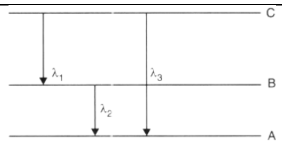
BRAIN INTERNATIONAL SCHOOL

SUBJECT: PHYSICS **CLASS XII** **NOV, 2024**

CH: -MODERN PHYSICS

	CH-ATOMS	
1	When the hydrogen atom is in first excited level, its radius is a) same b) four times c) half d) twice	
2	The ionization energy of 10 times ionized sodium atom is: a) $13.6 \times 11 eV$ b) $13.6 \times (11)^2 eV$ c) 13.6 / 11 eV d) 13.6 eV	
3	The 20 cm radiowave emitted by hydrogen in interstellar space is due to the interaction, called the hyperfine interaction in atomic hydrogen. The energy of the emitted wave is nearly a) 7×10^{-15} J b) 7×10^{-8} J c) 10^{-17} J d) 10^{-24} J	
4	The wavelengths involved in the spectrum of deuterium ($_1 H^2$) are slightly different from that of hydrogen spectrum, because a) nuclear forces are different in the two cases b) masses of the two nuclei are different c) attraction between the electron and the nucleus is different in the two cases d) sizes of the two nuclei are different	
5	The Rydberg constant R for hydrogen is: a) $R = \left(\frac{1}{4\pi\varepsilon_0}\right) \cdot \frac{2\pi^2 me^4}{ch^2}$	

	b) $R = -\left[\frac{1}{4\pi\varepsilon_0}\right] \cdot \frac{2\pi^2 me^2}{ch^2}$ c) $R = \left(\frac{1}{4\pi\varepsilon_0}\right)^2 \cdot \frac{2\pi^2 me^4}{c^2h^2}$ d) $R = \frac{me^4}{8\epsilon_0^2 h^3 c}$	
6	Using Bohr's total postulates, derive the expression for the total energy of the electron in the stationary states of hydrogen atom.	
7	State the basic assumption of the Rutherford model of the atom. Explain in brief why this model cannot account for the stability of an atom?	
8	1. In an experiment on a - particle scattering by a thin foil, draw a plot showing the number of particles scattered versus the scattering angle 0. 2. Why is it that a very small fraction of the particles is scattered at 0 > 90°? 3. Write two important conclusions that can be drawn regarding the structure of the atom from the study of this experiment.	
9	An electron in a hydrogen atom makes transitions from orbits of higher energies to orbits of lower energies. 1. When will such transitions result in (a) Lyman (b) Balmer series? 2. Find the ratio of the longest wavelength in Lyman series to the shortest wavelength in Balmer series.	
10	1. Draw the energy level diagram for the line spectra representing Lyman series and Balmer series in the spectrum of hydrogen atom. 2. Using the Rydberg formula for the spectrum of hydrogen atom, calculate the largest and shortest wavelengths of the emission lines of the Balmer series in the spectrum of hydrogen atom. (Use the value of Rydberg constant $R = 1.1 \times 10^{7}\ m^{-1}$)	
11	1. How is the stability of hydrogen atom in Bohr model explained by de - Broglie's hypothesis? 2. A hydrogen atom initially in the ground state absorbs a photon which excites it to n = 4 level. When it gets de - excited, find the maximum number of lines which are emitted by the atom. Identify the series to which these lines belong. Which of them has the shortest wavelength?	
12	Using Bohr's postulates derive the expression for the frequency of radiation emitted when electron in hydrogen atom undergoes transition from higher energy state (quantum number n_i) to the lower state, (n_f). When electron in hydrogen atom jumps from energy state $n_i = 4$ to n_f = 3, 2, 1, identify the spectral series to which the emission lines belong.	
13	1. State Bohr's quantization condition for defining stationary orbits. How does de - Broglie hypothesis explain the stationary orbits? 2. Find the relation between the three wavelengths λ_1, λ_2 and λ_3 from the energy level diagram shown below:	



14 The number of particles scattered at 60° is 100 per minute in an α - particle scattering experiment, using gold foil. Calculate the number of particles per minute scattered at 90° angle.

