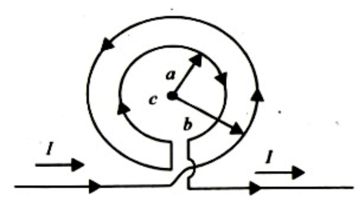
SECTION - 1
PHYSICS

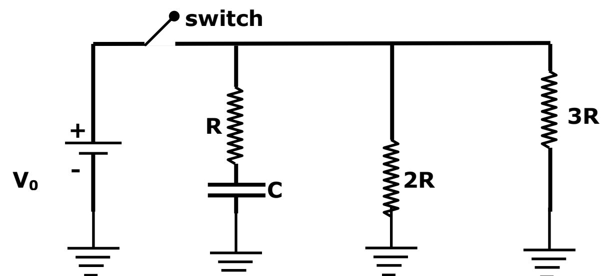
1. An α - particle and a proton are fired through the same magnetic field which is perpendicular to their velocity vectors. The α - particle and the proton move such that radius of curvature of their paths is same. Find the ratio of their de Broglie wavelengths.
(a) 2 : 3 (b) 3 : 4 (c) 5 : 7 (*d) 1 : 2

2. An otherwise infinite, straight wire has two concentric loops of radii a and b carrying equal currents in opposite directions as shown in fig. The magnetic field at the common center is zero for



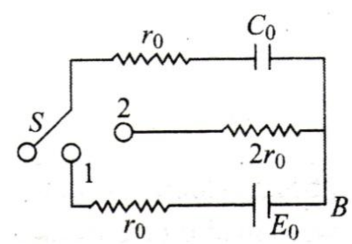
(a) $\frac{a}{b}=\frac{\pi-1}{\pi}$ (*b) $\frac{a}{b}=\frac{\pi}{\pi+1}$
(c) $\frac{a}{b}=\frac{\pi-1}{\pi+1}$ (d) $\frac{a}{b}=\frac{\pi+1}{\pi-1}$

3. The fig. shown of a RC circuit. Find the ratio of time constant of charging and discharging.



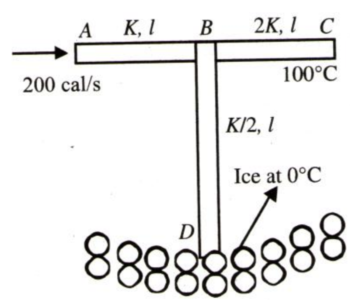
(*a) 5/11
(b) 1
(c) 2
(d) 6/11

4. In the circuit given in fig, switch S is at position 1 for long time. Find the total heat generated in resistor of resistance ($2r_o$), when the switch S is shifted from position 1 to position 2



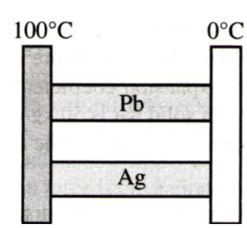
(a) $\frac{C_oE_o^2}{2}$ (b) $C_oE_o^2$
(*c) $\frac{C_oE_o^2}{3}$ (d) none

5. Three rods AB, BC and BD of same length l and cross section A are arranged as shown. The end D is immersed in ice whose mass is 440 g and is at 0°C. The end C is maintained at 100°C. Heat is supplied at constant rate of 200 cal/s. Thermal conductivities of AB, BC and BD are K, 2K and K/2, respectively. Time after which whole ice will melt is (K = 100 cal/m-s-°C, A = 10 cm^2, l = 1 m)
(a) 400 s (b) 600 s
(c) 700 s (*d) 800 s



For Problems 6 to 8

Two insulated metal bars each of length 5 cm and rectangular cross section with sides 2 cm and 3 cm are wedged between two walls, one held at 100°C and the other at 0°C. The bars are made of lead and silver. K_{pb} = 350 W/mK, K_{Ag} = 425 W/mK

