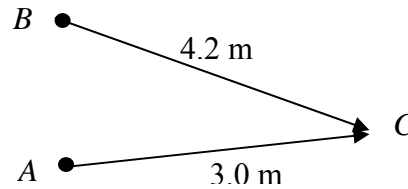


Q1.

A completely destructive interference has been found at location C that is 3.00 m from wave source A and 4.20 m from wave source B . If the two sources A and B are in phase, what is the maximum wavelength of the waves?



- A) 2.40 m
- B) 0.60 m
- C) 1.20 m
- D) 12.6 m
- E) 1.40 m

Q2.

A harmonic wave, of amplitude 3.0 cm, wavelength 40 cm and 100 Hz frequency, is generated on a string under constant tension by a vibrating source. If the power delivered to the string by the source is increased 5 times, what is the new amplitude of the wave?

- A) 6.7 cm
- B) 15 cm
- C) 8.7 cm
- D) 3.0 cm
- E) 13.9 cm

Q3.

Which of the following statements is TRUE?

- A) The pressure of sound wave is not in phase with the displacement.
- B) The speed of sound in water is less than in air.
- C) Sound waves are transverse waves.
- D) For a string fixed at both ends, the speed of waves on the string decreases when its linear density decreases.
- E) Waves on a stretched string are longitudinal waves.

Q4.

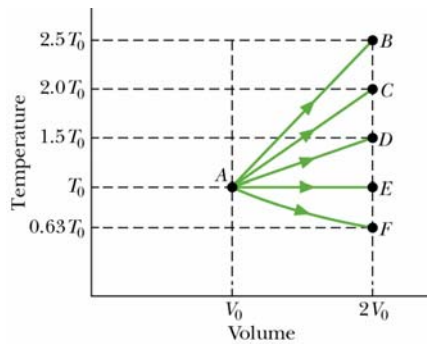
Two moles of monatomic gas are placed in a fixed volume container at a pressure 1.0 atm and a temperature of 273 K. How much heat energy is needed to double the pressure of the gas?

- A) 6.8 kJ
- B) 9.2 kJ
- C) 1.1 kJ

- D) 16 kJ
- E) 0.7 kJ

Q5.

An ideal monatomic gas at initial temperature T_0 expands from initial volume V_0 to volume $2V_0$ by each of the five processes shown in the T-V diagram below. In which process is the change of entropy of the gas zero?



- A) Process AF
- B) Process AB
- C) Process AC
- D) Process AD
- E) Process AE

Q6.

What mass of water at 0.0°C can a refrigerator make into ice cubes in one hour, if the coefficient of performance of the refrigerator is 3.0 and the power input is 0.1 Kilowatt?

- A) 3.2 kg.
- B) 1.9 kg.
- C) 2.4 kg.
- D) 9.2 kg.
- E) 6.5 kg.

Q7.

Which one of the following statements is WRONG?

- A) The total entropy of a system increases only if it absorbs heat.
- B) A refrigerator works like a heat engine in reverse.
- C) Thermal energy cannot be transferred spontaneously from a cold object to a hot object.
- D) No heat engine has higher efficiency than Carnot heat engine.
- E) After a system has gone through a reversible cyclic process, its total entropy does not change.

Q8.

Two small spheres carry positive charges q_1 and q_2 such that $q_1 = 4.0 q_2$. If each sphere is repelled from the other with an electrostatic force of 90 N when they are 1.0 m apart, the charge q_1 is:

- A) 2.0×10^{-4} C
- B) 8.0×10^{-4} C
- C) 1.3×10^{-5} C
- D) 5.0×10^{-5} C
- E) 3.7×10^{-4} C

Q9.

A conducting spherical shell of inner radius 4.0 cm and outer radius 5.0 cm has a net charge of $-4.0 \mu\text{C}$. Now, if you place a point charge of $8.0 \mu\text{C}$ at the center of the shell, what will be the electric field at a distance of 4.5 cm from the center of the shell?

- A) Zero
- B) 0.90×10^6 N/C
- C) 1.20×10^3 N/C
- D) 4.50×10^2 N/C
- E) 1.78×10^4 N/C

Q10.

