PHYSICS

BOOKS - CBSE COMPLEMENTARY MATERIAL PHYSICS (HINGLISH)

DUAL NATURE OF MATTER AND RADIATION & ATOMS AND NUCLEI

Very Short Answer Questions

1. The rest mass of the photon is

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2. A good mirror reflects 80% of light incident on it. Which of of the following is correct ?

(a) Energy of each reflected photon decreases by 20%

(b) Total no. of reflected photons decreases by 20% . Justify your answer.

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3. Why in a photocell the cathode is coated with alkali metals ?

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4. Name the phenomenon which shows the quantum nature of electromagnetic radiation.

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5. Einsteins photoelectric equation is

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6. The stopping potential in an experiment on a photo electric effect is 1.5 V. What is the maximum kinetic energy of the photoelectrons emitted?

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7. A metal emits photoelectrons when red light falls on it. Will this metal emit photoelectrons when blue light falls on it ? Why ?

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8. What is the value of impact parameter for a head on collision ?

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9. The photoelectric cut off voltage in a certain experiment is 1.5V. What is the maximum kinetic energy of photoelectrons emitted? $e = 1.6 \times 10^{-19} C$.

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10. What is the de-Broglie wavelength of a 3 kg object moving with a speed of $2ms^{-1}$?

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11. What determines the maximum velocity of the photoelectrons?

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12. The rest mass of the photon is

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13. Work functions of caesium and lead are 2.14 eV and 4.25 eV respectively.

Which of the two has a higher threshold wavelength ?

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14. What is the de-Broglie wavelength of a neutron at absolute temperature T K ?

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15. Define atomic mass unit. Write its energy equivalent in MeV.

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16. What were the drawbacks of Rutherford's model of an atom?

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17. What are the number of electrons and neutrons in $^{236}_{92}U$ atom ?

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18. Name the series of hydrogen spectrum, which has least wavelength.

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19. Any two protons repel each other, then how is this possible for them to remain together in a nucleus.

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20. Define radioactive decay constant.

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21. You are given reaction : ${}_1H^2 + {}_1H^2 \rightarrow {}_2He^4 + 24MeV$. What type of nuclear reaction is this ?

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22. After losing two electrons to which particle does a helium atom get transformed into ?

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23. For any H like system, the ratio of velocities of electron in I, II & III orbit e.e.,$V_1 : V_2 : V_3$ will be:

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24. Which part of an atom was discovered by Rutherford's alpha particle scattering experiement ?

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25. In nuclear reaction ${}_1^1H \rightarrow {}_0^1n + {}_Q^Px$ find P, Q and hence identify x.

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26. The binding energies of deuteron $\left(._1 H^2\right)$ and α-particle $\left(._2 He^4\right)$ are 1.25 and 7.2 MeV/nucleon respectively. Which nucleus is more stable?

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27. α- particles are incident on a thin gold foil. For what angle of deviation will the number of deflected α-particles be minimum ?

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28. If the amount of a radioactive substance is increased four times then how many times will the number of atoms disintegrating per unit time be increased ?

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29. An electron jumps from fourth to first orbit in an atom. How many maximum number of spectral lines can be emitted by the atom ?

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30. Under what conditions of electronic transition will the emitted light be monochromatic ?

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31. Why does only a slow neutron (.03 eV energy) cause the fission in the uranium nucleus and not the fast one ?

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32. Write the relation for distance of closest approach.

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33. In Bohr's atomic model , the potential energy is negative and has a magnitude greater than the kinetic energy, what does this imply ?

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34. The physical quantity which has same dimensions as that of Planck's constant is

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35. Define ionisation potential.

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36. If the ionisation potential of helium atom is 24.6 volt, the energy required to ionise it will be

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37. What is the energy possessed by an electron whose principal quantum number is infinite ?

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38. What is the S.I. unit of work?

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39. Name the series of hydrogen atom which lies in U.V. region.

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40. Name two series of hydrogen spectrum lying in the infra red region.