15 Use Bohr's postulates to derive the expressions for the potential and kinetic energy of the electron moving in the nth orbit of the hydrogen atom. How is the total energy of the electron expressed in terms of its kinetic and potential energies?

CH-NUCLEI

16 Which one of the following is a possible nuclear reaction?

1. $_5B^{10} + {}_2He^4 \rightarrow {}_7N^{13} + {}_1H^1$
2. $_{11}Na^{23} + {}_1H^1 \rightarrow {}_{10}N^{20} + {}_2He^4$
3. $_{93}Np^{239} \rightarrow {}_{94}Pu^{239} + {}_{-1}e^0 + \bar{\nu}$
4. $_7N^{11} + {}_1H^1 \rightarrow {}_6C^{12} + {}_{-1}e^0 + \bar{\nu}$

a) (B)

b) (A)

c) (C)

d) (D)

17 The curve of binding energy per nucleon as a function of atomic mass number has a sharp peak for helium nucleus. This implies that helium nucleus is

a) radioactive

b) unstable

c) easily fissionable

d) more stable nucleus than its neighbours

18 If number of nucleons increases, then binding energy per nucleon of the nucleus

a) remains constant with mass number

b) continuously decreases with mass number

c) continuously increases with mass number

d) first increases and then decreases with mass number

19 The binding energy per nucleon in $^7_3\mathbf{Li}$ and ^4_2He are 7.06 MeV and 5.60 MeV respectively, then in the reaction: $p + {}^7_3Li \rightarrow 2({}^4_2He)$ the energy of proton must be:

a) 28.24 MeV

	b) 39.2 MeV c) 17.28 MeV d) 1.46 MeV	
20	A nucleus of uranium decays at rest into nuclei of thorium and helium. Then a) The helium nucleus has more momentum than the thorium nucleus. b) The helium nucleus has less momentum than the thorium nucleus. c) The helium nucleus has more kinetic energy than the thorium nucleus. d) The helium nucleus has less kinetic energy than the thorium nucleus.	
21	Suppose India had a target of producing by 2020 AD, 200,000 MW of electric power, ten percent of which was to be obtained from nuclear power plants. Suppose we are given that, on an average, the efficiency of utilization (i.e. conversion to electric energy) of thermal energy produced in a reactor was 25%. How much amount of fissionable uranium would our country need per year by 2020? Take the heat energy per fission of ^{235} U to be about 200 MeV.	
22	1. Write the process of β^- decay. How can radioactive nuclei emit β^- particles even though they do not contain them? Why do all electrons emitted during β^- decay not have the same energy? 2. A heavy nucleus splits into two lighter nuclei. Which one of the two - parent nuclei or the daughter nuclei has more binding energy per nucleon?	
23	The radionuclide ^{11} C decays according to $^{11}_{6}C \rightarrow ^{11}_{5} B + e^+ + v$: $T_{1/2}$ = 20.3 min. The maximum energy of the emitted positron is 0.960 MeV. Given the mass values:m ($^{11}_{6}C$) = 11.011434 u and m ($^{11}_{5}B$) = 11.009305 u, calculate Q and compare it with the maximum energy of the positron emitted.	
24	A given number of atoms, N_0 of a radioactive element with a half - life T is uniformly distributed in the bloodstream of a normal person A having total volume V of blood in the body person B in need of blood transfusion having a volume V of blood in the body. The number of radioactive atoms per unit volume in the blood streams of the two persons after a time nT are found to be N_1 and N_2 . Prove mathematically that the additional volume of blood that needs to be transfused in the body ofperson B equals $\left(\frac{N_2-N_1}{N_2}\right)$ V.	
25	Calculate the energy generated in kilowatt hours, when 100 g of 3 Li are converted into $^{4}_{2}He$ by proton bombardment. Given: mass of $^{7}_{3}Li$ atom = 7.0183 amu, mass of 4 He atom = 4.0040 amu, mass of $^{1}_{1}H$ atom = 1.0081 amu.	
26	Calculate the binding energy per nucleon (in MeV) for $^{4}_{2}He$ and $^{4}_{3}He$. Comment on the difference of these binding energies and its significance in relation to α - decay of the nuclei. [Given: mass of $^{1}_{1}H$ =1.00783 u, mass of $^{1}_{0}n$ = 1.00867 u, mass of $^{3}_{2}He$ = 3.01664 u, mass of $^{4}_{2}He$ = 4.00387 u]	
27	Distinguish between nuclear fission and fusion. Show how in both these processes energy is released. Calculate the energy release in MeV in the deuterium - tritium fusion reaction: $^{2}_{1}H +$	