An electron is moving parallel to the x-axis under the influence of a uniform electric field directed along the positive x-axis. The electron has an initial velocity of 3.0×10^6 m/s at point A and its velocity is reduced to 2.0×10^6 m/s at point B. Calculate the potential difference $[V(B)-V(A)]$. [Assume $V = 0$ at infinity.]

- A) -14 V
- B) zero
- C) +14 V
- D) +28 V
- E) -28 V

Q11.

A $3.0\text{-}\mu\text{F}$ capacitor is connected in series with a $6.0\text{-}\mu\text{F}$ capacitor and a 12-V battery for a long time. What is the charge on the $3.0\text{-}\mu\text{F}$ capacitor?

- A) 24 μC
- B) 36 μC
- C) 48 μC
- D) 6 μC
- E) 82 μC

Q12.

At $20\text{ }^{\circ}\text{C}$, a light bulb has a resistance of $12\ \Omega$. To increase its resistance to $36\ \Omega$, the temperature of the bulb should be: [Assume α of the filament is constant and $= 0.006\ \text{K}^{-1}$].

- A) $353\text{ }^{\circ}\text{C}$.
- B) $505\text{ }^{\circ}\text{C}$.
- C) $520\text{ }^{\circ}\text{C}$.
- D) $151\text{ }^{\circ}\text{C}$.
- E) $654\text{ }^{\circ}\text{C}$.

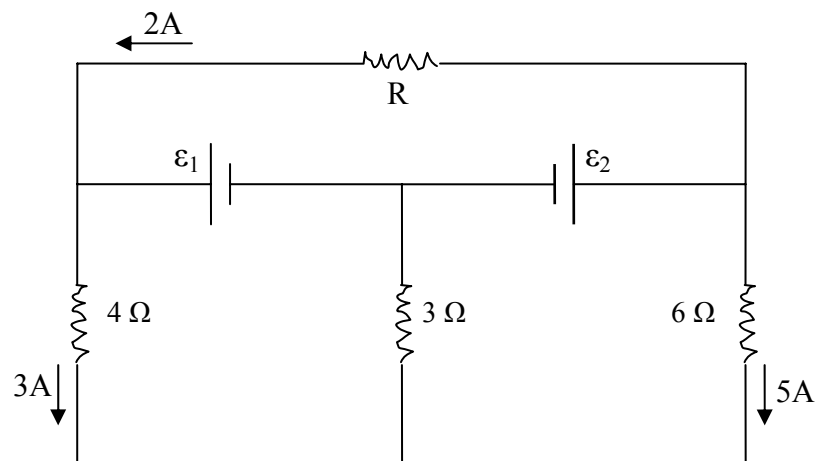
Q13.

A 6-V battery supplies a total of $48\ \text{W}$ to three identical light bulbs connected in parallel. The resistance of each bulb is:

- A) $2.25\ \Omega$
- B) $3.23\ \Omega$
- C) $4.02\ \Omega$
- D) $1.51\ \Omega$
- E) $0.13\ \Omega$

Q14.

In the following figure, find the current in $3\ \Omega$ resistor and the resistance R for the given currents.



- A) $8\ \text{A}$, $9\ \Omega$
- B) $5\ \text{A}$, $8\ \Omega$
- C) $8\ \text{A}$, $8\ \Omega$
- D) $2\ \text{A}$, $9\ \Omega$
- E) $1\ \text{A}$, $8\ \Omega$

Q15.

Two resistors r and R are connected in series across 100 V line. If $r = 30 \text{ k}\Omega$ and the voltage across it is found to be 60 V, find the resistance of R .

- A) 20 $\text{k}\Omega$
- B) 30 $\text{k}\Omega$
- C) 10 $\text{k}\Omega$
- D) 15 $\text{k}\Omega$
- E) 5 $\text{k}\Omega$

Q16.

A 30.0 $\text{k}\Omega$ resistor and a capacitor are connected in series and a 15.0 V potential difference is suddenly applied across them. The potential difference across the capacitor rises to 5.00 V in 1.50 μs . Find the capacitance of capacitor.