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41. What is the order of velocity of electron in a hydrogen atom in ground state?

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42. Write a relation for the wavelength in Paschan series lines of hydrogen. Spectrum.

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43. Arrange radioactive radiation in the increasing order of penetrating power.

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44. Write the relation between average life and decay constant of a radioactive atom.

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45. Write two units for activity of radioactive element and relate them with number of disintegration per second.

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46. The half life of a radioactive element A is same as mean life time of another radioactive element B.Initially, both have same number of atoms. B decays faster than A . Why?

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47. Draw the graph showing distribution of kinetic energy of electrons emitted during beta decay.

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48. Compare the radii of two nuclei with mass number 1 and 27 respectively.

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49. Which element has highest value of Binding Energy per nucleon.

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50. Mention the range of mass number for which the Binding energy curve is almost horizontal.

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51. What is the ratio of nuclear densities of the two nuclei having mass numbers in the ratio 1:4 ?

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52. Draw a graph of number of undecayed nuclei to the time, for a radioactive nuclei.

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53. Write an equation to represent α decay.

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Very Short Answer Questions 1 Mark

1. Illustrate by giving suitable example, how you can show that electromagnetic waves carry both energy and momentum.

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2. Define the term "threshold frequency ", in the context of photolelectric emission.

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3. Define the term "Intensity" in photon picture of electromagnetic radiation.

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4. Define intensity of radiation based on photon picture of light.

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5. Draw a plot showing the variation of photoelectric current versus the intensity of incident radiation on a given photosenstive surface.

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6. Draw and explain the graph showing the variation of stopping potential with frequency of incident radiation in relation to photoelectric effect.

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7. Plot a graph of the de-Broglie wavelength associated with a photon versus its momentum.

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8. Plot a graph of the de - Broglie wavelength associated with electron as a function of accelerating potential .

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9. A proton is accelerated through a potential difference V, subujected to a uniform magnetic field acting normal to the velocity of the proton. If the potential difference is doubled, how will the radius of the circular path described by the proton in the magnetic field charge ?

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10. If the frequency of light in a photoelectric experiment is double then maximum kinetic energy of photoelectron

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Very Short Answer Questions 2 Mark

1. Write one similarity and one difference between matter wave and an electromagnetic wave.

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2. Does a photon have a de-Broglie wavelength ? Explain.

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3. A photon and an electron have energy 200 eV each. Which one of these has greater de-Broglie wavelength ?

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4. The work function of the following metal is given Na = 2.75 eV, K=2.3 eV, Mo= 4.14 eV, Ni =5.15 eV which of these metal will not give

a photoelectric emission for radiation of wave length $3300A^{\circ}$ from a laser source placed at 1m away from the metal . What happens if the laser is brought nearer and placed 50 cm away.

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5. Represent graphically Variation of the de-Broglie wavelenght with linear momentum of a particle.

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6. In a photoelectric effect experiment , the graph between the stopping potential V and frequency of the incident radiation on two different metals P and Q shown in Fig:

(i) Which of the two metals has greater value of work function ?

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7. Do all the photons have same dynamic mass ? If not, Why ?

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8. Why photoelectrons ejected from a metal surface have different kinetic energies although the frequency of incident photons are same ?

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9. Find the ratio of de-Broglie wavelengths associated with two electrons A and B which are accelerated 8V and 64 Volts respectively.

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10. Explain the term stopping potential and threshold frequency.

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11. How does the maximum kinetic energy of emitted electrons very with the increase in work function of metals ?

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12. Define the distance of closest approach. An α-particle of kinetic enegy $'K'$ is bombarded on a thin gold foil. The distance of the closest approach is $'r'$. What will be the distance of closest approach for an α-particle of double the kinetic energy ?

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13. During an experiment an α-particle and a proton are accelerated by same potential difference , their de Broglie wavelength ratio will be :

(Take mass of photon = mass of neutron)

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14. Which of the following radiations α, β and γ are :

similar to x-rays ?

