6$ or, $\lambda = \frac{\ln(6/5)}{t} = \frac{\ln(6/5)}{40\,\text{min}}$ The half-life is $t_{1/2} = \frac{\ln 2}{\lambda} = \frac{\ln 2}{\ln(6/5)} \times 40\,\text{min} = 152$ min
Example 9.	A radioactive sample decays with an average-life of 20 ms. A capacitor of capacitance 100 μF is charged to some potential and then the plates are connected through a resistance R. The value of R so that the ratio of the charge on the capacitor to the activity of the radioactive sample remains constant in time is (1) 50 Ω (2) 100 Ω (3) 200 Ω (4) 300 Ω
Solution	**(3)** The activity of the sample at time t is given by $A = A_0\, e^{-\lambda t}$ where λ is the decay constant and A_0 is the activity at time t = 0 when the capacitor plates are connected. The charge on the capacitor at time t is given by $Q = Q_0\, e^{-t/CR}$ where Q_0 is the charge at t = 0 and C = 100 μF is the capacitance. Thus, $\frac{Q}{A} = \frac{Q_0}{A_0}\frac{e^{-t/CR}}{e^{-\lambda t}}$ It is independent of t if $\lambda = \frac{1}{CR}$ or, $R = \frac{1}{\lambda C} = \frac{t_{av}}{C} = \frac{20 \times 10^{-3}\,\text{s}}{100 \times 10^{-6}\,\text{F}} = 200\ \Omega$
Example 10.	Calculate the energy released when three alpha particles combine to form a ${}^{12}C$ nucleus. The atomic mass of ${}^{4}_{2}\text{He}$ is 4.002603 u (1) 4.6 MeV (2) 7.27 MeV (3) 9.38 MeV (4) 11.65 MeV
Solution	**(2)** The mass of a ${}^{12}C$ atom is exactly 12 u. The energy released in the reaction $3\left({}^{4}_{2}\text{He}\right) \rightarrow {}^{12}_{6}\text{C}$ is $[3\, m({}^{4}_{2}\text{He}) - m({}^{12}_{6}\text{C})]c^2$ = [3 × 4.002603 u – 12u] (931 MeV/u) = 7.27 MeV

MULTIPLE CHOICE QUESTIONS

LEVEL – I

1. Avarage binding energy is maximum for
(1) C^{12} (2) Fe^{56}
(3) U^{235} (4) P_0^{210}

2. Nuclear density (ρ) of a nucleus varies with its mass number (A) as
(1) $\rho \propto A^0$ (2) $\rho \propto A$
(3) $\rho \propto A^{1/3}$ (4) $\rho \propto A^{2/3}$

3. The quantity which is not conserved in a nuclear reaction is
(1) Momentum (2) Charge
(3) Mass (4) None of these

4. The ratio of Angular momentum of an electron is the 2nd state and 3rd excited state of H-atom
(1) 2 : 3 (2) 3 : 4
(3) 1 : 2 (4) 1 : 1

5. Which of the following spectral series of H-atom has the range in visible region
(1) Lyman series (2) Bracket series
(3) Paschen series (4) Balmer series

6. If one move up in the energy states of a H-like atom, the energy difference between two consecutive energy states
(1) Decreases (2) Increases
(3) First decreases then increases
(4) First increases then decreases

7. Ionisation energy of O^{7+} in Rydberg is
(1) 64 (2) 36
(3) 16 (4) 9

8. A nucleus undergoes γ-decay due to
(1) Excess of protons
(2) Excess of neutrons
(3) Large mass (4) its excited state

9. During k-electron capture reaction x-rays are emitted due to
(1) Excitation of nucleons in side the nucleus
(2) Annihilation of electron with proton
(3) Transitition of electron from higher shell to k-shell
(4) Heat formation inside the nucleus

10. Moderator used in a nuclear reactor is
(1) Heavy water (2) Uranium
(3) Cadmium (4) Polonium

11. In case of lower stable nuclides if number of neutrons and protons are N and Z respectively then
(1) N > Z (2) N < Z
(3) N = Z (4) Can't said

12. Nuclear force is
(1) Repulsive for a very small inter neuclear distance
(2) Central force
(3) Spin independent (4) Charge dependent

13. The number of quantum energy states in a Na atom
(1) 2 (2) 3
(3) 4 (4) None of these

14. 'Rhc' has the dimension of (R-Rydberg's const, h-Planck's const, c-velocity of light)
(1) Momentum (2) Energy
(3) Frequency (4) Wave number

