6. An electron and proton are accelerated through the same potential, which one has higher De-Broglie's wavelength ? Justify your answer. **[Q.N.2(c), Supp. 2071]**
7. An electron and a proton have same kinetic energy, which of the two has greater de-Broglie wavelength? Justify your answer. **[Q.N. 2(c), Set 'C' 2071]**
8. A proton and an electron have same de-Broglie wavelengths, which of the two has greater kinetic energy? Justify your answer. **[Q.N. 2(b), Set 'D' 2071]**
9. Distinguish between stimulated emission and spontaneous emission. **[Q.N. 2(c), Set 'D' 2071]**
10. A cricket ball is moving with a speed of 120 km/hr. What would be its de-Broglie wavelength if its mass is 400 gms. **[Q.N.2 (a), 2070 'Supp']**
11. Can X-rays be produced from gases ? Explain. **[Q.N.2(c), 2070 'Supp']**
12. Find the value of 1 amu in terms of MeV. **[Q.N.2(e), 2070 'Supp']**
13. A proton and an electron have the same speed. Which has longer wavelength? **[Q.N. 2(b), 2070 'C']**
14. The wave nature of particles is not observable in daily life. Why? **[Q.N. 2(b), 2070 'D']**
15. Can aluminum be used as a target in a x-ray tube? Justify your answer. **[Q.N. 2(c), Supp. 2069]**
16. A stone is dropped from the top of a building. How does its de Broglie wavelength change? **[Q.N. 2(c), 2069 Set A]**
17. Compare the wavelengths of an electron with that of a proton if their kinetic energies are equal. Mass of a proton is nearly equal to 1840 times the mass of an electron. **[Q.N. 2(c), Set 'B' 2069]**
18. Define population inversion and optical pumping. **[Q.N.2(d), 1st Exam 2068]**
19. A proton and an electron have the same kinetic energy. Which has longer wavelength? **[Q.N.2(b), 1st Exam 2068]**
20. When x-rays are produced only about 10% of the initial input energy appears as x-ray energy. Explain what has happened to the other 90% of the energy. **[Q.N.2(f), 2nd Exam 2068]**
21. A proton and an electron have the same kinetic energy. Which one has longer wavelength? **[Q.N.2(d), 1st Exam 2067]**
22. What are the differences between matter wave and electromagnetic wave? **[Q.N. 2(c), 2067 2nd Exam.]**
23. The phenomenon of X-rays production is also called an inverse of photoelectric effect. Why? **[Q.N.1(f), 2066]**
24. If matter has a wave nature, why is this not observable in our daily experiences? **[Q.N.2(f), 2066]**
25. Why is the wave nature of particles not observable in daily life ? **[Q.N.2(c) 2063 Supp]**
26. A patient is suggested to put off gold ornaments before entering into the X-rays room. Explain why ? **[Q.N.2(d) 2063 Supp]**
27. What do you mean by matter waves? **[Q.N.2(f), 2062]**
28. Production of X-rays is the reverse phenomenon of photoelectric effect. Justify this statement. **[Q.N.1(g), 2061]**
29. How much energy is required to take an electron from the ground state to the second excited state of a hydrogen atom if its ionisation energy is - 13.6 eV ?**[Q.N.1(f), Supp. 2060]**
30. Distinguish between stimulated emission and spontaneous emission. **[Q.N.2(f), 2060]**
31. Can aluminum be used as a target in X-ray tube? **[Q.N.1(g), 2058]**
32. Differentiate between stimulated and spontaneous emission of radiations. **[Q.N.12(d), 2056]**
33. What do you mean by uncertainty principle? **[Q.N. 12(e), 2056]**
34. Why a glowing gas, such as that in a neon tube, gives only certain wavelengths of light? **[Q.N.12(a), 2056]**
35. Point out the importance of a De Broglie wave. **[Q.N.12(c), 2055]**
36. Write relativistic mass variation formula and explain various quantities involved in it. **[Q.N. 12(e), 2055]**
37. What do you mean by de-Broglie waves? **[Q.N.12(a), 2054]**

38. Which has more energy, a photon in the infrared or one in the ultraviolet? Give reason. [Q.N.12(b), 2054]
39. In the production of X-ray, will you control the penetrating power of X-rays? [Q.N.12(c), 2052]
40. How Paschen series is originated in Hydrogen spectra? [Q.N.12(e), 2052]
41. An electron is in the third excited state. How many different photon-wave lengths are possible? [Q.N.12(a), 2053]

Long Questions

1. State Bohr's postulates of hydrogen atom and use them to calculate the radius of n^{th} orbit of a the hydrogen atom. [Q.N.6(c), 2072'D']
2. Explain the working of He-ne laser. [Q.N.6(b), 2072'E']
3. Derive Bragg's equation and explain how this equation is used to determine the crystal plane spacing. [Q.N.6(d), Supp. 2071]
4. State Bohr's postulates of hydrogen atom. Use these postulates to derive an expression for the radius of the n^{th} orbit of the hydrogen atom. [Q.N. 6(b),Set 'D' 2071]
5. What are x-rays? Describe the modern Coolidge tube method to produce x-rays. [Q.N. 6 (b), Set 'C' 2071]
6. State Bohr's postulates of atomic structure. Use the postulates to determine the total energy of an electron in n^{th}orbit of hydrogen atom. [Q.N.6(b), 2070 'Supp']
7. State Bohr's postulates and hence derive expression for the radius of n^{th} orbit of hydrogen atom. [Q.N. 6 (b), 2070 'C']
8. Describe the construction and working of a Helium-Neon laser. [Q.N. 6 (b), 2070 'D']
9. On the basis of Bohr's postulates, explain how spectral series of hydrogen atoms are produced. [Q.N. 6 (c), Supp. 2069]
10. Describe the construction and working principle of He-Ne-laser. Write some important uses of laser. [Q.N.6 (d), 2069 Set A]
11. Describe the construction and working principle of He–Ne laser. Also write its important uses. [Q.N. 6 (d), Set 'B' 2069]
12. Describe the modern method of productions of X-rays. Discuss crystal diffraction. [Q.N.6(d), 2nd Exam 2068]
13. What is laser? Describe the construction and working principle of He-Ne laser. [Q.N.6(c), 1st Exam 2067]
14. Obtain an expression for the energy of electron in nth orbit of hydrogen atom. [Q.N. 6(d), 2067 2nd Exam.]
15. Obtain the expression of energy of electron in n^{th} orbit of hydrogen atom. [Q.N.9(Or), 2066]
16. Derive Bragg's law. [Q.N.9, 2066]
17. Write down the postulates of Bohr's model of hydrogen atom and obtain expression for the energy of the n^{th} orbit of electron. [Q.N.8(a), 2065]
18. What are the postulates of Bohr atomic model? Obtain an expression for the energy of n^{th} orbit of hydrogen atom. [Q.N.8(a or), 2064]
19. Describe briefly the method of production of x-ray and give their four uses. [Q.N.7(Or), Supp. 2063]
20. What are Bohr's Postulates? Derive an expression for the total energy of electron in n^{th} orbit of hydrogen atom. [Q.N.9, 2063]
21. What are Bohr's postulates of hydrogen atom ? Find the total energy of an electron in n^{th} orbit. [Q.N.6(a), Supp. 2062]
22. X-ray diffraction has been very useful in determining the structure of a crystallize substance. Use this concept to determine the distance between two planes. [Q.N.8(a), 2062]
23. Explain how Bohr modified the Rutherford model of an atom to explain the emission of radiation from atoms:
(only quantitative discussion is required). [Q.N.8(a, Or), 2062]

24. What are Bohr's postulates? Derive the formula for the radius of the third Bohr's orbit. **[Q.N.8(a), 2059]**
25. Derive Bragg's law and explain how is this law used to determine the crystal plane spacing. **[Q.N.9, 2058]**
26. Derive an expression for the energy of an electron in a hydrogen atom. **[Q.N.9, 2057]**
27. What are the X-rays? Confirm with experiment the wave nature of X-rays. **[Q.N.14, 2055]**
28. What are Bohr's postulates of hydrogen atom? Derive an expression for the radius of Bohr's orbit. **[Q.N.15, 2053]**
29. (a) Differentiate between excitation potential and ionization potential. **[Q.N.9(Or, b), 2052]**