	${}_{1}^{3}H \rightarrow {}_{2}^{4}He + {}_{0}n^{1}$ Using the data: $m({}_{1}^{2}H)$ =2.014102 u $m({}_{1}^{3}H)$ = 3.016049 u $m({}_{2}^{4}He)$ == 4.002603 u m_{n} =1.008665 u 1amu = 931.5 $\frac{MeV}{c^2}$	
28	Draw a plot of potential energy of a pair of nucleons as a function of their separations. Mark the regions where the nuclear force is 1. attractive and 2. repulsive. Write any two characteristic features of nuclear forces.	
29	State two distinguishing features of nuclear force.	
30	Explain why binding energy for heavy nuclei is low.	
	CH- DUAL NATURE OF RADIATION AND MATTER	
31	Energy of a photon of green light of wavelength 5500 $\overset{o}{A}$ (given: h = $6.62 \times 10^{-34} Js^{-1}$) approximately is a) 2.81 ev b) 3.01 eV c) 2.26 eV d) 2.93 eV	
32	Wavelength of light incident on a photo cell is 3000 $\overset{0}{A}$, if stopping potential is 2.5 volts, then work function of the cathode of photocell is a) 1.64 eV b) 2.41 eV c) 4.56 eV d) 3.52 eV	
33	In photoelectric effect, the photoelectric current a) decreases when frequency of incident photons increases b) depends both on intensity and frequency of incident beam	

	c) does not depend on photon frequency but only on intensity of incident d) increases when frequency of incident photons increases	
34	The ratio of de - Broglie wavelength associated with two electrons accelerated through 25 Vand 36 V is a) $\frac{5}{6}$ b) $\frac{36}{25}$ c) $\frac{6}{5}$ d) $\frac{25}{36}$	
35	A photoelectric cell is illuminated by a point source of light 1 m away. The plate emits electrons having stopping potential V. Then: a) V decreases as distance increase. b) V increases as distance increase. c) V becomes zero when distance increases or decreases. d) V is independent of distance (r).	
36	1. Calculate the energy and momentum of a photon in a monochromatic beam of wavelength 331.5 nm. 2. How fast should a hydrogen atom travel in order to have the same momentum as that of the photon in part (a)?	
37	1. Why photoelectric effect cannot be explained on the basis of wave nature of light? Give reasons. 2. Write the basic features of photon picture of electromagnetic radiation on which Einstein's photoelectric equation is based.	
38	1. Plot a graph to show the variation of stopping potential with frequency of incident radiation in relation to photoelectric effect. 2. Use Einstein's photoelectric equation to show how from this graph, (i) Threshold frequency, and (ii) Planck's constant can be determined.	
39	Explain giving reasons for the following : 1. Photoelectric current in a photocell increases with the increase in the intensity of the incident radiation. 2. The stopping potential (V_0) varies linearly with the frequency (ν) of the incident radiation for a given photosensitive surface with the slope remaining the same for different surfaces. 3. Maximum kinetic energy of the photoelectrons is independent of the intensity of incident radiation.	