- A) 123 pF
- B) 405 pF
- C) 360 pF
- D) 150 pF
- E) 111 pF

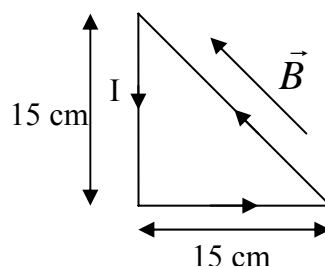
Q17.

Four resistors, each of 20- Ω , are connected in parallel and the combination is connected to a 20 V emf device. The current in any one of the resistors is:

- A) 1.0 A
- B) 0.2 A
- C) 4.0 A
- D) 5.0 A
- E) 100 A

Q18.

The following figure shows a loop of wire carrying a current of 2.0 Ampere is in the shape of a right triangle with two equal sides, each 15 cm long. A 0.7 T uniform magnetic field is parallel to the hypotenuse as shown in the figure. The resultant magnetic force on the two equal sides has a magnitude of:



- A) zero
- B) 0.21 N

- C) 0.44 N
- D) 0.50 N
- E) 0.75 N

Q19.

An electron moving perpendicular to a $50 \mu\text{T}$ magnetic field goes through a circular trajectory. What is the time required to complete one revolution?

- A) $7.15 \times 10^{-7} \text{ s}$
- B) $3.22 \times 10^{-7} \text{ s}$
- C) $4.20 \times 10^{-7} \text{ s}$
- D) $8.40 \times 10^{-7} \text{ s}$
- E) $1.50 \times 10^{-7} \text{ s}$

Q20.

An electron has a velocity:

$$\mathbf{v} = (5 \times 10^6 \hat{i} - 3 \times 10^6 \hat{j}) \text{ m/s}$$

and moves through a uniform magnetic field:

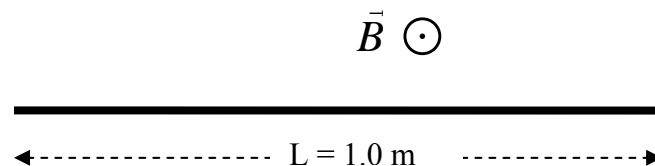
$$\mathbf{B} = (0.5 \hat{i} + 0.3 \hat{j}) \text{ T.}$$

Find the magnetic force (in Newtons) on the electron.

- A) $-4.8 \times 10^{-13} \hat{k}$
- B) $3.2 \times 10^{-13} \hat{j}$
- C) $2.1 \times 10^{-13} \hat{k}$
- D) $9.6 \times 10^{-13} \hat{i}$
- E) $2.1 \times 10^{-13} \hat{j}$

Q21.

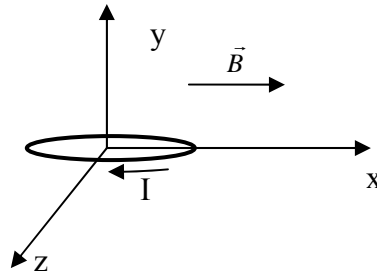
The following figure shows a straight horizontal length of copper wire of mass $m = 50 \text{ g}$ and length $L = 1.0 \text{ m}$ lies in a uniform magnetic field $B = 0.5 \text{ T}$ directed out of the page. What is the magnitude and direction of the current in the wire to balance the gravitational force?



- A) 0.98 A, to the left
- B) 0.98 A, to the right
- C) 0.35 A, to the right
- D) 0.35 A, to the left
- E) 1.51 A, to the right

Q22.

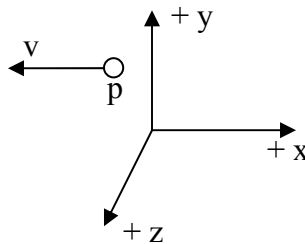
A 100 turns coil, lies in xz -plane, has an area of 2.0 m^2 and carries a current $I = 0.3 \text{ A}$ in the direction indicated in the following figure. The coil lies in a magnetic field directed along the x -axis and has a magnitude of 1.5 T . What is magnitude and direction of the torque on the coil?



