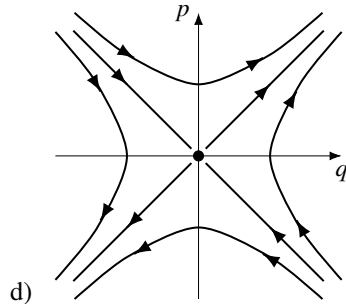
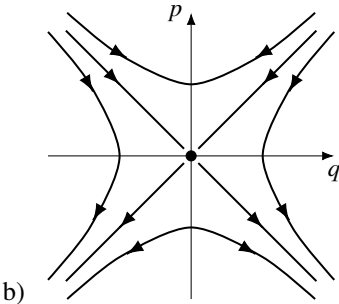
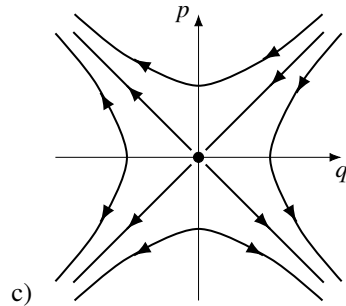
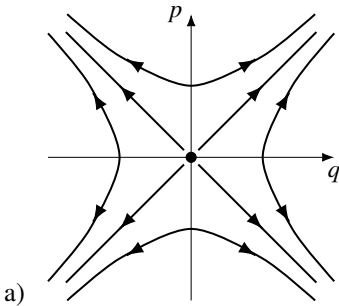


2014 Physics

1

AI24BTECH11003 - Badde Vijaya Sreyas

- 1) Neutrons moving with speed $10^3 \frac{m}{s}$ are used for the determination of crystal structure. If the Bragg angle for the first order diffraction is 30° , the interplanar spacing of the crystal is _____ Å.
(Given: $m_n = 1.675 \times 10^{-27} \text{ kg}$, $h = 6.625 \times 10^{-34} \text{ J.s}$)
- 2) The Hamiltonian of a particle of mass m is given by $H = \frac{p^2}{2m} - \frac{aq^2}{2}$. Which of the following figured describes the motion of the particle in phase space?



- 3) The intensity of a laser in free space is $150 \frac{mW}{m^2}$. The corresponding amplitude of the electric field of the laser is _____ $\frac{V}{m}$. ($\epsilon_0 = 8.854 \times 10^{-12} \frac{C^2}{N.m^2}$)
- 4) The emission wavelength for the transition $^1D_2 \rightarrow ^1F_3$ is 3122 Å . The ratio of populations of the final to initial states at a temperature 5000 K is
($h = 6.626 \times 10^{-34} \text{ J.s}$, $c = 3 \times 10^8 \frac{m}{s}$, $k_B = 1.380 \times 10^{-23} \frac{J}{K}$)
- a) 2.03×10^{-5} b) 4.02×10^{-5} c) 7.02×10^{-5} d) 9.83×10^{-5}
- 5) Consider a system of 3 fermions, each of which can occupy any of the 4 available energy states with equal probability. The entropy of the system is:

- a) $k_B \ln 2$ b) $2k_B \ln 2$ c) $2k_B \ln 4$ d) $3k_B \ln 4$

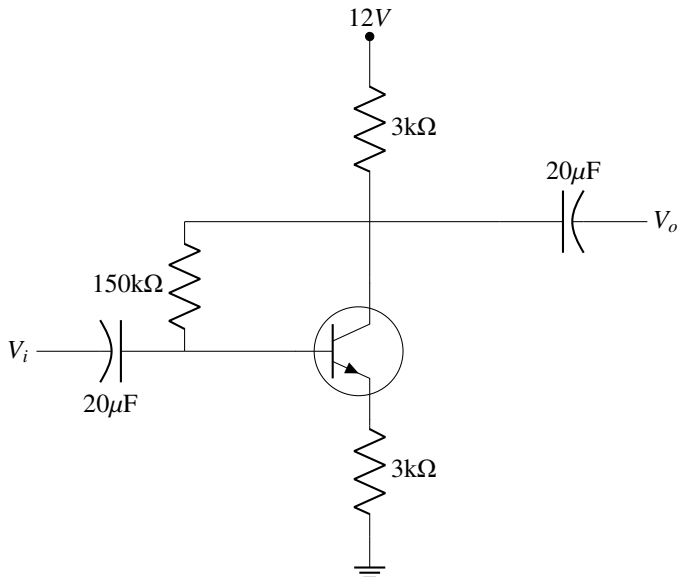
- 6) A particle is confined to a one-dimensional potential box with the potential

$$V(x) = \begin{cases} 0, & 0 < x < a \\ \infty, & \text{otherwise} \end{cases}$$

If the particle is subjected to a perturbation within the box, $W = \beta x$, where β is a small constant, the first-order correction to the ground state energy is:

- a) 0 c) $\frac{\beta a}{2}$
 b) $\frac{\beta a}{4}$ d) βa
- 7) Consider the process $\mu^- + \mu^+ \rightarrow \pi^- + \pi^+$. The minimum kinetic energy of the muons (μ) in the center-of-mass frame required to produce the pion (π) pairs at rest is _____ MeV. (Given: $m_\mu = 105 \text{ MeV}/c^2$, $m_\pi = 140 \text{ MeV}/c^2$)
- 8) A one-dimensional harmonic oscillator is in the superposition of number states, $|\psi\rangle = \frac{\sqrt{2}}{3}|2\rangle + \frac{1}{\sqrt{3}}|3\rangle$. The average energy of the oscillator in the given state is _____ ω .
- 9) A nucleus X undergoes a first-forbidden β -decay to a nucleus Y . If the angular momentum (I) and parity (P), denoted by I^P , are $\frac{7}{2}^-$ for X , which of the following is a possible I^P value for Y ?
- a) $\frac{1}{2}^+$ b) $\frac{1}{2}^-$ c) $\frac{3}{2}^+$ d) $\frac{3}{2}^-$

- 10) The current gain of the transistor in the following circuit is $\beta_{dc} = 100$. The value of the collector current I_C is _____ mA.



- 11) In order to measure a maximum of 1 V with a resolution of 1 mV using an n -bit A/D converter working under the principle of a ladder network, the minimum value of n is _____.
- 12) If L_+ and L_- are the angular momentum ladder operators, then the expectation value of $(L_+L_- + L_-L_+)$, in the state $|l = 1, m = 1\rangle$ of an atom is _____ $2\hbar$.
- 13) A low-pass filter is formed by a resistance R and a capacitance C . At the cut-off angular frequency $\omega_c = \frac{1}{RC}$, the voltage gain and the phase of the output voltage relative to the input voltage are, respectively:
- a) 0.71 and 45° b) 0.71 and -45° c) 0.5 and -90° d) 0.5 and 90°