    (b) State and explain uncertainty principle. **[Q.N.15(a, Or), 2052]**

Numerical Problems

1. A X-ray tube works at a dc potential difference of 50KV. Only 0.4% of the energy of the cathode rays in converted into x-rays and heat is generated in the target at the rate of 600 watt. Estimate the current passed into the tube and the velocity of the electrons striking the target. (mass of electron = 9×10^{-31} kg, charge of electron = 1.6×10^{-19}C)
   [Ans : 1.2×10^{-2} A, 1.33×10^{8} m/s] **[Q.N.10(b), 2072'C']**
2. A X-ray tube works at a dc potential difference of 50KV. Only 0.4% of the energy of the cathode rays in converted into x-rays and heat is generated in the target at the rate of 500 watt. Estimate the current passed into the tube and the velocity of the electrons striking the target. (mass of electron = 9×10^{-31} kg, charge of electron = 1.6×10^{-19}C) **[Q.N.10(b), 2072'D']**
   [Ans : I = 10×10^{-2}A, V = 1.34×10m/s]
3. An X-ray spectrometer has a crystal of rock salt for which atomic spacing is 2.82A set at an angle of 14° to the beam coming from a tube operated at a constantly increasing voltage. An intense first line appears when the voltage across the tube is 9045V. Calculate the value of Planck constant. **[Q.N.10(a), 2072'E']**
   [Ans: 6.58×10^{-34} Js]
4. An x-ray tube works at a dc potential difference of 50KV and the current through the tube is 0.5mA. find (i) the number of electrons hitting the target per second (ii) the energy falling on the target per second as the kinetic energy of electrons (iii) the cut off wavelength of x-ray emitted. (The charge of electron = 1.6×10^{-19}c, velocity of light c = 3×10^{8}m/s, Plank's constant = 6.62×10^{-34} Js) **[Q.N.10(a), Supp. 2071]**
   [Ans : 3.125×10^{15}, 8.0×10^{-15}J, 2.5×10^{-11} m]
5. Determine the energy that must be given to a hydrogen atom so that it can emit second line of Balmer series. **[Q.N.10(c), Supp. 2071]**
   (Rydberg's constant R = $1.097\times10^{7}m^{-1}$)
   [Ans : 4.08×10^{-19}J]
6. X-rays are incident on the zinc sulphide crystal of crystal spacing 3.08×10^{-8} cm such that first order reflection takes place at glancing angle 12°. Calculate the wavelength of X-rays and glancing angle for second order maximum.
   [Ans : 1.28×10^{-10} m, 24.55°] **[Q.N.10(b), 2070 'Supp']**
7. The cathode ray tubes that generated the picture in early color television were sources of x–rays. If the acceleration voltage in a television tube is 15.0 kV, what are the shortest wavelength x–rays produced by the television.
   [Ans : 8.27×10^{-11} m] **[Q.N. 10 (c), Supp. 2069]**
8. Obtain the de Broglie wavelength of neutron of kinetic energy 150 eV. (mass of neutron = 1.675×10^{-27} Kg, h = 6.62×10^{-34}Js.)
   [Ans : 2.35×10^{-12} m **[Q.N. 10 (b), Supp. 2069]**

9. An X-ray tube, operated at a dc potential difference of 10KV, produces heat at the target at the rate of 720W. Assuming 0.5% of the energy of incident electrons is converted into x-radiation, calculate the tube current and velocity of the incident electrons. ($e/m = 1.8 \times 10^{11}$ Ckg^{-1})
[Ans: 7.24 × 10^{-2} A, 6 × 10^{7} ms^{-1}] **[Q.N. 10 (b), Set 'A' 2069]**

10. X-rays are incident on the zinc sulphide crystal. Its crystal spacing is 3.08×10^{-8}cm and the first order reflection takes place at a glancing angle of 12°. Calculate the wavelength of incident X-rays. **[Q.N. 10 (b), Set 'B' 2069]**
[Ans: 1.28 × 10^{-10} m)

11. Find the wavelength of the radiation emitted from a hydrogen atom when an electron jumps from third orbit to second orbit.
(Given – $E_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}, $h = 6.62 \times 10^{-34}$ Js, me = 9.1×10^{-31} kg.)
[Ans: 7.71×10^{-6}m] **[Q.N. 10(b), 2067 1st Exam.]**

12. An X-ray tube operated at a d.c. potential difference of 40 KV, produces heat at the rate of 720 W assuming 0.5% of the energy of the incident electrons converted into x-radiation. Calculate (i) number of electrons per second striking the target. (ii) the velocity of the incident electrons. [Given $\frac{e}{m} = 1.8 \times 10^{11}$C/Kg]
[Ans: 1.13×10^{17}; 1.2 × 10^{8} m/s] **[Q.N. 10(b), 2067 2nd Exam.]**

13. X-rays of wavelength 0.36 A^0 are diffracted by a Bragg's crystal spectograph at a glancing angle of (4.8)°. Find the spacing of the atomic planes in the crystal. 4
[Ans: 2.15 × 10^{-10} m] **[Q.N.8(b), 2065]**

14. Find the radius of Li^{++} ion in its ground state assuming Bohr's model to be valid ?
(Ans: 1.77 × 10^{-11} m) **[Q.N.6(b), 2063 Supp.]**

15. The spacing at atomic planes in a crystal is 1.1×10^{-10} m and when a monochromatic beam of X–ray is incident on them at glancing angle of 5^0, a first order image is produced. calculate the wavelength. What is the glancing angle for the second order image? **[Q.N.6(b), Supp. 2062]**
(Ans: $\lambda = 1.92 \times 10^{-11}$m, 10°)

16. If an electron position can be measured to an accuracy of 10^{-9}m. How accurately can its velocity be measured ? ($m_e = 9.1 \times 10^{-31}$kg.)
[Ans : 1.16 × 10^{5} ms^{-1}] **[Q.N. 8(b), 2062]**

17. Obtain the De Broglie wave length of the electron having the kinetic energy of 3600eV. (mass of electron = 9.1×10^{-31} kg, Electronic charge = 1.6×10^{-19} C, Plank's constant = 6.6×10^{-34} Js) **[Q.N. 8(Or), 2061]**
[Ans : 2.04 × 10^{-11} m]

18. In an X-ray tube the current through the tube is 1.0 mA and the accelerating potential is 1.5KV. Calculate (i) the number of electrons striking the target (anode) per second and (ii) the rate of production of heat at anode, $e = 1.6 \times 10^{-19}$C. **[Q.N.7(b) Or, 2060 Supp.]**
(Ans: (i) 6.25 × 10^{15} electrons/s, (ii) 1.5 W)

19. Calculate energy in electron volts of a quantum of X-radiation of wavelength 0.15nm. Take $e=1.6\times10^{-19}$ C, $h=6.5\times10^{-34}$ JS, $c= 3\times10^{8}$ ms^{-1} **[Q.N. 8(b), 2060]**
[Ans : 8125 eV]

20. Obtain the de Broglie wave length of neutron of kinetic energy 150 eV. (mass of neutron = 1.675×10^{-27}kg) **[Q.N. 8(b), 2058]**
[Ans : 2.35 × 10^{-12}m]

21. An electron of energy 20eV comes into collision with a hydrogen atom in its ground state. The atom is excited into a-higher state and the electron is scattered with reduced velocity. The atom subsequently returns to its ground state with the emission of photon of wavelength 1.216×10^{-7} m. Determine the velocity of the scattered electron, (mass of electron = 9.1×10^{-31} kg).
[Ans : 1.86 × 10^{6} ms^{-1}] **[Q.N. 15, 2055]**

22. Calculate the wavelength of the first line of the Balmer series, if the wavelength of the second line of this series is 4.86×10^{-7}m. [Q.N. 16, 2054]
[Ans : 6.65×10^{-7}m]

