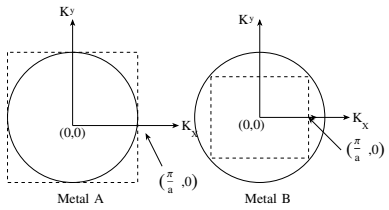
# 2024-PH-14-26

AI24BTECH11011 - Himani Gourishetty

1) If a thermodynamical system is adiabatically isolated and experiences a change in volume under an externally applied constant pressure, then the thermodynamical potential minimized at equilibrium is the
   a) enthalpy
   b) Helmholtz free energy
   c) Gibbs free energy
   d) grand potential
2) The mean distance between the two atoms of HD molecules is $r$, where H and D denote hydrogen and deuterium, respectively. The mass of the hydrogen atom is $m_H$. The energy difference between two lowest lying rotational states of HD in multiples of $\frac{h^2}{m_H r^2}$ is
   a) $\frac{3}{2}$
   b) $\frac{2}{3}$
   c) 6
   d) $\frac{4}{3}$
3) Crystal structures of two metals A and B are two-dimensional square lattices with same lattice constant $a$. Electrons in metal behave as free electrons. The Fermi surfaces corresponding to A and B are shown by solid circles in figures The electron concentrations in A and B are $n_A$ and $n_B$ respectively.




   The value of $\frac{n_B}{n_A}$ is
   a) 3
   b) 2
   c) $3\sqrt{3}$
   d) $\sqrt{2}$
4) Consider the induced nuclear fission reaction

$$^{235}_{92}U + n \rightarrow ^{93}_{37}Rb + ^{141}_{55}Cs + 2n$$

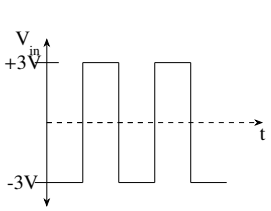
   where neutron momenta in both initial and final states are negligible. The ratio of the kinetic energies (KE) of the daughter nuclei,

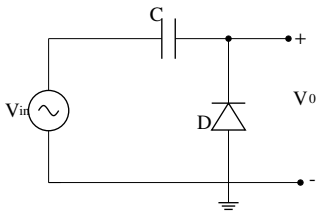
$$\frac{KE\left(^{93}_{37}Rb\right)}{KE\left(^{141}_{55}Cs\right)}$$

   is _____ .

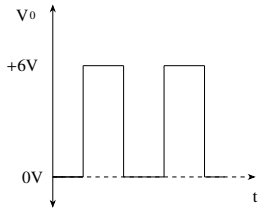
a) $\frac{93}{141}$
b) $\frac{141}{93}$
c) 1
d) 0

5) The symbols $C, D, V_{in}$ and $V_0$ shown in the figure denote capacitor, ideal diode , input voltage and output voltage, respectively, Which one of the following output waveforms ($V_0$) is correct for the

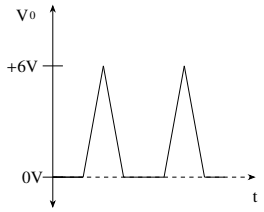



given input waveform ($V_{in}$)




a)

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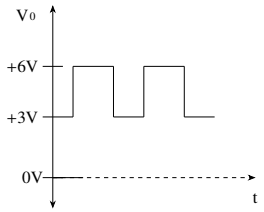
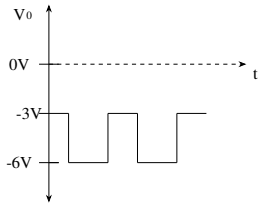
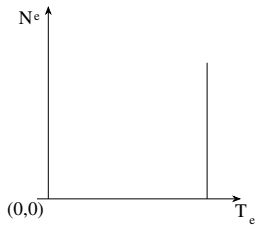



c)

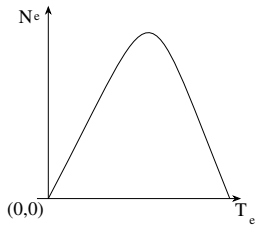



d)

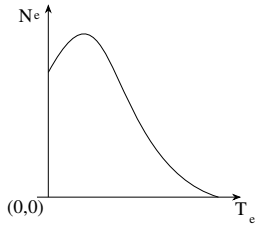
6) Let $N_0$ and $T_e$ respectively, denote number and kinetic energy of electrons produced in a nuclear beta decay. Which one of the following ditributions is correct?