15. The concept of circular orbit of electrons around the nucleus was initially given by
(1) Thomson (2) Bohr
(3) Rutherford (4) Sommerfiesd

16. According to Bohr's theory, the variation of perimeter(s) of the electronic orbit with the order of orbit (n) in a particular atom is
(1) Linear (2) Parabolic
(3) Exponential
(4) Rectangular hyperbolic

17. Nuclear volume of a nucleus having mass number 8 is V. Nuclear volume of the nucleus having mass number 64 will be
(1) V (2) 2V
(3) 4V (4) 8 V

18. Two samples having their initial activities in the ratio 1 : 4 have half life periods 15 years and 10 years respectively. The time after which both posses equal activity is
(1) 60 years (2) 120 years
(3) 30 years (4) 90 years

19. The half life of a radioactive nucleus is 3 hours. In 9 hours, its activity will be reduced to a factor of

(1) 1/9 (2) 1/27
(3) 1/6 (4) 1/8

20. Two substance having number of nuclei in the ratio 2 : 3 have equal activity at some instant. The half life period of both the substances may be respectively

(1) 28 years and 14 years
(2) 15 years and 10 years
(3) 8 years and 32 years
(4) 16 years and 24 years

LEVEL – II

1. An electron in 20th state of a H-like atom tries to come to its 5th state. The number of possible transitions are

(1) 80 (2) 120
(3) 105 (4) 145

2. If principal quartum number n > 5 are not allowed in nature, the number of possible elements are

(1) 28 (2) 60
(3) 110 (4) 182

3. Out of the following, de-Broglie's wavelength is least in case of

(1) 1st excited state of H-atom
(2) 2nd state of He^{+}-atom
(3) 2nd excited state of Li^{++}-atom
(4) 2nd state of Li^{++}-atom

4. Binding energy per nucleon is 8.5 MeV for A = 240 and 7.6 MeV for A = 120. A nucleus having A = 240 breaks into two nuclei having nearly equal masses. The amount of energy released in the process is

(1) 216 MeV (2) 184 MeV
(3) 148 MeV (4) 261 MeV

5. A radioactive element X decays to form a element Y with a half life period 15 years. Initialy there is no nuclei of Y. The instant at which the ratio of X to Y is 1 : 15 is

(1) 60 years (2) $\frac{15\,\ell n(15)}{0.693}$ years
(3) 45 years (4) $\frac{\ell n(15)}{0.693}$ years

6. The state of triply ionised beryllium (Be^{3+}) which has the same orbital radius as that of the ground state of hydrogen is

(1) n = 1 (2) n = 2
(3) n = 3 (4) n = 4

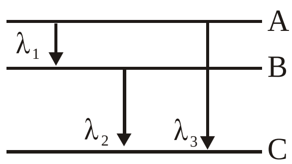
7. An excited hydrogen atom emits a photon of wavelength λ in returing to the ground state. The quantum number of n the excited state is given by (R = Rydberg constant)

(1) $\sqrt{\lambda R(\lambda R - 1)}$ (2) $\sqrt{\lambda R/(\lambda R - 1)}$
(3) $\sqrt{(\lambda R - 1)/\lambda R}$ (4) $\frac{1}{\sqrt{\lambda R(\lambda R - 1)}}$

8. A uniform magnetic field B exists in a region. An electron projected perpendicular to the field goes in a circle. Assuming Bohr's quantization rule for angular momentum is valid, then the smallest possible radius of orbit of electron is

(1) $\sqrt{\frac{h}{\pi eB}}$ (2) $\sqrt{\frac{h}{2\pi eB}}$
(3) $\sqrt{\frac{h}{eB}}$ (4) $\sqrt{\frac{h}{2eB}}$

9. Energy levels A, B, C of a certain atom corresponds to increasing values of energy, i.e., $E_A < E_B < E_C$. If λ_1, λ_2 and λ_3 are the wavelengths or radiations correspoinding to the transitions, C to B, B to A and C to A respectively, which of the following statement is correct



(1) $\lambda_3 = \lambda_1 + \lambda_2$ (2) $\lambda_3 = \frac{\lambda_2\lambda_1}{\lambda_1 + \lambda_2}$
(3) $\lambda_1 + \lambda_2 + \lambda_3 = 0$ (4) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

10. If the shortest wavelength of Lyman series of H atom is x, then the wavelength of first member of Balmer series of H atom will be

(1) 9x/5 (2) 36x/5
(3) 5x/9 (4) 5x/36

11. The frequency f of certain line of the Lyman series of the atomic spectrum of hydrogen satisfies the following conditions

I. It is the sum of the frequencies of another Lyman line and a Balmer line

II. It is the sum of the frequencies of a Lyman line, a Balmer line and a Paschen line

III. It is the sum of the frequencies of a Lyman and a Paschen line but no Bracket line. To what transition does f correspond?