23. Calculate the speed of particle if the mass of it is equal to 5 times its rest mass.
[Ans : 2.68×10^{8} ms^{-1}] [Q.N. 16, 2052]

24. X-ray beam of wavelength 2.9 Å is diffracted from the plane of cubic crystal. The first order diffration is obtained at angle 35°. Calculate the spacing between the planes.
[Ans : 5×10^{-10} m] [Q.N. 16(Or), 2052]

4. Nuclear Physics

Short Questions

1. All the nuclei have nearly the same density. Justify. [Q.N.2(c), 2072'D']
2. How do the mass number and atomic number of a radioactive element change in an α-decay? [Q.N.2(d), 2072'D']
3. What is the significance of binding energy per nucleon ? [Q.N.2(d), Supp. 2071]
4. Why is a neutron considered the most effective bombarding particle in nuclear reactions? [Q.N. 2(d), 2070 'C']
5. Does a nucleus contain electrons? Explain. [Q.N. 2(d), 2070 'D']
6. 'Nuclear charge determines the chemical elements'. Justify. [Q.N. 2(d), Supp. 2069]
7. Why is the mass of a nucleus slightly less than the mass of constituent nucleons? [Q.N. 2(d), 2067 2nd Exam.]
8. The nuclear density is almost constant for all nuclei. Why? [Q.N.1(g), 2066]
9. Explain the significance of Einstein's mass energy equivalence relation. [Q.N.1(g), 2065]
10. Define atomic mass unit and convert it into MeV. [Q.N.2(g), 2065]
11. Define mass defect and packing fraction of a nucleus. [Q.N.1(f), 2061]
12. Distinguish between isotopes and isobar? [Q.N.2(f), 2059]
13. Explain why the mass of a nucleus is always less than the combined masses of its constituent particles. [Q.N.12(f), 2056]
14. Explain binding energy in terms of packing fraction. [Q.N.12(b), 2055]
15. Point out the difference between nuclear fission and fusion. [Q.N. 12(c), 2055]
16. What is meant by chain reaction? [Q.N.12(b), 2053]
17. Distinguish between fission and fusion reactions. [Q.N.12(d), 2052]

Long Questions

1. Discuss four important properties of nuclei. [Q.N.6(c), 2072'C']
2. What are meant by mass defect and binding energy per nucleon ? Draw a graph showing the relation between binding energy per nucleon and atomic number. Explain its significances. [Q.N.6(c), Supp. 2071]
3. Define binding energy. How does binding energy per nucleon very with mass number? What is its significance? [Q.N. 6 (c), Set 'C' 2071]
4. Discuss fission and fusion with an example of each. In which reaction is the energy released greater? [Q.N. 6 (c), 2070 'C']
5. What is nuclear fusion? Discuss the source of the energy released during fusion. [Q.N. 6(d),2070'D']
6. Distinguish between nuclear fusion and fission with examples. [Q.N.9(Or), 2061]
7. Distinguish between nuclear fusion and fission with examples. [Q.N.9(Or), 2057]
8. What is nuclear fission? Give an example of nuclear reaction. [Q.N.14, 2056]
9. State and explain Einstein's mass energy relation with example. [Q.N.13, 2052]

Numerical Problems

1. The energy liberated in the fission of single Uranium –235 atom is 3.2×10^{-11}J. Calculate the power production corresponding to the fission of 1gram of uranium per day. (Avogadro constant = 6×10^{23}mol^{-1}) [Q.N.10(c), 2072'D']
[Ans : 9.37×10^{5} watt]

2. $_{28}Ni^{62}$ may be described as the most strongly bound nucleus because it has the highest B.E. per nucleon. Its neutral atomic mass is 61.928349 amu. Find its mass defect, its total binding energy and binding energy per nucleon.
Given, mass of neutron = 1.008665 amu
mass of proton = 1.007825 amu
1 amu = 931.5MeV. **[Q.N.10(c), 2072'E']**
[Ans: ΔM = 0.583561 amu, B.E. = 543.58 MeV, B.E./Nucleon = 8.76 MeV]

3. The energy released by fission of one U^{235} atom is 200 MeV. Calculate the energy released in Kwh, when one gram of uranium undergoes fission.
[Ans : 2.278 × 10⁴ kwh] **[Q.N. 10 (c), Set 'C' 2071]**

4. Calculate the binding energy per nucleon for a helium nucleus. Given that mass of helium nucleus = 4.001509 amu, mass of proton = 1.007277 amu and mass of neutron = 1.008666 amu.
[Ans : 7.07 Mev] **[Q.N. 10 (b), Set 'D' 2071]**

5. The most common isotope of uranium $_{92}^{238}U$, has atomic mass 238.050783u. calculate the a) mass defect, b) binding energy, c) Binding energy per nucleon (Mass of proton = 1.007825u, mass of neutron = 1.008665u)
[Ans : 7.56 mev] **[Q.N.10(c), 2070 'Supp']**

6. Calculate the binding energy per nucleon of $_{26}Fe^{56}$
Given: mass of proton = 1.007825 amu
mass of neutron = 1.008665 amu
mass of $_{26}Fe^{56}$ = 55.934939 amu.
[Ans : 1.41 × 10⁻¹² J] **[Q.N. 10 (c), 2070 'D']**

7. Estimate the binding energy per nucleon of $_3Li^7$. Mass of $_3Li^7$, a proton and a neutron are respectively 7.01435 amu, 1.00728 amu and 1.00867 amu.
[Ans: 5.6 MeV) **[Q.N. 10 (a), Set 'B' 2069]**

8. Calculate the binding energy per nucleon of $_{26}Fe^{56}$. Atomic mass of $_{26}Fe^{56}$ is 55.9349u and that of $_1H^1$ is 1.00783u. Mass of $_0n^1$ = 1.00867u and 1u = 931 MeV. **[Q.N.7(b), 2060 Supp.]**
(Ans: 1.41 × 10⁻¹²J/nucleon)

5. Radioactivity

Short Questions

1. A nucleus contains no electrons, yet it ejects them. Explain. **[Q.N.2(e), 2072'C']**
2. There are no electrons inside the nucleus, but they are emitted from an unstable nucleus. Why ? **[Q.N.2(e), Supp. 2071]**
3. Write down the decay schemes separately for alpha and beta decays from a nucleus X_Z^A. **[Q.N. 2(b), Set 'B' 2069]**
4. Beta particles penetrate through a matter easily than that of alpha-particle of the same energy. Why? **[Q.N. 2(d), 2069 Set A]**
5. Heavy unstable nuclei usually decay by emitting an α or β particle. Why do they not usually emit a single proton or neutron? **[Q.N.2(d), 2nd Exam 2068]**
6. How do you get emission of β-particles from the nucleus, although there are no electrons within it? **[Q.N.2(g), 2064]**
7. What is radiation hazard? **[Q.N.1(e), 2063]**
8. Write a scheme for beta decay. **[Q.N.2(e), Supp. 2060]**
9. What is the result if an α-particle is emitted from a nucleus ? Give an example. **[Q.N.2(g), 2060]**
10. Can a single nucleus at a time emit α-particle, β-particle and gamma ray? **[Q.N.2(f), 2058]**

11. How do β– particles differ from electrons? [Q.N.1(f), 2057]
12. Explain the term 'artificial radio isotopes'. [Q.N. 12(c), 2054]
13. What are beta, gamma rays? State three properties for each. [Q.N.13, 2053]
14. What do you mean by curie? [Q.N.12(a), 2052]
15. How will you identify α, β and γ radiations by simple experiment? [Q.N.12(b), 2052]