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15. Which of the following radiations α, β and γ are :

(ii) easily absorbed by matter

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16. Which of the following radiations α, β and γ are :

travel with greatest speed ?

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17. Which of the following radiations α, β and γ are :

similar to the nature of cathode rays ?

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18. Some scientists have predicted the global nuclear war on the earth would be followed by a serve nuclear winter with a devastating effect on life on earth.What might be the basis of this prediction?

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19. If the total number of neutrons and protons in a nuclear reaction is conserved how then is the energy absorbed or evolved in the reaction ?

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20. In the ground state of hydrogen atom orbital radius is 5.3×10^{-11}m.

The atom is excited such that atomic radius becomes $21.2 \times 10^{-11} m$.

What is the principal quantum number of the excited state of atom ?

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21. Calculate the percentage of any radioactive substance left undecayed after half of half life.

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22. Why is the density of the nucleus more than that of atom ?

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23. The atom ${}_8O^{16}$ has 8 protons 8 neutrons and 8 electrons while atom ${}_4Be^8$ has 4 proton, 4neutrons and 4 electrons, yet the ratio of their atomic masses is not exactly 2. Why ?

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24. What is the effect on neutron to proton ratio in a nucleus when β^- particle is emitted ? Explain your answer with the help of a suitable nuclear reaction.

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25. Why must heavy stable nucleus contain more neutrons than protons ?

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26. Show that the decay rate R of a sample of radionuclide is related to the number of radioactive nuclei N at the same instant by the expression $R = \lambda N$.

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27. What is a nuclear fusion reaction ? Why is nuclear fusion difficult to carry out for peaceful purpose ?

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28. Write two characteristic features of nuclear forces which distinguish them from coulomb force.

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29. Half life of certain radioactive nuclei is 3 days and its activity is 8 times the safe limit. After how much time will the activity of the radioactive sample reach the safe limit ?

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30. Derive $mvr = \frac{nh}{2\pi}$ using de-Broglie equation.

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31. Draw graph of number of scattered particles to scattering angle in Ratherford's experiment.

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32. If the energy of a photon is 25 eV and work function of the material is 7eV , find the value of slopping potential.

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33. What is the shortest wavelength present in the (i) Paschen series (ii) Balmer series of spectral lines ?

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34. The radius of innermost electron orbit of a hydrogen atom is $5.3 \times 10^{-11} m$. What are the radii of n=2 and n=3 orbits.?

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35. The ground state energy of hydrogen atom is -13.6 eV. What are the kinetic and potential energies of the electron in this state ?

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36. Why is the wave nature of matter not more apparent to our daily observations?

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37. from the relation $R = R_0 A^{1/3}$, where R_0 is a constant and A is the mass number of a nucleus, show that the nuclear matter density is nearly constant (i.e., independent of A).

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38. The energy equivalent of one atomic mass unit is

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39. Write four properties of nuclear force.

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Very Short Answer Questions 3 Mark

1. Explain the working of a photocell ? Give its two uses.

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2. On the basis of the de Broglie hypothesis, obtain the expression for the de Broglie wavelength associated with an electron accelerated from rest through a p.d. V.

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3. What is Einstein's explanation of photo electric effect ? Explain the laws of photo electric emission on the basis of quantum nature of light.

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4. Light of intensity I and frequency ν is incident on a photosensitive surface and causes photoelectric emission. What will be the effect on anode current when (i) the intensity of light is gradually increased, (ii) the frequency of incident radiation is increased and (iii) the anode potential is increased? In each case, all other factors remains the same. Explain, giving justification in each case.

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5. Light of intensity I and frequency v is incident on a photossensitive surface and causes photoelectric emission. Justify with the help of graph, the effect on photoelectric current when the frequency of incident radiation is increased
all other factors remain the same.

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6. Light of intensity I and frequency v is incident on a photossensitive surface and causes photoelectric emission. Justify with the help of graph, the effect on photoelectric current when the anode potential is increased

In each case, all other factors remain the same.