(1) $n_2 = 3$ to $n_1 = 1$ (2) $n_2 = 3$ to $n_1 = 2$

(3) $n_2 = 2$ to $n_1 = 1$ (4) $n_2 = 4$ to $n_1 = 1$

12. An electron in a hydrogen atom makes a transition from $n = n_1$ to $n = n_2$. The time period of the electron in the initial state is eight times that in the final state. The possible values of n_1 and n_2 are

(1) $n_1 = 4$ to $n_2 = 1$ (2) $n_1 = 8$ to $n_2 = 4$

(3) $n_1 = 8$ to $n_2 = 1$ (4) $n_1 = 6$ to $n_2 = 4$

13. If ${}_{92}U^{238}$ changes to ${}_{85}At^{210}$ by a series of α-and β-decays, the number of α-and β-decays undergone is

(1) 7 and 7 (2) 7 and 5

(3) 5 and 7 (4) 14 and 5

14. Radon 220 will eventually decay to Bismuth-212 as

$${}_{86}Rn^{220} \rightarrow {}_{84}Po^{216} + {}_{2}He^{4}; \text{half life} = 55\,s$$

$${}_{86}Po^{116} \rightarrow {}_{82}Pb^{212} + {}_{2}He^{4}; \text{half life} = 0.016\,s$$

$${}_{82}Pb^{212} \rightarrow {}_{83}Bi^{212} + {}_{-1}e^{0}; \text{half life} = 10.6\,h$$

If a certain mass of radon-220 is allowed to decay in a certain container, after five minutes the elements with the greatest mass will be

(1) radon (2) polonium

(3) lead (4) bismuth

15. The activity of a given sample of radioactive substance is reduced to 1/32 of its former value in 25 days. Its half life is

(1) $\frac{25}{32}$ days (2) $\frac{25}{4}$ days

(3) 5 days (4) 10 days

16. Two radioactive materials X_1 and X_2 have decay constants 10λ and λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that of X_2 will be 1/e after a time

(1) $\frac{1}{10\lambda}$ (2) $\frac{1}{11\lambda}$

(3) $\frac{11}{10\lambda}$ (4) $\frac{1}{9\lambda}$

17. A sample of radioactive material has a mass m, decay constant λ and molecular weight M. Avogadro constant N_A. The initial activity of the sample is

(1) λM (2) $\frac{\lambda m}{M}$

(3) $\frac{\lambda m N_A}{M}$ (4) $mN_A e^{-\lambda t}$

18. Energy released in the fission of a single ${}_{92}U^{235}$ nucleus is 200 MeV. The fission rate of ${}_{92}U^{235}$ fuelled reactor operating at a power level of 5W is

(1) $1.56 \times 10^{10}\,s^{-1}$

(2) $1.56 \times 10^{11}\,s^{-1}$

(3) $1.5 \times 10^{16}\,s^{-1}$ (4) $1.56 \times 10^{17}\,s^{-1}$

19. When electron and positron travelling in opposite directions with equal speed annihilate (destroy) each other, they cannot produce just one gamma photon, because it will violate

(1) Conversation of charge

(2) Conversation of momentum

(3) Conversation of energy

(4) Conversation of spectrum

20. A container is filled with a radioactive substance for which the half-life is 2 days. A week later, when the container is opened, it contains 5 grams of the substance. Approximately how may grams of the substance were initially placed in the container?