40	A beam of monochromatic radiation is incident on a photosensitive surface. Answer the following questions giving reasons. 1. Do the emitted photoelectrons have the same kinetic energy? 2. Does the kinetic energy of the emitted electrons depend on the intensity of incident radiation? 3. On what factors does the number of emitted photoelectrons depend?	
41	Photoelectrons are emitted from a metal surface when UV light of wavelengthλ = 300 nm is incident on it. The minimum negative potential required to stop the emission of electrons is 0.54 V. Calculate: 1. the energy of the incident photons 2. the maximum kinetic energy of the photoelectrons emitted 3. the work function of the metal. Express all answers in eV.	
42	What is the de Broglie wavelength of 1. a bullet of mass 0.040 kg travelling at the speed of 1.0 km/s, 2. a ball of mass 0.060 kg moving at a speed of 1.0 m/s, and 3. a dust particle of mass 1.0×10^{-9} kg drifting with a speed of 2.2 m/s?	
43	Write Einstein's photoelectric equation and point out any two characteristic properties of photons on which this equation is based. Briefly explain three observed features which can be explained by this equation.	
44	Hydrogen atom in third excited state de - excites to the first excited state. Obtain the expressions for the frequency of radiation emitted in this process. Also determine the ratio of the wavelengths of the emitted radiations when the atom de - excites from the third excited state to the second excited state and from the third excited state to the first excited state.	
45	Estimating the following two numbers should be interesting. The first number will tell you why radio engineers do not need to worry much about photons.The second number tells you why our eye can never count photons, even in barely detectable light. 1. The number of photons emitted per second by a Medium wave transmitter of 10 kW power, emitting radio waves of wavelength 500 m. 2. The number of photons entering the pupil of our eye per second corresponding to the minimum intensity of white light that we humans can perceive ($\sim 10^{-10}$ Wm^{-2}). Take the area of the pupil to be about 0.4 cm^{2} , and the average frequency of white light to be about 6×10^{14} Hz.	
	CH-SEMICONDUCTOR ELECTRONICS	
46	A silicon specimen is made into a p - type semiconductor by doping on an average one indium atom per 5×10^{7} silicon atoms. If the number density of atoms in the silicon specimen is 5×10^{28}	

atom/m^3 , then the number of acceptor atoms in silicon per cubic centimetre will be

a) 2.5×10^{30} atom/cm^3

b) 1.0×10^{13} atom/cm^3

c) 1.0× 10 $^{$ atom/cm 3

d) 2.5×10^{35} atom/cm^3

47 A p - type semiconductor can be obtained by adding

a) phosphorus to pure germanium

b) gallium to pure silicon

c) arsenic to pure silicon

d) antimony to pure germanium

48 At 0 K, the resistivity of an intrinsic semiconductor is:

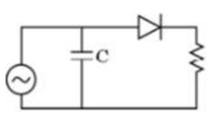
a) same as that at 0^o C

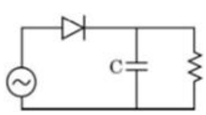
b) zero

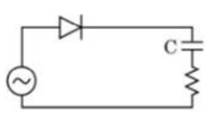
c) infinite

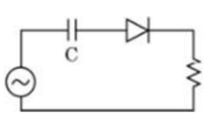
d) same as that at 300 K

49 In which of the following diagrams is the capacitor **C** connected correctly to provide smooth output of a half - wave rectifier?

a) 

b) 

c) 

d) 

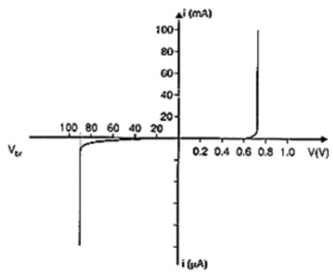
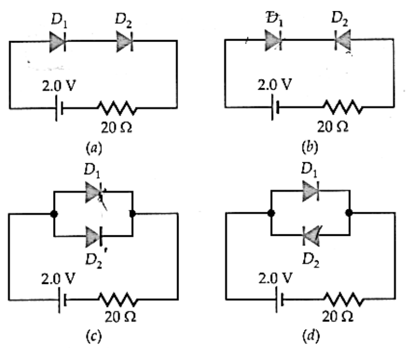
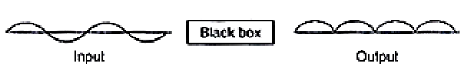
50 Knee voltage in Ge diode is of the order of:

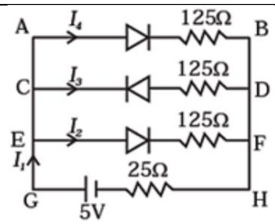
a) 0.3 V

b) 5 V

c) 100 V

	d) 0.7 V	
51	In the terminology related to semiconductors, what is a hole? a) space which was previously occupied by an electron b) space which is negatively charged c) dense area in space which even absorbs light i.e., black hole. d) a hole in space - time distribution of the universe	
52	Drift current in a p - n junction is due to a) charge not carriers density b) electric field c) collision of electrons d) charge carriers density	
53	In forward bias, the width of a potential barrier in a p - n junction diode a) remains constant b) increases c) decreases d) first remains constant then decreases	
54	At a certain temperature in an intrinsic semiconductor, the electrons and holes concentration is 1.5×10^{16} m^{-3}. When it is doped with a trivalent dopant, hole concentration increases to 4.5×10^{22} m^{-3}. In the doped semiconductor, the concentration of electrons (n_e) will be: a) 5×10^{9} m^{-3} b) 3×10^{6} m^{-3} c) 5×10^{7} m^{-3} d) 6.75×10^{38} m^{-3}	
55	The electrical conductivity of semiconductor increases when electromagnetic radiation of wavelength shorter than 2800 nm is incident on it. The band gap in (eV) for the semiconductor is: a) 0.5 eV b) 0.7 eV c) 2.5 eV d) 1.2 eV	
56	The following figure shows the V - I characteristics of a semiconductor diode.	

	1. Identify the semiconductor diode used. 2. Draw the circuit diagram to obtain the given characteristics of this device. 3. Briefly explain how this diode can be used as a voltage regulator. 	
57	Determine the currents through the resistances of the circuits shown in figure. 	
58	What are the limitations of intrinsic semiconductors when we use them for developing semiconductor devices?	
59	Draw V - I characteristics of a p - n junction diode. Answer the following giving reasons: 1. Why is the reverse bias current almost independent of applied voltage up to breakdown voltage? 2. Why does the reverse current show a sudden increase at breakdown voltage?	
60	If a small voltage is applied to a p - njunction diode how will the barrier potential be affected when it is 1. forward biased, and 2. reverse biased? Briefly explain.	
61	The black box, shown here, converts the input voltage waveform into the output voltage waveform as is shown in the figure:  Draw the circuit diagram of the circuit present in the black box and give a brief description of its working.	
62	If each diode in the given Figurehas a forward bias resistance of 125Ω and infinite resistance in reverse bias, what will be the values of the currentI_1, I_2, I_3 andI_4?	

		
63	1. How are energy bands formed in a crystalline solid? 2. Draw the energy band diagrams for p - type and n - type semiconductors. Depict the donor/acceptor energy levels in these diagrams and write their significance.	
64	1. Distinguish between n - type and p - type semiconductors on the basis of energy band diagrams. 2. Compare their conductivities at absolute zero temperature and at room temperature.	
65	Explain the formation of depletion layer and barrier potential in a p - n junction diode.	
66	1. Distinguish between metals, insulators and semiconductors on the basis of their energy bands. 2. Why are photodiodes used preferably in reverse bias condition? A photodiode is fabricated from a semiconductor with band gap of 2.8 eV. Can it detect a wavelength of 6000 nm? Justify.	
67	1. Briefly describe the classification of solids into metals, insulators and semi - conductors on the basis of energy level diagrams. 2. In a silicon diode, the current increases from 10 mA to 20 mA when the voltage changes from 0.6 V to 0.7 V. Calculate the dynamic resistance of the diode.	
68	Explain how the heavy doping of the p and n sides of a p - n junction diode helps in internal field emission (or zener breakdown) even with a reverse bias voltage of few volts only. Draw the general shape of the V - l characteristics of a zener diode. Discuss how the nature of these characteristics led to the use of a zener diode as a voltage regulator.	
69	1. Distinguish between an intrinsic semiconductor and a p - type semiconductor. Give reason why a p - type semiconductor is electrically neutral, although $n_h >> n_e$. 2. Explain, how the heavy doping of both p - and n - sides of a p - n junction diode results in the electric field of the junction being extremely high even with a reverse bias voltage of a few volts.	
70	1. Describe briefly, with the help of a diagram, the role of the two important processes involved in the formation of a p - njunction. 2. Name the device which is used as a voltage regulator. Draw the necessary circuit diagram and explain its working.	