Long Questions

1. State the laws of radioactive disintegration. Derive a relation between the half life and decay constant of a radioactive substance. [Q.N.6(d), 2072'D']
2. What are different units of radio activity? Describe "carbon dating". [Q.N.6(c), 2072'E']
3. State the laws of radioactive disintegration. What is half life period of a radioactive substance? Derive an expression for it. [Q.N. 6 (c), Set 'D' 2071]
4. Discuss radioactive decay law. Deduce an expression for the number of atoms after a time 't' has elapsed an hence write an expression for half life of the radioactive substance. [Q.N.6(c), 2070 'Supp']
5. State the laws of radioactivity and derive the decay equation. [Q.N. 6 (c), 2070'D']
6. Define the terms half life and mean life of a radioactive substance. Present beta decay scheme from a radioactive material. [Q.N. 6 (d), Supp. 2069]
7. Write down laws of radioactive disintegration and establish a relation between half life and decay constant. [Q.N.6(c), 1st Exam 2068]
8. Derive the decay equation and establish the relationship between decay constant and half life of radio-active element. [Q.N. 6(c), 2067 2nd Exam.]
9. What do you understand by the activity of a radioactive material? Write its unit. Also derive the law of radioactive disintegration. [Q.N.8(a, Or), 2065]
10. State laws of radioactive disintegration and show that the number of atoms of a given radioactive substance decreases exponentially with time. Also, derive a relation between decay constant and half life of a radioactive substance. [Q.N.9(Or), 2064]
11. What are the laws of radioactive disintegration ? Derive the relation $N = N_0e^{-\lambda t}$ where the symbol have their usual meanings. [Q.N.6(a), Or, Supp. 2063]
12. What do you understand by radioactivity and its half life period. Derive relation between decay constant and half life period. [Q.N.7, Supp. 2062]
13. Define half life and decay constant of a radioactive substance. Establish a relation between them. [Q.N.8(a), 2061]
14. Discuss both the useful and harmful effects of radiation. Suggest some ways of avoiding radiation hazard. [Q.N.8, Supp. 2060]
15. What is radioactivity? Obtain its exponential decay law and hence derive an expression for half life period. [Q.N.9, 2060]
16. What do you mean by radiation hazard? What are its safety measures? [Q.N.10(Or), 2058]
17. State the law of radioactive disintegration. Derive a relation between half–life and decay constants. [Q.N.13, 2054]

Numerical Problems

1. After a certain lapse of time, the fraction of radioactive polonium undecayed is found to be 12.5% of the initial quantity. What is the duration of this time lapse if half life of polonium is 139 days? [Q.N.10(c), 2072'C']
   [Ans : 417.5 days]
2. If 15% of the radioactive material decays in 5 days, what would be the percentage of amount of original material left after 25 days ? [Q.N.10(b), Supp. 2071]
   [Ans : 44.4%]
3. The mass number of radium is 226. It is observed that 3.67×10^{10} ∝- particles are emitted per second form 1g of radium. Calculate the half life of radium. (Avogadro number = 6.023×10^{23}/mole)
   [Ans : 1594.7 yrs] [Q.N. 10 (b), Set 'C' 2071]

4. Measurements on a certain isotope show that the decay rate decreases from 8318 decays/min. to 3091 decays/min. in 4 days. What is the half life of this isotope? **[Q.N. 10 (c), 2070 'C']**
[Ans : 2.8 days]

5. Find the half life of U^{238}, if one gram of it emits $1.24\times 10^{4}\alpha$ – particles per second. (Avogadro's number = 6.023×10^{23}) **[Q.N. 10 (c), Set 'A' 2069]**
[Ans: 1.42×10^{17}s)

6. At a certain instant, a piece of radio active meterial contains 10^{12} atoms. The half-life of the material is 30 days. Calculate the number of disintegrations in the first second.
[Ans: $2.7 \times 10^{5}\ s^{-1}$] **[Q.N.10(c),2068 2nd Exam.]**

7. The initial number of atoms in a radioactive element is 6×10^{20} and its half life is 10 hours. Calculate the number of atoms which have decayed in 30 hours and the amount of energy liberated if the energy liberated per atom decay is 4×10^{-13} J.
[Ans: 5.25×10^{20}; 2.1×10^{6}J] **[Q.N. 10(c), 2067 1st Exam.]**

8. A small volume of a solution which contain a radioactive isotope of sodium had an activity of 12000 disintegrations per minute when it was injected into the blood stream of a patient. After 30 hours the activity of 1 cm^3 of the blood was found to be 0.5 disintegration per minute. If the half life of the sodium isotope is 15 hours, estimate the volume of the blood in the patient.
(Ans: 6001.77 cm^3) **[Q.N. 8(b), 2066]**

9. A sample of Ra-226 has half life of 1620 years. What is the mass of the sample which undergoes 20000 disintegrations per second ?
(Avogadro's no. = 6.02×10^{23} mol^{-1}) **[Q.N. 8b(Or), 2063]**
[Ans : 5.44×10^{-10} kg]

10. The isotope $^{40}_{19}$k with a half life period of 1.37×10^{9} years decays to $^{14}_{18}$Ar which is stable. Moon rocks from the sea of Tranquility show that the ratio these potassium atoms to argon atoms is $\frac{1}{7}$. Estimate age of rock. **[Q.N.6(b), Or, 2062 Supp.]**
[Ans: 4.11×10^{9} years]

11. The isotope c^{14} has a half life 5700 yrs. If the sample contains 1×10^{22}carbon 14 nuclei. What is the activity of the sample ? **[Q.N. 8(b)Or, 2062]**
[Ans : 4×10^{10} disintegrations/second]

12. The unstable isotope of potassium–40 has a half life of 2.4×10^{8} yrs. How many decays occur per second in a sample containing 2×10^{-6} g of potassium – 40 ?
[Ans : 2.79 dis/S] **[Q.N. 8(b)Or, 2059]**

13. A radioactive source which has the half life of 130 days, contains initially $1x10^{20}$ radioactive atoms, and the energy released per disintegration is $8x10^{-13}$ J, calculate the activity of the source after 260 days have elapsed and total energy released during this period. **[Q.N. 8(b)Or, 2057]**
[Ans : 1.54×10^{12} dis/S, 6×10^{7} J]

14. A radio-active source has decayed to one tenth of one percent of its initial activity in one hundred days. What is its half-life period ? **[Q.N. 16, 2056]**
[Ans : 10 days]

15. If 4g of radio - active material of half life period of 10 years disintegrates, find out mean life of the given sample. **[Q.N. 16, 2055]**
[Ans : 14.43 years]

16. At certain instant a piece of radio active material contained 10^{12} atoms. The half life of the material is 15 days. Calculate the rate of decay after 30 days have elapsed.
[Ans : 1.15×10^{10} dis/sec.] **[Q.N. 16(Or), 2053]**

6. Nuclear Energy and Other Sources of Energy

Short Questions

1. What do you mean by global warming? [Q.N.2(f), 2072'C']
2. What is acid rain? Explain. [Q.N.2(f), 2072'D']
3. What are cosmic rays? [Q.N.2(c), 2072'E']
4. What is global warming? Explain. [Q.N. 2(f), Set 'C' 2071]
5. What is acid rain? Explain. [Q.N. 2(f), Set 'D' 2071]
6. Write the meaning of conservation of energy and degradation of energy. [Q.N. 2(e), Set 'C' 2071]
7. What is acid rain? Explain. [Q.N. 2(e), 2070 'C']
8. What is global warming? Explain. [Q.N. 2(e), 2070 'D']
9. What is global warming? Write two of its effects. [Q.N. 2(e), Supp. 2069]
10. What is global warming? Give two examples of its effect. [Q.N. 2(e), Set 'B' 2069]
11. What is acid rain? Explain. [Q.N.2(f), 1st Exam 2068]
12. If energy is conserved, why is there an energy 'crisis'? [Q.N.2(e), 2nd Exam 2068]
13. What is energy conservation and energy degradation? [Q.N.2(d), 1st Exam 2067]
14. What is global warming? [Q.N. 2(f), 2067 2nd Exam.]
15. What is a black hole? [Q.N.2(h), 2066]
16. What do you understand by energy crisis? [Q.N.1(h), 2065]
17. What is black hole? [Q.N.1(g), 2064]
18. What is black hole? [Q.N.1(g), 2063]
19. Which bomb is more explosive, hydrogen bomb or atom bomb? [Q.N.2(e), 2063]
20. What is the source of energy of sun? [Q.N.2(f), 2063]
21. What are the main sources of energy in Nepal? [Q.N.1(f), Supp. 2062]
22. What is black hole? [Q.N.1(h), 2061]
23. What are renewable and non-renewable sources of energy ? Give example. [Q.N.1(e), Supp. 2060]
24. How does greenhouse effect lead to global warming ? [Q.N.2(f), Supp. 2060]
25. What is water pollution? [Q.N.2(h), 2060]
26. What is noise pollution? [Q.N.1(h), 2059]
27. Why is solar energy more preferable than fossil-fuel energy? Explain. [Q.N.2(h), 2059]
28. What are renewable sources of energy? [Q.N.1(g), 2057]

