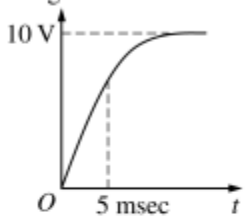
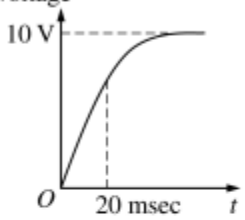
GRE Physics Practice Test 4

40. In the circuit shown above, the switch S is closed at $t = 0$. Which of the following best represents the voltage across the inductor, as seen on an oscilloscope?

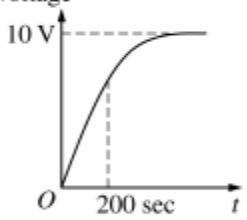
(A) Voltage



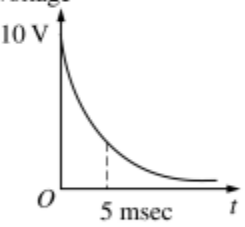
(B) Voltage



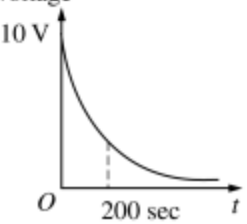
(C) Voltage



(D) Voltage



(E) Voltage



41. Maxwell's equations can be written in the form shown below. If magnetic charge exists and if it is conserved, which of these equations will have to be changed?

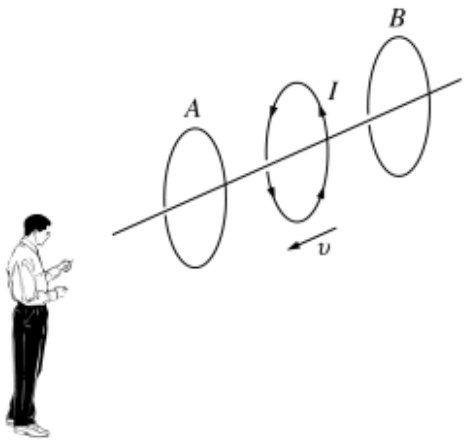
I. $\nabla \cdot \mathbf{E} = \rho / \epsilon_0$

II. $\nabla \cdot \mathbf{B} = 0$

III. $\nabla \times \mathbf{E} = -\dfrac{\partial \mathbf{B}}{\partial t}$

IV. $\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \dfrac{\partial \mathbf{E}}{\partial t}$

(A) I only
(B) II only
(C) III only
(D) I and IV
(E) II and III



42. Three wire loops and an observer are positioned as shown in the figure above. From the observer's point of view, a current I flows counterclockwise in the middle loop, which is moving towards the observer with a velocity υ. Loops A and B are stationary. This same observer would notice that

(A) clockwise currents are induced in loops A and B
(B) counterclockwise currents are induced in loops A and B
(C) a clockwise current is induced in loop A, but a counterclockwise current is induced in loop B
(D) a counterclockwise current is induced in loop A, but a clockwise current is induced in loop B
(E) a counterclockwise current is induced in loop A, but no current is induced in loop B

43. The components of the orbital angular momentum operator $\mathbf{L} = (L_x, L_y, L_z)$ satisfy the following commutation relations.

$[L_x, L_y] = i\hbar L_z$,

$[L_y, L_z] = i\hbar L_x$,

$[L_z, L_x] = i\hbar L_y$.

What is the value of the commutator $[L_x L_y, L_z]$?

(A) $2i\hbar L_x L_y$

(B) $i\hbar\left(L_x^2 + L_y^2\right)$

(C) $-i\hbar\left(L_x^2 + L_y^2\right)$

(D) $i\hbar\left(L_x^2 - L_y^2\right)$

(E) $-i\hbar\left(L_x^2 - L_y^2\right)$

44. The energy eigenstates for a particle of mass m in a box of length L have wave functions $\phi_n(x) = \sqrt{2/L}\sin(n\pi x/L)$ and energies $E_n = n^2\pi^2\hbar^2/2mL^2$, where $n = 1, 2, 3, \ldots$. At time $t = 0$, the particle is in a state described as follows.

$$\Psi(t=0) = \frac{1}{\sqrt{14}}[\phi_1 + 2\phi_2 + 3\phi_3]$$

Which of the following is a possible result of a measurement of energy for the state Ψ?