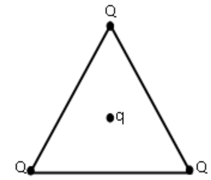


6. Thermal current through lead bar is

(a) 210 W (*b) 420 W (c) 510 W (d) 930 W

7. Total thermal current through the two- bar system is

(a) 210 W (b) 420 W (c) 510 W (*d) 930 W



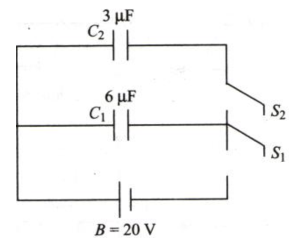
8. Equivalent thermal resistance of the two bar system is

(*a) 0.1 K / W (b) 0.23 K / W (c) 0.19 K / W (d) 0.42 K / W

9. In the circuit shown in fig, $C_1 = 6\mu F$, $C_2 = 3\mu F$ and battery B = 20 V. The switch S_1 is first closed. It is then opened, and S_2 is closed. What is the final charge on C_2?

(a) 120 μC (b) 80μC

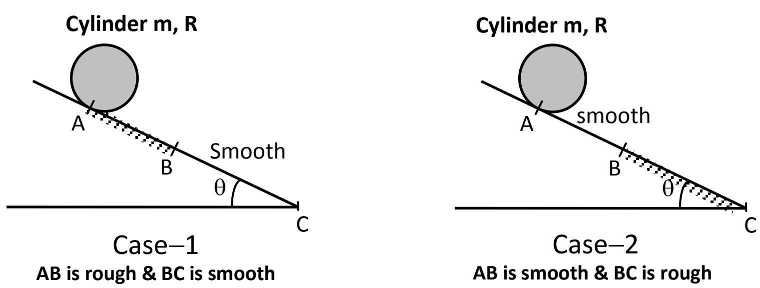
(*c) 40 μC (D) 20 μC



10. The temperature of ice is – 10^{0}C [specific heat = 0.5 kcal/kg-^{0}C] and that of water 60^{0}C. They are mixed in equal amounts. What part of the ice will be melted?

(a) 5/6 th (*b) 11/16 th (c) whole of ice will be melted (d) 5/11 th

11.



Select the wrong statement for above two cases of cylinder on inclined plane

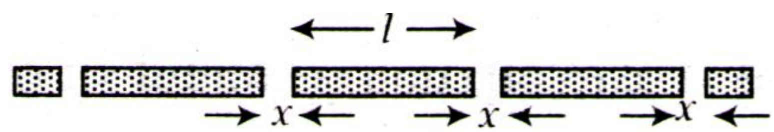
(a) body is in rolling motion on AB and slipping on BC in case – 1

(b) total mechanical energy is conserved at A, B, C point in case –1

(c) body is slipping on AB track and total mechanical energy at A and B is conserved in case –2

(*d) on AB track body is slipping, on BC it is rolling and total mechanical energy at A, B & C is conserved in case –2

12. The gap between any two rails, each of length l laid on a railway track equals x at 27°C. When the temperature rises to 40°C, the gap closes up. The coefficient of linear expansion of the material of the rail is α. The length of a rail at 27°C will be



(a) $\frac{x}{26\alpha}$ (*b) $\frac{x}{13\alpha}$ (c) $\frac{2x}{13\alpha}$ (d) none of these

13. In a container of negligible mass 'm' grams of steam at 100°C is added to 100 g of water that has temperature 20°C. If no heat is lost to the surrounding at equilibrium, match the items given in Column I with that in Column II

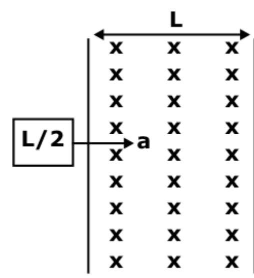
Column I	Column II
i. Mass of steam in the mixture, if m = 20 g (in g)	p. 114.8
ii. Mass of water in the mixture, if m = 20 g (in g)	q. 76.4
iii. If m = 20 g, final temperature of the mixture (in °C)	r. 5.2
iv. If m = 10 g, final temperature of the mixture (in °C)	s. 100

(a) i→s.;ii→p.;iii→r.;iv→q
(*b) i→r.;ii→p.;iii→s.;iv→q
(c) i→p.;ii→q.;iii→r.;iv→s
(d) i→r.;ii→s.;iii→p.;iv→q