Long Questions

1. What are renewable and non renewable sources of energy? Write with examples. Describe the necessity of conservation of natural resources of energy to reduce energy crisis in the future. [Q.N.6(d), 2072'C']
2. What are the major energy sources? Discuss the global energy consumption pattern. [Q.N. 6 (d), 2070 'C']
3. How does nuclear fusion differ from nuclear fission? How is the energy released estimated in the fusion reaction? [Q.N.6 (c), 2069 Set A]
4. What are major energy sources? Give a brief account on the global energy consumption pattern and demands. [Q.N.6(d), 1st Exam 2068]
5. What is nuclear fission? Compare the energy released from nuclear fission with that of fusion. [Q.N.6(c), 2nd Exam 2068]
6. Write down the schemes for nuclear fusion and nuclear fission. How can the release energy in any of these reactions estimated? What do you mean by Q-value of a nuclear reaction? [Q.N.6(d), 1st Exam 2067]
7. Write an essay on water pollution. [Q.N.10, 2066]
8. Write an essay on water pollution. [Q.N.10(or), 2065]
9. What is water pollution? Discuss its adverse effects and give some measures to control it. [Q.N.10, 2064]
10. Write an essay about the energy scenario of our country. [Q.N.8, Supp. 2063]

11. What is air pollution? How can it be controlled? Give information about air pollution in Nepal. **[Q.N.8(Or), Supp. 2063]**
12. Describe the present sources of energy being used in our country. **[Q.N.10 (or), 2063]**
13. What is nuclear fission? How energy is released in nuclear fission reaction? **[Q.N.8(a), 2063]**
14. Write an essay on major sources of energy in Nepal. **[Q.N.8, Supp. 2062]**
15. Discuss energy crisis in a modern society. **[Q.N.8, 2062]**
16. What are the causes of air pollution? Mention its effects and ways to minimize it. **[Q.N.10, 2061]**
17. Write an essay on major sources of energy in Nepal. **[Q.N.10(Or), 2061]**
18. Discuss various sources of Noise pollution and some ways of controlling it. **[Q.N.8(Or), Supp. 2060]**
19. Give a brief account on "Energy sources of Nepal". **[Q.N.10, 2060]**
20. What is air pollution? Discuss major sources of air pollution and suggest some ways of controlling it. **[Q.N.10(Or), 2060]**
21. What is renewable source of energy? Nepal is rich in hydro power next to Brazil. Comment on it. **[Q.N.10 (or), 2059]**
22. What do you mean by fission? How energy is released in fission of uranium nucleus ? **[Q.N.8(a), 2058]**
23. What is water pollution? What degree of water pollution do you think exists in Kathmandu valley? **[Q.N.10, 2058]**

Numerical Problems

1. The energy liberated in the fission of single uranium-235 atom is 3.2×10^{-11} J. Calculate the power production corresponding to the fission of 1 gm of uranium per day. Assume avogadro constant as 6×10^{23} mol^{-1}. **[Q.N.10(b),2068 1st Exam]**

   [Ans: 9.46 x 10^5watt)

2. A nucleus of uranium-238 disintegrates according to the reaction $_{92}U^{238} \times 90Th^{234} + 2$ He^4. Calculate: i) the total energy released in the disintegration ii) the K.E. of the alpha particle, the nucleus being at rest before disintegration.

   [Mass of $_{92}U^{238}$ = 238.12492u, mass of $_{90}Th^{234}$ = 234.1165u, mass of $_2He^4$ = 4.00387 u, 1u = 931Mev]

   [Ans: 4.236 MeV; 4.16 Mev] **[Q.N. 10(c), 2067 2nd Exam.]**

3. The energy liberated in the fission of a single Uranium-235 atom is 3.2×10^{-11} J. Calculate the power production corresponding to the fission of 1.5g of Uranium per day. **[Q.N. 8(b)Or, 2064]**

   [Ans : 9.4 x 10^8 W]

4. The energy liberated in the fission of a single uranium–235 atom is 3.2×10^{-11}J. Calculate the power production corresponding to the fission of 1 kg of uranium per day.

   (Avogadro constant = 6.0×10^{23} $mole^{-1}$). **[Q.N. 16(Or), 2054]**

   [Ans : 9.4 x 10^8 W/ day]

5. Calculate the Q-value of the reaction & mention the type of reaction (endo-thermic or exothermic)

   $_2He^4$ = 4.00377 amu $_8O^{17}$ = 17.00450 amu

   $_7N^{14}$ = 14.00783 amu $_1H^1$ = 1.00814 amu **[Q.N. 14, 2052]**

   [Ans : 0.96824 MeV]

7. Particle Physics and Cosmology

Short Questions

1. Write quark composition of proton and neutron. [Q.N.2(d), 2072'C']
2. State Hubble's law and write its significance. [Q.N.2(e), 2072'D']
3. Show that proton contains three quarks: up , up and down. [Q.N.2(e), 2072'E']
4. What are quarks ? Write their names with charge they contained. [Q.N.2(f), Supp. 2071]
5. State Hubble's law and write the significance of Hubble's constant. [Q.N. 2(e), Set 'D' 2071]
6. Does the universe have a centre ? Explain. [Q.N.2(f), 2070 'Supp']
7. Explain the significance of Hubble's constant. [Q.N. 2(f), 2070 'C']
8. Show that a proton contains three quarks: up, up and down (uud). [Q.N. 2(f), 2070 'D']
9. Give two examples each of baryons and leptons. [Q.N. 2(f), Supp. 2069]
10. What are the quark combination of proton and neutron. [Q.N. 2(f), 2069 Set A]
11. Explain the significance of Hubble constant. [Q.N. 2(a), Set 'B' 2069]
12. Write the quark combination of proton and neutron. [Q.N.2(e), 1st Exam 2068]
13. What are the similarities and differences between a neutrino and a photon? [Q.N.2(c), 2nd Exam 2068]
14. A particle consisting up, up and down quarks is a proton. Justify? [Q.N.2(f), 1st Exam 2067]
15. Write down the quark combination for proton and antineutron. [Q.N. 2(e), 2067 2nd Exam.]
16. What are mesons? Write the names of two mesons. [Q.N.2(g), 2066]
17. Give two examples of the pairs of particle-antiparticle system. [Q.N.2(g), 2063]
18. What is the quark combination of a neutron ? [Q.N.2(e), 2062 Supp.]
19. What is the quark combination of a proton? [Q.N.2(g), 2061]
20. How can we say that neutron contains three quarks down, down and up ? [Q.N.1(d), Supp. 2060]
21. What quarks combination will give a neutron? [Q.N.1(g), 2059]
22. How do you know that the universe is ever expanding? Give reasons. [Q.N.2(g), 2059]
23. What particles do the $\bar{u}\,\bar{u}\,\bar{d}$ combinations produce? [Q.N.2(g), 2057]

Long Questions

1. Name the quarks you know. Also present the quark combinations of baryon and meson groups of particles. [Q.N. 6 (c), Set 'B' 2069]
2. What are fundamental particles? How are they classified? Write the properties of quarks and lepton. [Q.N.9, 2062]
3. Explain how Universe expands. Explain the Hubble's law. [Q.N.9(Or), 2062]
4. Give a classification of elementary particles with example. *[Q.N.9(Or), 2058]*

2. CHEMISTRY

Course Content

General & Physical Chemistry (Section A)