(A) $2E_1$

(B) $5E_1$

(C) $7E_1$

(D) $9E_1$

(E) $14E_1$

45. Let $|\, n\,\rangle$ represent the normalized n^{th} energy eigenstate of the one-dimensional harmonic oscillator, $H|\, n\,\rangle = \hbar\omega\left(n + \frac{1}{2}\right)|\, n\,\rangle$. If $|\, \psi\,\rangle$ is a normalized ensemble state that can be expanded as a linear combination $|\, \psi\,\rangle = \frac{1}{\sqrt{14}}|\, 1\,\rangle - \frac{2}{\sqrt{14}}|\, 2\,\rangle + \frac{3}{\sqrt{14}}|\, 3\,\rangle$ of the eigenstates, what is the expectation value of the energy operator in this ensemble state?

(A) $\frac{102}{14}\hbar\omega$

(B) $\frac{43}{14}\hbar\omega$

(C) $\frac{23}{14}\hbar\omega$

(D) $\frac{17}{\sqrt{14}}\hbar\omega$

(E) $\frac{7}{\sqrt{14}}\hbar\omega$

46. A free particle with initial kinetic energy E and de Broglie wavelength λ enters a region in which it has potential energy V. What is the particle's new de Broglie wavelength?

(A) $\lambda\,(1 + E/V)$

(B) $\lambda\,(1 - V/E)$

(C) $\lambda\,(1 - E/V)^{-1}$

(D) $\lambda\,(1 + V/E)^{1/2}$

(E) $\lambda\,(1 - V/E)^{-1/2}$

47. A sealed and thermally insulated container of total volume V is divided into two equal volumes by an impermeable wall. The left half of the container is initially occupied by n moles of an ideal gas at temperature T. Which of the following gives the change in entropy of the system when the wall is suddenly removed and the gas expands to fill the entire volume?

(A) $2nR \ln 2$

(B) $nR \ln 2$

(C) $\frac{1}{2}nR \ln 2$

(D) $-nR \ln 2$

(E) $-2nR \ln 2$

48. A gaseous mixture of O_2 (molecular mass 32 u) and N_2 (molecular mass 28 u) is maintained at constant temperature. What is the ratio $\frac{v_{rms}(N_2)}{v_{rms}(O_2)}$ of the root-mean-square speeds of the molecules?

(A) $\frac{7}{8}$

(B) $\sqrt{\frac{7}{8}}$

(C) $\sqrt{\frac{8}{7}}$

(D) $\left(\frac{8}{7}\right)^2$

(E) $\ln\left(\frac{8}{7}\right)$

49. In a Maxwell-Boltzmann system with two states of energies ϵ and 2ϵ, respectively, and a degeneracy of 2 for each state, the partition function is

(A) $e^{-\epsilon/kT}$

(B) $2e^{-2\epsilon/kT}$

(C) $2e^{-3\epsilon/kT}$

(D) $e^{-\epsilon/kT} + e^{-2\epsilon/kT}$

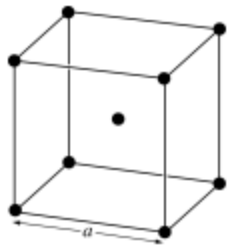
(E) $2[e^{-\epsilon/kT} + e^{-2\epsilon/kT}]$

50. At 20°C, a pipe open at both ends resonates at a frequency of 440 hertz. At what frequency does the same pipe resonate on a particularly cold day when the speed of sound is 3 percent lower than it would be at 20°C ?

(A) 414 Hz
(B) 427 Hz
(C) 433 Hz
(D) 440 Hz
(E) 453 Hz

51. Unpolarized light of intensity I_0 is incident on a series of three polarizing filters. The axis of the second filter is oriented at 45° to that of the first filter, while the axis of the third filter is oriented at 90° to that of the first filter. What is the intensity of the light transmitted through the third filter?

(A) 0
(B) $I_0/8$
(C) $I_0/4$
(D) $I_0/2$
(E) $I_0/\sqrt{2}$



52. The conventional unit cell of a body-centered cubic Bravais lattice is shown in the figure above. The conventional cell has volume a^3. What is the volume of the primitive unit cell?

(A) $a^3/8$
(B) $a^3/4$
(C) $a^3/2$
(D) a^3
(E) $2a^3$