14. 2 kg of ice at -15°C is mixed with 2.5 kg of water at 25°C in an insulating container. If the specific heat capacities of ice and water are 0.5 cal/g°C and 1 cal/g°C, find the amount of water present in the container? (in kg nearest integer)

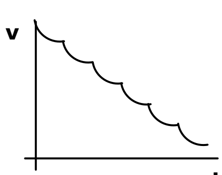
(a) 4 (b) 5 (*c) 3 (d) 6

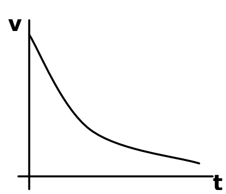
15. Uniform magnetic field B=10T is acting in a region of length L=2m as shown. A square loop of side L/2 enters in it with constant acceleration a= 1m/s^2. resistance per unit length of the square frame is 1Ω/m AT, t=1s:

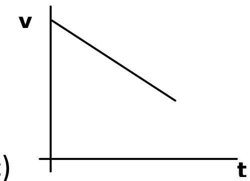


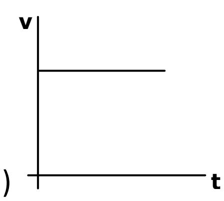
(a) induced current in square frame is clock wise
(*b) induced current in the frame is 2.5A
(c) magnetic force on the frame is 25N
(d) magnetic torque on the frame is zero

16. Figure shows the alternative region each of width 'd' regions I, III, V, VII etc contain magnetic field of intensity B where as regions II, IV, VI etc are field free, a square loop of mass m side 'd' is given velocity v and left, the graph between velocity of loop and is represented by

(*a) 

(b) 

(c) 

(d) 

Question [17-18]: In hydrogen atom electron is orbiting in that orbit in which energy of Li^{+2} is equal to ground state energy of hydrogen. It now jumps to some higher energy state where its angular momentum becomes twice.

17. What is the initial state of electron in hydrogen atom.

(a) 2 (*b) 3 (c) 4 (d) 6

18. In final state:

(a) radius of orbit becomes 2 times (*b) speed of electron will remain half

(c) both (a) and (b) are correct (d) both (a) and (b) are wrong

Question [19 -20] : Work function of metal A is equal to the ionization energy of hydrogen atom in first excited state. Work function of metal B is equal to the ionization energy of He^+ ion in second orbit. Photons of same energy E are incident on both A and B. Maximum kinetic energy of photoelectrons emitted from A is twice that of photoelectrons emitted from B.

19. Value of E (in eV) is:

(a) 20.8 (b) 32.2 (c) 24.6 (*d) 23.8

20. The difference in maximum kinetic energy of photoelectrons from A and from B:

(a) increases with increase in E (b) decreases with increase in E

(c) first increases than decreases with increase in E (*d) remains constant

21. If the electron in an hydrogen atom jumps from an outer orbit n = 3 to an inner orbit n = 2, the emitted radiation has a wavelength given by:

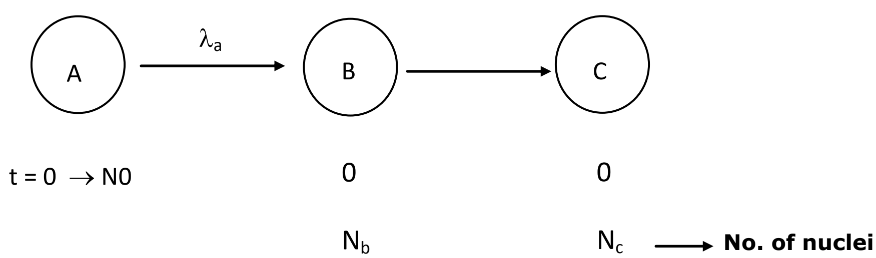
(a) λ= R/6 (b) λ= 36/R (c) λ= 5R/36 (*d) λ= 36/5R

22. Hydrogen (H), deuterium (D), singly ionized helium (He^+) and doubly ionized lithium (Li^{2+}) all have one electron around the nucleus. Consider n = 2 to n = 1 transition. If the wavelengths of emitted radiations are λ_1, λ_2, λ_3, and λ_4 respectively, then approximately:

(*a) $\lambda_1=\lambda_2=4\lambda_3=9\lambda_4$ (b) $4\lambda_1=2\lambda_2=2\lambda_3=\lambda_4$