Unit 1: Chemical Bonding and Shape of Molecules - 3 teaching hours

1. Hybridization and concept of sigma and pi bond
2. Valence shell Electron Pair Repulsion (VSEPR) theory
3. Prediction of molecular geometry (Shape of molecules) on the basis of VSEPR and hybridization. (BeF_2, BF_3, NH_3, H_2O, CH_4, H_2O, C_2H_2 C_2H_4 H_2S)

Unit 2: Volumetric Analysis - 8 teaching hours

1. Different ways of expressing the concentration of solutions
   i. Molarity, ii. Normality iii. Molality iv. Gram /Litre v. Percentage
2. Titration : i. acid-base titration ii. Redox titration
3. Primary standard substances, primary standard solution , secondary standard solution, end point, equivalence point, neutral point, indicators
4. Derivation of normality equation
5. Relation between normality and molarity
6. Selection of indicators in acid-base titration and pH curve
7. Solving related numerical problems

Unit 3: Ionic Equilibrium - 12 teaching hours

1. Introduction
2. Ionization of weak electrolyte (Ostwald's dilution law)
3. Degree of ionization and ionization constant
4. Strength of acids and base interm of K_a, K_b and pK_a and pK_b values
5. Acid-base concept
   i. Arrhenius concept of acids and bases. ii. Bronsted lowry concept of acids and bases
   iii. Lewis concept of acids and bases.
6. Ionization of water, pH and pH scale.
7. Hydrolysis of salts. (qualitative concept)
8. Solubility product principle and its application
9. Common ion effects and its application
10. Application of solubility product principle in qualitative analysis
11. Buffer Solution (Solving numerical problems related with solubility, solubility product, pH and pOH)

Unit 4: Electrochemistry - 10 teaching hours

1. Introduction
2. Electrolysis; strong and weak electrolyte
3. Arrehenius theory of ionization
4. Faraday's laws of electrolysis
5. Criteria of product formation during electrolysis
6. Electrolytic conduction, equivalent and molar conductivities
7. Variation of conductivity with concentration
8. Electrode potential, standard electrode potential, standard hydrogen electrode and its applications
9. Eletrochemical series and its use to predict the feasibility of redox reactions
10. Electrochemical cell (Galvanic cell)
11. EMF of electrochemical cell in the standard state (Solving related numerical problems)

Unit 5: Energetics of Chemical Reactions - 8 teaching hours

1. Introduction , unit of energy
2. Some thermodynamical terms: system, surrounding , boundary , universe different types of system, state function, state variables and internal energy
3. Exchange of energy between the system and surrounding
4. Different types of thermodynamic process
5. The first law of thermodynamics
6. Sign convention of heat and work
7. Enthalpy, enthalpy change in chemical reactions
8. Hess's law of constant heat summation
9. Heat of neutralization, heat of solution, heat of combustion, heat of vapourization, heat of formation and bond energy (Solving related numerical problems)

HSEB Exam. 2073 C, D & Supplementary Exam. 2072

1. PHYSICS

Exam Questions

Unit 1: Waves and Optics

WAVES

1. Wave Motion

Short Questions

No Questions has been asked in this year.

Long Questions

No Questions has been asked in this year.

Numerical Problems

No Questions has been asked in this year.

2. Mechanical Waves

Short Questions

1. The velocity of sound in solid is generally greater than that in gas at STP. Why ? Give reason. **[Q.N.3(b), 2073 'C']**

Long Questions

1. What correction was made in Newton's expression for the velocity of sound ? Also explain, how change of temperature and pressure affect the velocity of sound. **[Q.N.7(b), 2073 'C']**
2. Write the Newton's formula for the velocity of sound in air. Explain why and how this formula is modified by Laplace. **[Q.N.7(a), Supp. 2072]**

Numerical Problems

1. Calculate the bulk modulus of a liquid in which longitudinal waves with frequency of 250 Hz have the wavelength of 8 m if the density of liquid is 900 kgm^{-3}. **(Ans: 3.6×10^9 N/m^2)** **4[Q.N.11, 2073 'D']**

3. Wave in Pipes and Strings

Short Questions

1. By what factor does the velocity of transverse wave in the string change when the tension in the stretched string is increased by four times. **[Q.N.3(a), 2073 'C']**
2. By what factor does the velocity of transverse wave in the string change when the tension in the stretched string is increased by four times ? **[Q.N.3(b), 2073 'D']**
3. The six strings of a guitar are of the same length and are under nearly the same tension, but have different thickness. On which string to waves travel the fastest ? **[Q.N.3(a), Supp. 2072]**
4. How does the pitch of an organ pipe change with temperature ? **[Q.N.3(b), Supp. 2072]**

Long Questions

1. What is the difference between an open and a close pipes ? Explain with proper sketches for the formation of second overtones in each case. Also express the length of pipes in terms of the wavelength of sound. **[Q.N.7(a), 2073 'D']**

Numerical Problems

1. On a day when the speed of sound is 345 m/s, the fundamental frequency of a closed organ pipe is 220 Hz. The second overtone of this pipe has the same wave length as the third harmonic of an open pipe. How long is the open pipe ? **4[Q.N.11, Supp. 2072]**
(Ans: 47 cm)

4. Acoustic Phenomena

Short Questions

1. Explain the difference in characteristics between ultrasonic and supersonic waves. [Q.N.3(a), 2073 'D']

Long Questions

1. How are beats formed when two waves are superimposed ? Deduce expression for the frequency of beats so formed. [Q.N.7(a), 2073 'C']
2. What is Doppler effect ? Explain this effect in case of both observer and source of sound moving toward each other. [Q.N.7(b), 2073 'D']
3. What is Doppler effect ? Deduce the formula for the apparent frequency of sound when both source and observe are moving towards each other. [Q.N.7(b), Supp. 2072]

Numerical Problems

1. A car travelling with a speed of 60 $Kmhr^{-1}$ sounds a horn of frequency 500Hz. The sound is heard in another car travelling behind the first car in the same direction with a speed of 80 $Kmhr^{-1}$. What frequencies will the driver of the second car hear before and after overtaking the first car if the velocity of sound is 340ms^{-1}? 4[Q.N.11, 2073 'C']
(Ans: before 507.78 Hz, after 491.41 Hz)

PHYSICAL OPTICS

1. Nature and Propagation of Light

Short Questions

1. What is the difference between wave front and wavelets in the explanation of Huygen's wave theory. [Q.N.4(a), 2073 'D']

Long Questions

1. Describe Huyge's principle with figure to prove the laws of reflection and refraction of light. [Q.N.8(b), 2073 'C']
2. What is Huygens' principle ? Show how refraction of light at a plane interface can be explained on the basis of wave theory of light. [Q.N.8(a), Supp. 2072]

Numerical Problems

No Questions has been asked in this year.

2. Interference

Short Questions

1. Two waves are represented in usual notation as $y_1 = a_1 \sin \omega t$ and $y_2 = a_2 \cos \omega t$. Their intensities are I_1 and I_2. What would be the ratio of their amplitudes when $I_1 = 2I_2$? [Q.N.4(a), 2073 'C']
2. A two-slit interference experiment is setup and the fringes are displayed on a screen. Then the whole apparatus is immersed in a water. How does the fringe pattern change ? [Q.N.4(a), Supp. 2072]

Long Questions

1. What are coherent sources of light ? Describe double slit experiment to find the fringe width from the experiment performed with light waves. [Q.N.8(a), 2073 'C']
2. What are the conditions for constructive and destructive interference of light waves ? Show that in Young's double slit experiment the dark and bright fringes are equally spaced. [Q.N.8(b), Supp. 2072]

Numerical Problems

1. The separation between the consecutive dark fringes in a Young's double slit experiment is 1 mm. The screen is placed at a distance of 2m from the slits of 1.0 mm separation. What is the wavelength of light used in the experiment ?3[Q.N.12, 2073 'D']
(Ans: 5×10^{-7} m)

3. Diffraction

Short Questions

1. Light waves undergo diffraction around an edge. Can sound wave different around an edge ? Explain. [Q.N.4(b), Supp. 2072]