- A) 90 N.m along the positive z axis
- B) 90 N.m along the negative z axis
- C) 30 N.m along the negative z axis
- D) 30 N.m along the positive z axis
- E) zero

Q23.

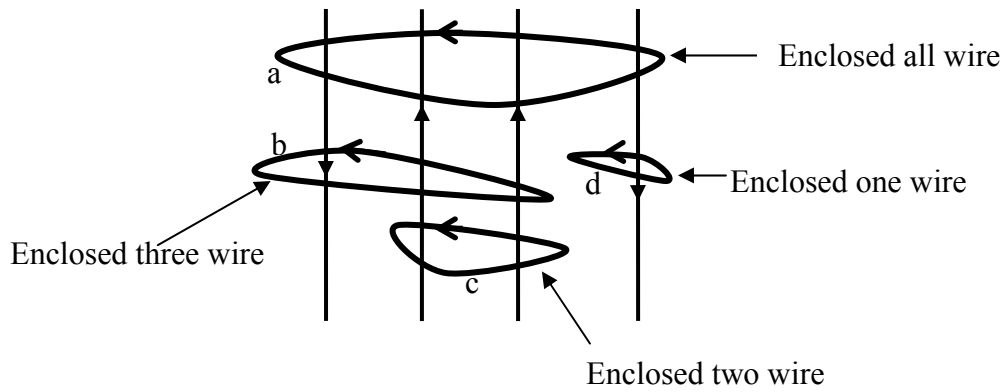
The following figure shows a proton moving at a constant speed of 300 m/s along the negative x -axis through uniform electric and magnetic fields. The electric field is directed along the positive y -direction and has a magnitude of 900 N/C . What is the magnitude and direction of the magnetic field?



- A) 3.0 T, along the negative z axis
- B) 3.0 T, along the positive z axis
- C) 0.3 T, along the negative x axis
- D) 0.3 T, along the negative x axis
- E) 0.1 T, along the negative y axis

Q24.

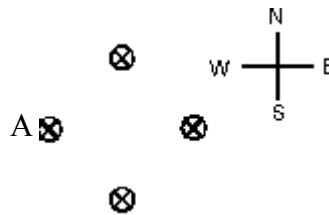
The figure shows four wires carrying equal currents and four Amperian loops. Rank the loops according to the magnitude of $\oint \vec{B} \cdot d\vec{s}$ along each, greatest first.



- A) c, b and d tie, then a
- B) a, b and a tie, then c
- C) c, a, b, d
- D) c, d, a, b
- E) a, b, c, d

Q25.

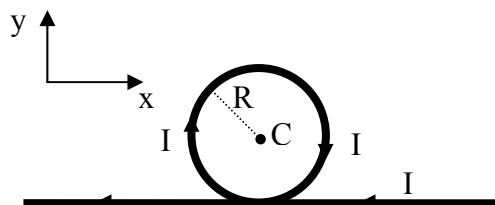
Four long straight wires carry equal currents into the page as shown in the figure. The direction of the net magnetic force exerted on wire A by the other three wires is:



- A) East
- B) North
- C) South
- D) West
- E) zero

Q26.

A very long wire carries a current $I = 0.5$ A directed along the negative x-axis. Part of the wire is bent into a circular section of radius $R = 2.5$ cm as shown in the figure. What is magnetic field at point C?



- A) $16.6 \mu\text{T}$, into the page

- B) 5.44 μT , out of the page
- C) 10.2 μT , into the page
- D) 5.44 μT , into the page
- E) 16.6 μT , out the page

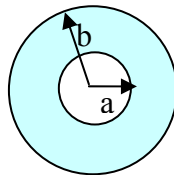
Q27.

An ideal solenoid that is 100 cm long has a diameter of 5.0 cm and a winding of 1000 turns and carries a current of 5.0 A. Calculate the magnetic field inside the solenoid.

- A) 6.3 mT
- B) 3.2 mT
- C) 0.9 mT
- D) 0.3 mT
- E) 1.8 mT

Q28.