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7. Write Einstein's photoelectric equation. State Clearly the three salient features observed in photoelectric effect which can be explained on the basis of the above equation

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8. Explain the effect of increase of (i) frequency (ii) intensity of the incident radiation on photoelectrons emitted by a phototube.

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9. Explain photoelectric effect Explain the effect of increase of intensity of incident radiations on photoelectrons emitted by a photo-tube.

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10. X-rays of wavelength λ fall on photosensitive surface, emitting electrons. Assuming that the work function of the surface can be neglected, prove that the de-broglie wavelength of electrons emitted will be $\sqrt{\frac{h\lambda}{2mc}}$.

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11. A particle of mass M at rest decays into two particles of masses m_1 and m_2 having velocities V_1 and V_2 respectively. Find the ratio of de- Broglie wavelengths of the two particles

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12. Give one example of a nuclear reaction. Also define the Q-value of the reaction. What does $Q > 0$ signify ?

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13. Explain how radio-active nucleus can emit β-particles even though nuclei do not contain these particles. Hence explain why the mass number of radioactive nuclide does not change during β-decay.

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14. Nuclear Fission and Fusion

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15. A radioactive nucleus A undergoes a series of decays according to following scheme

$$A \xrightarrow{\alpha} A_1 \xrightarrow{-\beta} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$$

The mass number and atomic number of A4 are 172 and 69 respectively. What are these numbers for A ?

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16. Obtain a relation for total energy of the electron in terms of orbital radius. Show that total energy is negative of K.E. and half of

potential energy $E = \frac{-e^2}{8\pi\varepsilon_0 r}$

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17. Draw energy level diagram for hydrogen atom and show the various line spectra originating due to transition between energy levels.

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18. The total energy of an electron in the first excited state of the hydrogen atom is about – 3.4 eV. What is

(a) the kinetic energy,

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19. The total energy of an electron in the first excited state of the hydrogen atom is about -3.4 eV.

What is the potential energy of the electron in this state ?

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20. The total energy of an electron in the first excited state of the hydrogen atom is about – 3.4 eV. What is

(c) Which of the answers above would change if the choice of the zero of potential energy in changed to (i) + 0.5 eV (ii) – 0.5 eV.

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21. What is beta decay? Write an equation to represent β^- and β^+ decay.

Explain the energy distribution curve is β decay.

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22. Using energy level diagram show emission of γ rays by $^{60}_{27}Co$ nucleus and subsequent β decay to obtain $^{60}_{28}Ni$.

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Long Answer Questions 5 Marks

1. State Bohr's postulates. Using these postulates, derive an expression for total energy of an electron in the n^{th} orbit of an atom. What does negative of this energy signify ?

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2. Define binding energy of a nucleus. Draw a curve between mass number and average binding energy per nucleon. On the basis of this curve, explain fusion and fission reactions.

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3. State and explain the laws of radioactive disintergration. Hence define disintergration constant and half life peroid. Establish relation between them.

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Numericals

1. Ultraviolet light of wavelength 350 nm and intensity $1W/m^2$ is directed at a potassium surface having work function 2.2 eV

(ii) if 0.5 percent of the incident photons produce photoelectric effect, how many photoelectrons per second are emitted from the potassium surface that has an area $1cm^2$.

$E_{\text{kmax}} = 1.3eV, n = 8.8 \times 10^{11} \frac{\text{photo electron}}{\text{second}}$ or $r = \frac{Nhv}{t} = nhv$

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2. An electron and photon each have a wavelength of 0.2 nm. Calculate their momentum and energy .

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3. An electron and proton each have a wavelength of 0.2 nm. Calculate their momentum and energy .

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4. An electron and photon each have a wavelength of 0.4 nm. Calculate their momentum and energy .

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5. What is the (i) speed (ii) Momentum (iii) de- Broglie wavelength of an electron having kinetic energy of 120 eV ?

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6. If the frequency of incident light in photoelectric experiment is doubled then does the stopping potential become double or more than double, justify ?