(1) 40 (2) 60

(3) 80 (4) 100

LEVEL – III

1. An element can decay by two process having half life period is years and 30 years respectively. The effective half life period of the element is

(1) 45 years (2) 15 years
(3) 10 years (4) 30 years

2. An element X having N_1 initial number of nuclei decays with avarage oife T_1 to form another element Y. Which is also unstable having initial number of nuclei N_2 decays to form another element z with avarage life T_2. If no. of nueler of Y remains unchanged with time then

(1) $N_1T_1 = N_2T_2$ (2) $N_1T_2 = N_2T_1$
(3) $N_1 = N_2$ (4) $T_1 = T_2$

3. A ground state H atom collides inelastically with a stationary ground state H-atom. If after collision, one of the H-atom get excited then the minimum kinetic energy of initial moving hydrogen atom is

(1) 13.6 ev (2) 3.4 ev
(3) 10.2 ev (4) 20.4 ev

4. Ionisation energy of a hydrogen like atom is 64 Rydberg. The difference in potential energy of the electron between its 2nd state and 3rd excited state is

(1) 163.2 ev (2) 326.4 ev
(3) 54.4 ev (4) 217.6 ev

5. A hydrogen atom of mass m enits a photon coresponding to 4th line of bracket series and recoils. If (R-Rydberg's const and h-plank's const) then recoiling velocity is

(1) $\frac{3Rh}{36m}$ (2) $\frac{3Rh}{64m}$
(3) $\frac{7Rh}{124m}$ (4) $\frac{7Rh}{3m}$

6. An element ${}_zX^A$ undergoes 6α, 8β, and 1γ decay to form an element Y. The ratio of proton number and neutron number os Y is

(1) $\frac{z-4}{A-z-20}$ (2) $\frac{z-20}{A-z-24}$
(3) $\frac{z-4}{A-z-24}$ (4) $\frac{z-12}{A-z-20}$

7. The ground state radius and velocity of a hydrogen atom is r_0 and v_0 respectively. If hypothetically mass of electron is decreased to $\left(\frac{1}{10}\right)$ times of its initial value, then its respective ground state radius & velocity is

(1) $\frac{r_0}{10}, v_0$ (2) $\frac{r_0}{10}, 10v_0$
(3) $10\,r_0, v_0$ (4) $10\,r_0, \frac{v_0}{10}$

8. The ratio of magnetic field at the centre due to the rotation of a Bohr's electron in 1st state of H-atom and 2nd excited state of Li^{++} atom is

(1) 9 : 1 (2) 27 : 4
(3) 9 : 4 (4) 27 : 1

9. f_1 is the frequency of rotation of as electron in nth state of H-like atom and f_2 is the coresponding frequency of transition of theelectron between n^{th} and $(n + 1)^{th}$ state. If n >> 1 then f_1/f_2 is proportional to

(1) n (2) n^2
(3) n^{-2} (4) n^0

10. A radioactive element has as activity A_1 at any time t_1 and has an activity A_2 at any time t_2 (> t_1). If the avarage life of the element is T, No. of nuclei decays in time interval $(t_2 - t_1)$ is

(1) $(A_1 - A_2)\,T$ (2) $\frac{A_1}{A_2}e^{-\frac{\lambda t_1}{t_2}}$
(3) $\frac{A_1}{A_2}e^{-\lambda T}$ (4) $\frac{(A_1 - A_2)}{T}$

11. A radioactive nucleus (initial mass number A and atomic number Z) emits 3 α–particles and 2 positions. The ratio of number of neutrons to that of protons in the final nucleus will be

(1) $\frac{A-Z-4}{Z-2}$ (2) $\frac{A-Z-8}{Z-2}$
(3) $\frac{A-Z-4}{Z-8}$ (4) $\frac{A-Z-12}{Z-4}$.

ANSWERS (ATOMS & NUCLEI)

LEVEL - I

1. (2)	5. (4)	9. (3)	13. (4)	17. (4)
2. (1)	6. (1)	10. (1)	14. (2)	18. (1)
3. (3)	7. (1)	11. (3)	15. (2)	19. (4)
4. (3)	8. (4)	12. (1)	16. (2)	20. (4)

LEVEL - II

1. (2)	5. (1)	9. (2)	13. (1)	17. (3)
2. (3)	6. (2)	10. (2)	14. (3)	18. (2)
3. (4)	7. (2)	11. (4)	15. (3)	19. (2)
4. (1)	8. (2)	12. (2)	16. (4)	20. (2)

LEVEL - III

1. (3)	3. (4)	5. (2)	7. (3)	9. (4)
2. (2)	4. (2)	6. (1)	8. (1)	10. (1)
				11. (3)

SOLUTIONS (LEVEL - III)