(c) $\lambda_1=2\lambda_2=2\sqrt{2}\,\lambda_3=3\sqrt{2}\,\lambda_4$ (d) $\lambda_1=\lambda_2=2\lambda_3=3\lambda_4$

23. As shown case of successive disintegration of radioactive substance A and B, where C is stable λ_a, λ_b are decay constant of A and B. If N_a, N_b, N_c are the present nuclei at t = t , select the wrong statement



(a) $\left|\frac{dN_a}{dt}\right| = \lambda_a N_a$ (b) $\left|\frac{dN_b}{dt}\right| \neq \lambda_b N_b = \left|\frac{dN_c}{dt}\right|$ (*c) $\left|\frac{dN_a}{dt}\right| = \lambda_a N_a = \left|\frac{dN_b}{dt}\right|$ (d) $\left|\frac{dN_b}{dt}\right| = \lambda_a N_a - \lambda_b N_b$

24. A hydrogen like atom of atomic number z is in a higher excited state of quantum number n. The excited atom can make a transition to the first excited state by successively emitting two photon of energy 10.2 ev & 17.0 ev respectively. Alternately the atom from the same excited state can make a transition to the second excited state by successively emitting two photons of energies 4.25 ev and 5.95 ev respectively. The value of n & z is

(a) n = 6; z = 2 (*b) n = 6; z = 3 (c) n= 4; z = 2 (d) n = 4; z = 3.

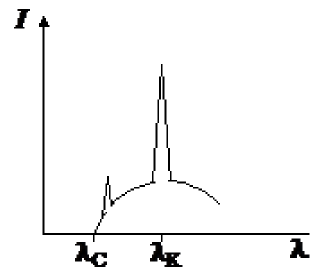
25. The binding energy of deuteron ($^2_1\mathbf{H}$) is 1.15 MeV per nucleon and an alpha particle ($^4_2\mathbf{He}$) has a binding energy of 7.1 MeV per nucleon. Then in the reaction; $^2_1\mathbf{H} + ^2_1\mathbf{H} \rightarrow ^4_2\mathbf{He} + Q$ the energy Q released is:

(a) 1 MeV (b) 11.9 MeV (*c) 23.8 MeV (d) 931 MeV.

26. The intensity of X-rays from a Coolidge tube is plotted against wavelength λ as shown in the figure. The minimum wavelength found is λ_C and the wavelength of the K_α line is λ_K. As the accelerating voltage is increased

(*a) $\lambda_K - \lambda_C$ increases (b) $\lambda_K - \lambda_C$ decreases

(c) λ_K increases (d) λ_K increases



27. K_α wavelength emitted by an atom, of atomic number Z = 11 is λ. Find the atomic number for an atom that emits K_α radiation with wavelength 4λ.

(*a) Z = 6 (b) Z = 4

(c) Z = 11 (d) Z = 44

28. The wavelength of the first spectral line in the Balmer series of hydrogen atom is 6561 $\overset{\circ}{A}$. The wavelength of the second spectral line in the Balmer series of singly ionized helium atom is:

(a) 1215 $\overset{\circ}{A}$ (b) 1640 $\overset{\circ}{A}$ (c) 2430 $\overset{\circ}{A}$ (*d) 4687 $\overset{\circ}{A}$

29. The electron in a hydrogen atom makes a transition $n_1 \rightarrow n_2$, where n_1 and n_2 are the principal quantum numbers of the two states. Assume the Bohr model to be valid. The time period of the electron in the initial state is eight times that in the final state. The possible values of n_1 and n_2 are

(*a) $n_1 = 4$, $n_2 = 2$ (b) $n_1 = 8$, $n_2 = 2$ (c) $n_1 = 8$, $n_2 = 1$ (d) $n_1 = 6$, $n_2 = 3$

30. Binding energy per nucleon vs. mass number curve for nuclei is shown in fig. W, X, Y and Z are four nuclei indicated on the curve. The process that would release energy is

(a) $Y \rightarrow 2Z$ (b) $W \rightarrow X + Z$

(*c) $W \rightarrow 2Y$ (d) $X \rightarrow Y + Z$