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Long Answer Question

1. Why wave theory of light could not explain the photoelectric effect ? State two reasons. Draw graph between frequency ν vs stopping potential V_0 .

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2. Why wave theory of light could not explain the photoelectric effect ? State two reasons. Draw graph between Intensity vs photoelectric current.

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3. Why wave theory of light could not explain the photoelectric effect ? State two reasons. Draw graph between anode potential vs photoelectric current .

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4. A proton is accelerated through a potential difference V. Find the percentage increase or decrease in its de-Broglie wavelength if potential difference is increased by 21 % .

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5. For what kinetic energy of a neutron will the associated de-Broglie wavelength be $5.6 \times 10^{-10} m$?

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6. A nucleus of mass M initially at rest splits into two fragments of masses $\frac{M}{3}$ and $\frac{2M}{3}$. Find the ratio of de-Broglie wavelength of the fragments.

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7. An electron and proton are possessing the same amount of kinetic energy. Which of the two have greater wavelength ?

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8. The electron in a given Bohr orbit has a total energy of -1.51 eV. calculate the wavelength of radiation emitted, when this electron makes a transition of the ground state.

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9. Calculate the radius of the third Bohr orbit of hydrogen atom and the energy of electron in that orbit.

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10. Calculate the longest and shortest wavelength in the Balmer series of hydrogen atom. Given Rydberg constant = $1.0987 \times 10^{7} m^{-1}$.

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11. What will be the distance of closest approach of a 5 MeV α-particle as it approaches a gold nucleus ? (Given atomic no of gold =79)

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12. A 12.5 MeV α- particle approaching a gold nucleus is deflected 180° . What is the closest distance to which it approaches the nucleus ?

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13. Determine the speed of the electron in n=3 orbit of hydrogen atom .

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14. A sample of a radioactive substance has 10^6 radioactive nuclei. Its half life time is 20 s How many nuclei will remain after 10 s ?

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15. The half life of a radioactive substance is 5 hours. In how much time will 15/16 of the material decay ?

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16. At a given instant, there are 25% undecayed radioactive nuclei in a sample. After 10 seconds the number of undecayed nuclei reduces to 12.5%, the mean life of the nuclei is

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17. Binding energy of ${}_2He^4$ and ${}_3Li^7$ nuclei are 27.37 MeV and 39.4 MeV respectively. Which of the two nuclei is more stable? Why?

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18. Find the binding energy and binding energy per nucleon of nucleus ${}_{83}Bi^{209}$. Given : mass of proton = 1.0078254 u. mass of neutron = 1.008665 u.

Mass of ${}_{83}Bi^{209} = 208.980388u$

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19. Is the fission of iron $\left({}_{26}Fe^{56}\right)$ into $\left({}_{13}Al^{28}\right)$ as given below possible?

${}_{26}Fe^{56} \rightarrow {}_{13}Al^{28} + {}_{13}Al^{28} + Q$

Given mass of ${}_{26}Fe^{56} = 55.934940$ and ${}_{13}Al^{28} = 27.98191U$

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20. Find the maximum energy that β- particle may have in the following decay:

${}_{8}O^{19} \rightarrow {}_{9}F^{19} + {}_{-1}e^{0} + \overrightarrow{v}$

Given $m({}_{8}O_{19}) = 19.003576a.\,m.\,u.$

$m\left({}_{9}F^{19}\right) = 18.998403a.\,m.\,u.$

$m\left({}_{-}e^{0}\right) = 0.000549a.\,m.\,u.$

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21. The value of wavelength in the lyman series is given as

$$\lambda = \frac{913.4 n_i^2}{n_i^2 - 1} \text{Å}$$

Calculate the wavelength corresponding to transition from energy level 2,3 and 4. Does wavelength decreases or increase.

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22. The half life of $^{238}_{92}U$ undergoing α decay is 4.5×10^9 years what is the activity of 1g. Sample of $^{238}_{92}U$.

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