1. Probability of decaying by 1st process

$: P_{(1)} = \lambda_1 d\lambda$

Probability of decaying by 2nd process

$: P_{(2)} = \lambda_2 d\lambda$

Probability of decaying by 1st or 2nd process

$: P_{(1 \text{ or } 2)} = \lambda\, d\lambda$

But $P_{(1 \text{ or } 2)} = P_{(1)} + P_{(2)}$

$\Rightarrow \lambda\, d\lambda = \lambda_1\, d\lambda + \lambda_2\, d\lambda \Rightarrow \lambda_{eff} = \lambda_1 + \lambda_2$

So $\left(T_{1/2}\right)_{eff} = \dfrac{\left(T_{1/2}\right)_1 \left(T_{1/2}\right)_2}{\left(T_{1/2}\right)_1 + \left(T_{1/2}\right)_2} = \dfrac{15 \times 30}{15 + 30} = 10$ years

2. Rate of disintegration of X = $A_x = N_1\lambda_1 = \dfrac{N_1}{T_1}$

Rate of disintegration of Y = $A_Y = N_2\lambda_2 = \dfrac{N_2}{T_2}$

If no. of nuclei of Y remains unchanged then

$A_X = A_Y$. So $\dfrac{N_1}{T_1} = \dfrac{N_2}{T_2} \Rightarrow N_1T_2 = N_2T_1$

3. According to Conservation of momentum:

$mu = mv + mv \quad \Rightarrow \quad v = \dfrac{u}{2}$

According to Conservation of energy :

$$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \Delta E$$

(ΔE - amount of energy loss = amount of energy required to excite a hydrogen atom = 10.2 ev)

$\Rightarrow \dfrac{1}{2}mu^2 = m\left(\dfrac{u}{2}\right)^2 + \Delta E \quad \Rightarrow \Delta E = \dfrac{1}{4}mu^2$

$\Rightarrow \dfrac{1}{2}mu^2 = 2\Delta E = 2 \times 10.2 = 20.4$ ev

4. $E_1 = -64$ RY, So $E_n = \dfrac{E_1}{n^2}$

$E_2 = \dfrac{-64}{4} = -16$ RY So $(PE)_4 = -8$ RY

$E_4 = -\dfrac{64}{4} = -4$ RY, So $(PE)_4 = -8$ RY

$(PE)_4 - (PE)_2 = -8 - (-32) = 24$ RY = 326.4 ev

5. For Bracket series of H-atom and fourth line

$\dfrac{1}{\lambda} = R\left[\dfrac{1}{(4)^2} - \dfrac{1}{(8)^2}\right] = \dfrac{3R}{64}$

According to conservation of mementum

$mv = \dfrac{h}{\lambda} \Rightarrow v = \dfrac{h}{m\lambda} = \dfrac{3Rh}{64m}$

6. $_{Z}X^{A} \xrightarrow{6\alpha} {}_{Z-12}Z^{A-24} \xrightarrow{8\beta}$

$_{Z-12+8}Y^{A-24} \xrightarrow{1\gamma} {}_{Z-4}Y^{A-24}$

So $\frac{\text{Proton}}{\text{Neutron}}$ of $Y = \frac{Z-4}{(A-24)-(Z-4)} = \frac{Z-4}{A-Z-20}$

7. $r = \frac{n^2h^2}{4\pi^2 kmze^2} \Rightarrow r \propto \frac{1}{m}$

and $v = \frac{2\pi kmze^2}{nh} \Rightarrow v \propto m^0$

So if $m' = \frac{m}{10}$ $r = 10r_0$ and $v = v_0$

8. $A_1 = \lambda N_1 \Rightarrow N_1 = \frac{A_1}{\lambda} = A_1T$

$A_2 = \lambda N_2 \Rightarrow N_2 = \frac{A_2}{\lambda} = A_2T$

So $N_1 - N_2 = (A_1 - A_2)\,T$

9. $f_1 = \frac{v}{2\pi r}$, But $v \propto \frac{z}{n}$ and $r \propto \frac{n^2}{z}$

So $f_1 \propto \frac{z^2}{n^3}$ $\Rightarrow f_1 \propto \frac{1}{n^3}$

$f_2 = Rz^2\left(\frac{1}{n^2} - \frac{1}{(n+1)^2}\right) = Rz^2\left(\frac{2n+1}{n^2(n+1)^2}\right)$,

But $n >> 1 \Rightarrow f_2 \propto \frac{1}{n^3}$ So $\frac{f_1}{f_2} \propto n^0$

10. $(A_1 - A_2)T$

11. $\frac{A-Z-4}{Z-8}$.