Long Questions

1. What is diffraction of light ? Explain the case of diffraction at a single slit. Hence show the intensity distribution in the figure. [Q.N.8(a), 2073 'D']

Numerical Problems

1. A plane transmission grating having 500 lines per mm is illuminated normally by light source of 600 nm wavelength. How many diffraction maxima will be observed on a screen behind the grating ? 3[Q.N.12, 2073 'C']
(Ans: 3)

4. Polarization

Short Questions

1. Are light waves longitudinal ? Justify your answer. [Q.N.4(b), 2073 'C']
2. State and explain Brewster's law of polarization. [Q.N.4(b), 2073 'D']

Long Questions

1. What is polarization ? Prove that light is a transverse wave. [Q.N.8(b), 2073 'D']

Numerical Problems

1. The polarizing angle for a medium is 60°. Calculate the velocity of light in the medium.3
(Ans: 1.73×10^8m/s) [Q.N.12, Supp. 2072]

Unit 2 – Electricity and Magnetism

Current Electricity

1. D.C. Circuit

Short Questions

1. Will the drift velocity of electrons change if the diameter of a connecting wire is halved ? Why ? [Q.N.1(a), 2073 'C']
2. Five bulbs are connected in series across 220 volt line. If one bulb is fused, the remaining bulbs are again connected across the same line. Which one of the arrangements will be more illuminated ? Justify your answer. [Q.N.1(b), 2073 'C']
3. How can a galvanometer be converted into voltmeter ? Explain. [Q.N.1(f), 2073 'C']
4. Explain the difference between resistance and resistivity of a wire. [Q.N.1(a), Supp. 2072]

Long Questions

1. State and verify Joule's law of heating. [Q.N.5(a), Supp. 2072]

Numerical Problems

1. Resistance of a wire of length 1m, diameter 1mm is 2.2Ω. Calculate its resistivity and conductivity. [Q.N.9(c), 2073 'C']
(Ans: 1.72×10^{-6} Ωm, 5.78×10^5 Ωm)
2. An electric lamp consumes 60 W at 220 V. How many dry cells of emf. 1.5V and internal resistance 1Ω are required to glow the lamp ? [Q.N.9(a), 2073 'D']
(Ans: 177)
3. A copper wire has a diameter of 1.02 mm, cross-sectional area 8.2×10^{-7} m² and resistivity 1.72×18^{-8} Ωm. It carries a current 1.67A. Find the electric field magnitude in the wire and the potential difference between tow points in the wire 50 m apart. [Q.N.9(c), Supp. 2072]
(Ans: 0.035 V/m, 1.75 V)

2. Electrical Circuits

Short Questions

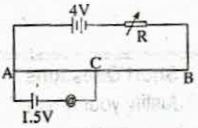
No Questions has been asked in this year.

Long Questions

1. State and apply Krichoff's rule of electrical circuits to measure the unknown resistance of a wire by metre bridge with necessary theory and circuit. **[Q.N.5(a), 2073 'C']**

Numerical Problems

1. A simple potentiometer circuit is setup as in fig Q(1), using uniform wire AB, 1.0 m long, which has a resistance of 2Ω. The resistance of the 4V battery is negligible. If the variable resistor R were given a value of 2.4Ω, what would be the length AC for zero galvanometer deflection ? **[Q.N.9(a), Supp. 2072]**
(Ans: 82.5cm)



3. Thermoelectric Effect

Short Questions

1. Point out the difference between Peltier and Seebeck effect in brief. **[Q.N.1(d), 2073 'C']**
2. What is Seebeck effect ? How is this effect different from Peltier effect ? Explain. **[Q.N.1(f), 2073 'D']**
3. On what factors does the temperature of inversion depend ? **[Q.N.1(e), Supp. 2072]**

Long Questions

No Questions has been asked in this year.

Numerical Problems

1. The thermo-emf $\in$ and the temperature of hot junction θ satisfy a relation $\in = a\theta + b\theta^2$ where $a = 4.1 \times 10^{-5}$ V(°C)$^{-1}$ and $b = -4.1 \times 10^{-8}$V(°C)$^{-2}$. If the cold junction temperature is 0°C find the neutral temperature. **[Q.N.9(c), 2073 'D']**
(Ans: 500°C)

4. Chemical Effect of Current

Short Questions

1. State the Faraday's laws of electrolysis. **[Q.N.1(e), 2073 'C']**
2. Explain electrochemical equivalent of a substance. **[Q.N.1(b), Supp. 2072]**

Long Questions

No Questions has been asked in this year.

Numerical Problems

No Questions has been asked in this year.

Magnetic Field of Current

1. Magnetic Field

Short Questions

1. How can the sensitivity of moving coil galvanometer be increased ? Explain. **[Q.N.1(c), 2073 'C']**
2. A charge particle carrying a charge 'q' moves in an electric field E. If its specific charge is 'S', write an expression of its acceleration in terms of above entities. **[Q.N.1(b), 2073 'D']**
3. Magnetic field at the centre of a solenoid is double than that at its ends. Why ? **[Q.N.1(c), 2073 'D']**

4. Hall voltages are much larger for semi-conductors than for good conductors for comparable currents, fields and dimensions. Why ? **[Q.N.1(c), Supp. 2072]**

Long Questions

1. State Ampere's law and deduce an expression for the force between two parallel current carrying wires. **[Q.N.5(c), 2073 'C']**
2. What is Hall effect ? Explain and deduce expressions for Hall voltage and Hall electric field. **[Q.N.5(d), 2073 'C']**
3. Explain the magnetic effect on a current carrying rectangular coil. Hence obtain expression for the torque on the coil. **[Q.N.5(a), 2073 'D']**
4. What is Hall effect ? Explain and deduce expressions for Hall voltage and electric field. **[Q.N.5(d), 2073 'D']**
5. Find an expression for the magnetic field on the axial line of a current carrying circular coil. **[Q.N.5(b), Supp. 2072]**

Numerical Problems

1. A straight conductor of length 15 cm is moving with uniform speed of 10 ms^{-1} making an angle of 30° with uniform magnetic field of 10^{-4} Tesla. Calculate the emf induced across the length. **[Q.N.9(a), 2073 'C']**
   (Ans: 7.5×10^{-5} V)
2. A circular coil has 100 turns and a mean diameter of 20 cm. It carries a current of 5A. Find the strength of the magnetic field at a point on its axis at a distance of 15 cm from the centre of the coil. **[Q.N.9(b), 2073 'D']**
   (Ans: 5.35×10^{-4} T)

2. Magnetic Properties of Materials

Short Questions

1. How do you expect about the directions of horizontal and vertical components of earth's magnetic intensity at pole and at equator ? Give justification in terms of angle of dip. **[Q.N.1(a), 2073 'D']**
2. Why should the permeability of a paramagnetic material be expected to decrease with increasing temperature ? **[Q.N.1(d), Supp. 2072]**

Long Questions

1. Relate magnetic permeability and susceptibility features of a magnetic material. Can hysteresis curve be drawn in the case of diamagnetic material ? Explain on the basis of above features. **[Q.N.5(b), 2073 'C']**

Numerical Problems

No Questions has been asked in this year.