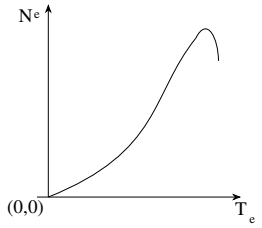

a)




b)




c)




d)

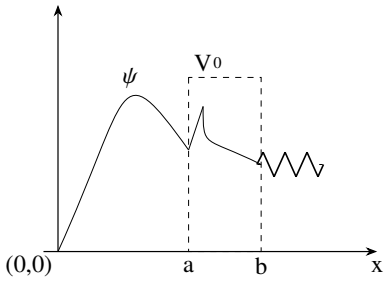
7) An infinitely long cylinder of radius R carries a frozen-in magnetization $\bar{M} = ke^{-s}\hat{Z}$, where k is a constant and s is the distance from the axis of cylinder. The magnetic permeability of free space is $\mu_0$. There is no free current present anywhere. The magnetic flux density $\left(\bar{B}\right)$ inside the cylinder is
   a) 0
   b) $\mu_0 ke^{-}R\hat{z}$
   c) $\mu_0 ke^{-}R\hat{z}$
   d) $\mu_0 ke^{-s}\left(\frac{R}{S}\right)\hat{z}$
8) Atomic numbers of V,Cr,Fe and Zn are 23,24,26 and 30, respectively. Which one of the following materials does NOT show an electron spin resonance ($ESR$) spectra?
   a) V
   b) Cr

c) Fe
d) Zn

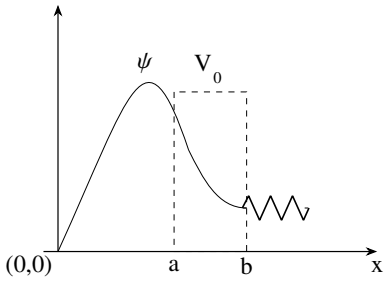
9) A particle is subjected to a potiential

$$V(x) = \begin{cases} \infty & x \leq 0 \\ V_0 & a \leq x \leq b \\ 0 & , elsewhere \end{cases}$$

Here, $a > 0$ and $b > a$. If the energy of the particle $E < V_0$, which one of the following schematics is a valid quantum mechanical wavefunction ($\psi$) for the system?




a)

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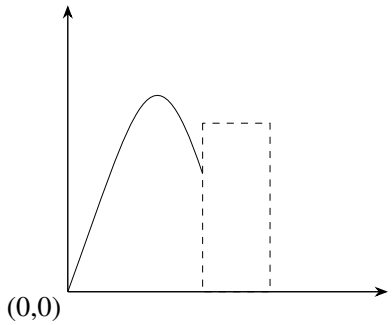
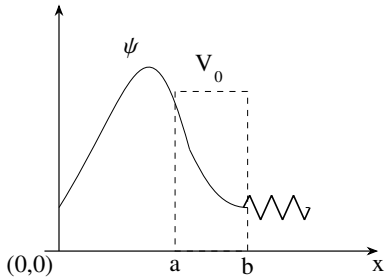



c)
d)

10) Let $\rho(\mathbf{p}, \mathbf{q}, t)$ be the phase space density of an ensemble of a system. The Hamiltonian of the system is $H(\mathbf{p}, \mathbf{q})$. If $\{A, B\}$ denotes the poisson bracket A and B, the

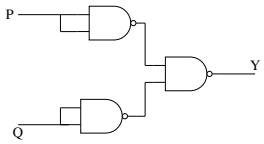
$$\frac{d\rho}{dt} = 0$$

implies



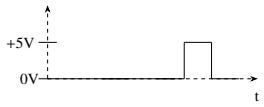

a) $\frac{d\rho}{dt} = 0$
b) $\frac{d\rho}{dt} \propto \{\rho, H\}$
c) $\frac{d\rho}{dt} \propto \left\{\rho, \frac{\mathbf{p}\cdot\mathbf{q}}{2}\right\}$
d) $\frac{d\rho}{dt} \propto \left\{\rho, \frac{\mathbf{q}\cdot\mathbf{q}}{2}\right\}$

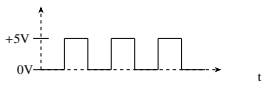
11) Consider the following circuit:
Suppose the input signal P is




and the input signal Q is

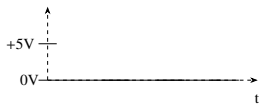

Which one of the following output signals is correct?



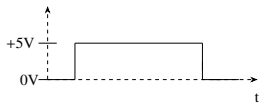




a)


b)




c)




d)

12) An inertial observer sees two spacecrafts S and T flying away from each other along x-axis with indivisual speed 0.5c, where c is the speed of light. The speed of T with respect to S is
   a) $\frac{4}{5}c$
   b) $\frac{4}{3}c$
   c) c
   d) $\frac{2}{3}c$

13) Let P,Q and R be three different nuclei. Which one of the following nuclear processes is possible?
   a) $v_e + {}^{A}_{z}P \rightarrow {}^{A}_{z+1}Q + e^-$
   b) $v_e + {}^{A}_{z}P \rightarrow {}^{A}_{z-1}R + e^+$
   c) $v_e + {}^{A}_{z}P \rightarrow {}^{A}_{z}P + e^+ + e^-$
   d) $v_e + {}^{A}_{z}P \rightarrow {}^{A}_{z}P + \gamma$