The following figure shows a hollow cylindrical conductor of inner radius $a = 3.0$ mm and outer radius $b = 5.0$ mm carries a current of 2.0 A parallel to its axis. The current is uniformly distributed over the cross section of the conductor. Find the magnitude of the magnetic field at a point that is 2.0 mm from the axis of the conductor.



- A) zero
- B) 32 nT
- C) 15 nT
- D) 45 nT
- E) 50 nT

Q29.

A 1.7-T uniform magnetic field makes an angle of 30° with the z axis. The magnetic flux through an area of 4.0-m^2 lying in the xy-plane is:

- A) 6.0 $\text{T}\cdot\text{m}^2$
- B) 4.0 $\text{T}\cdot\text{m}^2$
- C) 3.4 $\text{T}\cdot\text{m}^2$
- D) 8.0 $\text{T}\cdot\text{m}^2$
- E) 1.2 $\text{T}\cdot\text{m}^2$

Q30.

A uniform magnetic field B is perpendicular to a loop of an area 1.5 m^2 . The resistance of the wire forming the loop is $2.50\ \Omega$. At what rate must the magnitude of the magnetic field B change to induce a current of 0.3 A ?

- A) 0.5 T/s
 - B) 0.3 T/s
 - C) 0.1 T/s
 - D) 1.0 T/s
 - E) 1.5 T/s
-

Physics 102
Formula sheet for Final Exam

$v = \sqrt{\frac{\tau}{\mu}}, v = \lambda f \quad v = \sqrt{\frac{B}{\rho}}$ $S = S_m \cos(kx - \omega t)$ $I = \frac{\text{Power}}{\text{Area}}$ $y = y_m \sin(kx - \omega t - \phi)$ $P = \frac{1}{2} \mu \omega^2 y_m^2 v$ $\Delta P = \Delta P_m \sin(kx - \omega t)$ $\Delta P_m = \rho v \omega S_m$ $I = \frac{1}{2} \rho (\omega S_m)^2 v$ $\beta = 10 \log \frac{I}{I_0}, I_0 = 10^{-12} \text{ W/m}^2$ $f' = f \left(\frac{v \pm v_D}{v \mp v_s} \right)$ $y = \left(2y_m \cos \frac{\phi}{2} \right) \sin \left(kx - \omega t - \frac{\phi}{2} \right)$ $\Delta L = \frac{\lambda}{2\pi} \phi$ $\Delta L = n \frac{\lambda}{2} \quad n = 0, 1, 2, 3, \dots$ $\Delta L = m\lambda$ $\Delta L = \left(m + \frac{1}{2} \right) \lambda$ $f_n = \frac{nv}{2L}, \quad n = 1, 2, 3, \dots$ $f_n = \frac{nv}{4L}, \quad n = 1, 3, 5, \dots$ $y = 2y_m \sin(kx) \cos(\omega t)$ $\alpha = \frac{\Delta L}{L} \frac{1}{\Delta T}, PV = nRT = NkT$ $n = \frac{m}{M} = \frac{N}{N_A}, \beta = \frac{1}{V} \frac{\Delta V}{\Delta T}$ $Q = mL, \quad W = \int PdV,$ $P = \frac{2}{3} \frac{N}{V} \left(\frac{1}{2} m \bar{v}^2 \right), C_p - C_v = R$ $Q = mc \Delta T,$ $\Delta E_{\text{int}} = Q - W, \Delta E_{\text{int}} = nc_v \Delta T$	$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}, \frac{1}{2} m \bar{v}^2 = \frac{3}{2} k_B T,$ $P_{\text{cond}} = \frac{Q}{t} = \kappa A \frac{T_H - T_C}{L}$ $Q = n c_p \Delta T, \quad Q = n c_v \Delta T$ $P V^\gamma = \text{constant}, \quad T V^{\gamma-1} = \text{constant}$ $T_F = \frac{9}{5} T_C + 32, \quad T_K = T_C + 273$ $W = Q_H - Q_L, \quad \varepsilon = \frac{W}{Q_H} = 1 - \frac{Q_L}{Q_H}$ $\frac{Q_L}{Q_H} = \frac{T_L}{T_H}, K = \frac{Q_L}{W}, \Delta S = \int \frac{dQ_r}{T}$ $F = \frac{kq_1 q_2}{r^2}, \quad F = q_0 E$ $\phi = \int_{\text{Surface}} \vec{E} \cdot d\vec{A}, \quad E = \frac{kq}{r^2}$ $E = \frac{kQ}{R^3} r, \quad E = \frac{2k\lambda}{r}$ $\phi_c = \oint \vec{E} \cdot d\vec{A} = \frac{q_{\text{in}}}{\varepsilon_0}$ $E = \frac{\sigma}{2\varepsilon_0}, \quad E = \frac{\sigma}{\varepsilon_0}$ $V = \frac{kQ}{r}, \quad W = \Delta K = -\Delta U$ $\Delta V = V_B - V_A = - \int_A^B \vec{E} \cdot d\vec{s} = \frac{\Delta U}{q_0},$ $E_x = -\frac{\partial V}{\partial x}, E_y = -\frac{\partial V}{\partial y}, E_z = -\frac{\partial V}{\partial z}$ $U = \frac{kq_1 q_2}{r_{12}}, C = \frac{Q}{V}, C_0 = \frac{\varepsilon_0 A}{d}$ $C = 4\pi \varepsilon_0 \frac{ab}{b-a}, U = \frac{1}{2} CV^2$ $u = \frac{1}{2} \varepsilon_0 E^2, C = \kappa C_0,$ $E = \frac{E_0}{\kappa}, v = \frac{v_0}{\kappa}, I = \frac{dQ}{dt},$	$I = JA, R = \frac{V}{I} = \rho \frac{L}{A}$ $\rho = \rho_0 [1 + \alpha(T - T_0)], P = IV$ $q(t) = C\varepsilon [1 - e^{-t/RC}],$ $q(t) = q_0 e^{-t/RC}$ $\tau = N i A B \sin \theta$ $\vec{F} = q(\vec{v} \times \vec{B}), \quad \vec{F} = i(\vec{L} \times \vec{B})$ $F_{ba} = \frac{\mu_0 Li_a i_b}{2\pi d}, d\vec{B} = \frac{\mu_0 i d\vec{s} \times \vec{r}}{4\pi r^3},$ $\oint \vec{B} \cdot d\vec{s} = \mu_0 i_{\text{enc}}$ $B = \frac{\mu_0 i}{4\pi R} \phi, \quad B = \frac{\mu_0 i}{2\pi r},$ $B = \frac{\mu_0 i}{2\pi R^2} r$ $B_s = \mu_0 n i, \phi_B = \int_{\text{Surface}} \vec{B} \cdot d\vec{A}$ $\varepsilon = -\frac{d\phi_B}{dt}, \quad \varepsilon = BLv$ <hr style="border-top: 1px dashed black;"/> $v = v_0 + at$ $x - x_0 = v_0 t + \frac{1}{2} at^2$ $v^2 = v_0^2 + 2a(x - x_0)$ <hr style="border-top: 1px dotted black;"/> $\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2$ $k = 9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$ $q_e = -1.6 \times 10^{-19} \text{ C}$ $m_e = 9.11 \times 10^{-31} \text{ kg}$ $m_p = 1.67 \times 10^{-27} \text{ kg}$ $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$ $\mu_0 = 4\pi \times 10^{-7} \text{ Wb/A}\cdot\text{m}$ $k_B = 1.38 \times 10^{-23} \text{ J/K}$ $N_A = 6.02 \times 10^{23} \text{ molecules/mole}$ $1 \text{ atm} = 1.013 \times 10^5 \text{ N/m}^2$ $R = 8.31 \text{ J/mol}\cdot\text{K}$ $g = 9.8 \text{ m/s}^2, 1 \text{ cal} = 4.186 \text{ J},$ <p>for water:</p> $c = 4190 \frac{\text{J}}{\text{kg}\cdot\text{K}}$ $L_F = 333 \frac{\text{kJ}}{\text{kg}}, \quad L_V = 2256 \frac{\text{kJ}}{\text{kg}}$
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