3. Electromagnetic Induction

Short Questions

1. Lenz law follows the principle of conservation of energy. Explain. **[Q.N.1(d), 2073 'D']**
2. Describe the phenomena of self and mutual induction. Describe the construction and explain the action of a transformer. **[Q.N.5(c), Supp. 2072]**

Long Questions

1. Explain how the concept of self and mutual inductances are used in the working principle of a transformer. **[Q.N.5(c), 2073 'D']**

Numerical Problems

1. A jet plane is flying due west at the speed of 1800 km/hr. What is the voltage difference developed between the ends of the wings 25 m long of the earths' magnetic field at that location is 5×10^{-4}T and the angle of dip is 45° ?
   (Ans: 6.25 V) **[Q.N.9(b), Supp. 2072]**

4. Alternating Currents

Short Questions

1. Alternating current passes through a capacitor whereas direct current does not. Explain this fact on the basis of capacitative reactance. [Q.N.1(e), 2073 'D']
2. How does the resonance frequency of an L.C.R. series circuit change if the plates of the capacitor are brought closer together ? [Q.N.1(f), Supp. 2072]

Long Questions

1. Find expression for current in the case of alternating LCR series circuit and explain the phase relation between voltage and current. [Q.N.5(b), 2073 'D']
2. Find expression for current in the case of alternating LCR series circuit and explain the phase relation between voltage and current. [Q.N.5(b), 2073 'D']
3. Derive an expression for the impedance of a LCR series a.c. circuit. Show graphically how impedance varies with the variation of applied frequency. [Q.N.5(d), Supp. 2072]

Numerical Problems

1. L–C–R alternating current series circuit of L = 1H, C = 1μF and R = 100Ω are connected in series with a source of frequency 50Hz. What is the phase shift between current and voltage ? [Q.N.9(b), 2073 'C']
(Ans: – 90°)

Unit 3 – Modern Physics

1. Electrons and Photons

Short Questions

1. Human skin is relatively insensitive to visible light, but ultra violet radiation can cause severe burns. Does this have anything to do with photon energies ? Explain. [Q.N.2(b), Supp. 2072]

Long Questions

1. Explain photoelectric effect to write Einstein's photoelectric equation. Describe Millikan's laboratory method to determine Planck's constant. [Q.N.6(a), 2073 'C']
2. Describe the laboratory method to determine the specific charge of an electron by J.J. Thomson's method. [Q.N.6(d), 2073 'D']
3. Describe an experiment to determine the ratio of the charge to mass (e/m) for an electron. Show how the result is derived from the observations. [Q.N.6(b), Supp. 2072]

Numerical Problems

1. An electron having 500 eV energy enters at right angle to a uniform magnetic field of 10^{-4} Tesla. If its specific charge is 1.75×10^{11} Ckg^{-1} calculate the radius of its circular orbit. [Q.N.10(b), 2073 'C']
(Ans: 0.75 m
2. Sodium has a work function of 2 ev. calculate the maximum energy and speed of the emitted electrons when sodium is illuminated by radiation of wave length 150nm. (Given mass of electron = 9.1×10^{-31} Kg) [Q.N.10(b), Supp. 2072]
(Ans: 1×10^{-18} J, 1.48×10^{6}m/s)

2. Solids and Semiconductor Devices

Short Questions

1. How does the conductivity of semiconductor vary with temperature ? Explain. [Q.N.2(b), 2073 'C']
2. Explain how the conductivity of a semiconductor varies with temperature ? [Q.N.2(a), 2073 'D']
3. Explain the essential characteristics for an element to serve as (i) a donor impurity (ii) an acceptor impurity in a semiconductor. [Q.N.2(c), Supp. 2072]

Long Questions

1. How are intrinsic and extrinsic semiconductors conceptualized ? Explain the biasing characteristics of a junction diode. **[Q.N.6(b), 2073 'C']**
2. What is a rectifier ? Describe the working principle of a full wave rectifier. **[Q.N.6(c), 2073 'D']**
3. Describe the common emitter configuration in a n-p-n transistor. Draw and explain input, output and transfer characteristics. **[Q.N.6(c), Supp. 2072]**

Numerical

1. 400 nm wavelength of light falls on a photo sensitive material of work function 2.3 eV. Compute the maximum energy of photoelectrons. **[Q.N.10(a), 2073 'D']**
(Ans: 0.8 eV)

3. Quantization of Energy

Short Questions

1. The accelerating voltage of a proton is increased to twice. How will its de Broglie wavelength change ? Explain. **[Q.N.2(a), 2073 'C']**
2. Can X-ray diffraction experiment be performed by an ordinary grating ? Why ? **[Q.N.2(d), 2073 'C']**
3. Characteristic features of X-rays and Y-rays are similar in many aspects. Write two important features that explain the differences between these rays. **[Q.N.2(d), 2073 'D']**
4. Explain the difference between stimulated and spontaneous emissions of radiation. **[Q.N.2(f), 2073 'D']**
5. If a proton and an electron have the same speed, which has the longer de Broglie wavelength ? Explain. **[Q.N.2(f), Supp. 2072]**

Long Questions

1. Explain the working principle of a gas laser. How is population inversion achieved for lasing action ? **[Q.N.6(d), 2073 'C']**
2. Write down the postulates of Bohr's hydrogen atom. Hence derive expression for energy of the third electron orbit. **[Q.N.6(a), 2073 'D']**

Numerical Problems

1. The first member of Balmer series of hydrogen atom has a wavelength of 6563 Angstrom. Calculate the wavelength of its second member.
(Ans: 4861.5A°) **[Q.N.10(c), 2073 'C']**
2. Calculate the de Broglie wavelength of electron having kinetic energy of 400 eV.
(Ans: 1.94×10^{-9} m) **Q.N.10(c), 2073 'D']**
3. Calculate the wave length of electromagnetic radiation emitted by a hydrogen atom which undergoes a transition between energy levels of -1.36×10^{-19} J and -5.45×10^{-19} J. (Given plank constant = 6.6×10^{-34}JS) **[Q.N.10(a), Supp. 2072]**
(Ans: 4.84×10^{-7}m)

4. Nuclear Physics

Short Questions

1. Define atomic mass unit (amu). Hence convert the mass of a neutron, (1840 me), into amu where me is the mass of 'an electron'. **[Q.N.2(c), 2073 'C']**
2. Diameter of Al^{27} nucleus is D_{Al}. How can one express the diameter of Cu^{64} in terms of D_{Al}? Explain. **[Q.N.2(b), 2073 'D']**
3. By what factor must the mass number of a nucleus increase to double its volume ? Explain. **[Q.N.2(d), Supp. 2072]**

Long Questions

1. Write down the representative nuclear fission and fusion reactions. Explain, how the energy release in the case of four protons fused into doubly ionized helium can be estimated ? [Q.N.6(c), 2073 'C']

Numerical Problems

1. What will be the amount of energy released in the fusion of three alpha particles into a C^{12} nucleus if mass of He^4 and C^{12} nuclei are respectively 4.00263 amu and 12 amu. **(Ans: 7.34 meV)** [Q.N.10(b), 2073 'D']
2. The mass of the nucleus of the isotope Lithium (7Li) is 7.014351 u. Find its binding energy and binding energy per nucleon. (Given mass of proton = 1.00727 u, mass of neutron = 1.008665 u) [Q.N.10(c), Supp. 2072]
(Ans: 40.5 mev, 5.79 mev)

5. Radioactivity

Short Questions

No Questions has been asked in this year.

Long Questions

1. Deduce the law of radioactivity and hence define half life of a radioactive sample. How much is one Curie ? [Q.N.6(b), 2073 'D']
2. State the laws of radioactive disintegration. Derive disintegration equation. Using the equation find a relation between the half life and decay constant. [Q.N.6(d), Supp. 2072]

Numerical Problems

1. Half line of Ra^{226} is 1620 years. Estimate its mass when its activity is 0.5 Curie. **(Ans: 0.51 gm)** [Q.N.10(a), 2073 'C']

6. Nuclear Energy and Other Sources of Energy

Short Questions

1. Which type of renewable energy is most useful to our country ? Give reasons. [Q.N.2(e), Supp. 2072]

Long Questions

1. What are the environmental implications of the following energy sources :
(i) fossil fuels and (ii) nuclear fuels ? [Q.N.6(a), Supp. 2072]

Numerical Problems

No Questions has been asked in this year.

7. Particle Physics and Cosmology

Short Questions

1. State and explain Hubble's law. [Q.N.2(e), 2073 'C']
2. What class of quark combination one can expect in the combination of one quark and a lepton. Explain with example. [Q.N.2(f), 2073 'C']
3. How many types of quark you know ? Name them with their electronic charges. [Q.N.2(c), 2073 'D']
4. State and explain Hubble law. [Q.N.2(e), 2073 'D']
5. Does the universe have a center ? Explain. [Q.N.2(a), Supp. 2072]

Long Questions

No Questions has been asked in this year.