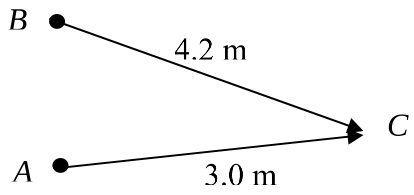
Q1.
A completely destructive interference has been found at location *C* that is 3.00 m from wave source *A* and 4.20 m from wave source *B*. If the two sources *A* and *B* are in phase, what is the maximum wavelength of the waves?



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?

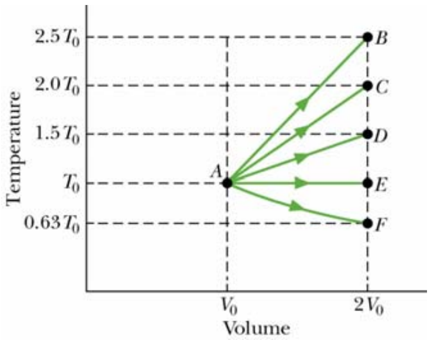
A) The pressure of sound wave is not in phase with the displacement.
B) The speed of sound in water is less than in air.
C) Sound waves are transverse waves.
D) For a string fixed at both ends, the speed of waves on the string decreases when its linear density decreases.
E) Waves on a stretched string 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_o expands from initial volume V_o to volume $2V_o$ 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 μC. Now, if you place a point charge of 8.0 μC 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-μF capacitor is connected in series with a 6.0-μF capacitor and a 12-V battery for a long time. What is the charge on the 3.0-μF capacitor?

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

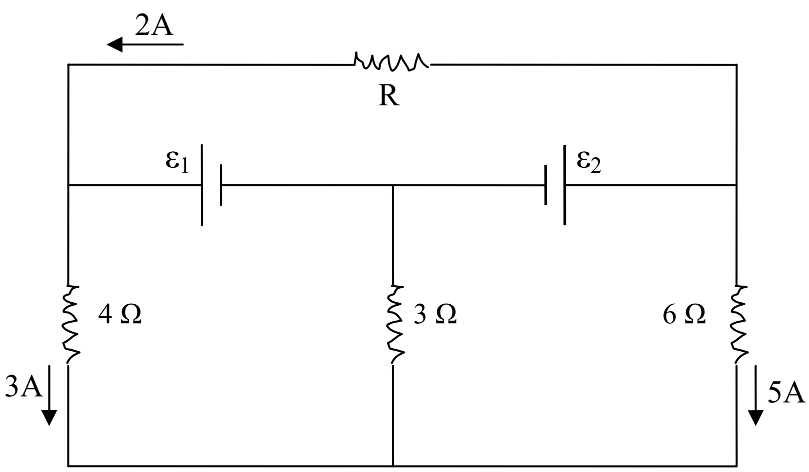
Q12.
At $20\ ^{o}C$, a light bulb has a resistance of 12 Ω. To increase its resistance to 36 Ω, the temperature of the bulb should be: [Assume α of the filament is constant and = 0.006 K^{-1}].

A) 353 ^{o}C.
B) 505 ^{o}C.
C) 520 ^{o}C.
D) 151 ^{o}C.
E) 654 ^{o}C.

Q13.
A 6-V battery supplies a total of 48 W to three identical light bulbs connected in parallel. The resistance of each bulb is:

A) 2.25 Ω
B) 3.23 Ω
C) 4.02 Ω
D) 1.51 Ω
E) 0.13 Ω

Q14.
In the following figure, find the current in 3 Ω resistor and the resistance R for the given currents.



A) 8 A, 9 Ω
B) 5 A, 8 Ω
C) 8 A, 8 Ω
D) 2 A, 9 Ω
E) 1 A, 8 Ω

Q15.

Two resistors *r* and *R* are connected in series across 100 V line. If *r* = 30 kΩ and the voltage across it is found to be 60 V, find the resistance of *R*.

A) 20 kΩ
B) 30 kΩ
C) 10 kΩ
D) 15 kΩ
E) 5 kΩ

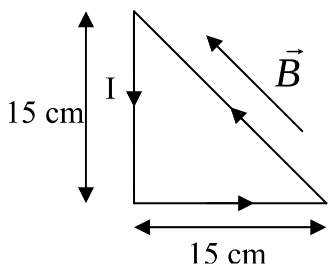
Q16.
A 30.0 kΩ resistor and a capacitor are connected in series and a 15.0 V potential difference is suddenly applied across them. The potential difference across the capacitor rises to 5.00 V in 1.50 μs. Find the capacitance of capacitor.

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 μT magnetic field goes through a circular trajectory. What is the time required to complete one revolution?

A) 7.15×10^{-7} s
B) 3.22×10^{-7} s
C) 4.20×10^{-7} s
D) 8.40×10^{-7} s
E) 1.50×10^{-7} s

Q20.
An electron has a velocity:

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

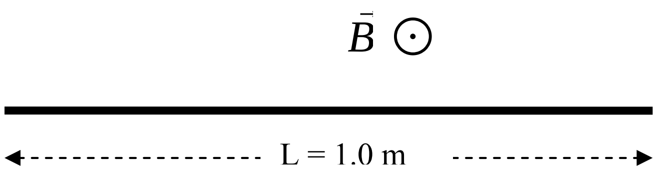
and moves through a uniform magnetic field:

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

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

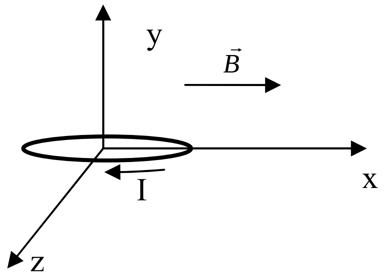
A) $-4.8 \times 10^{-13}\ \hat{k}$
B) $3.2 \times 10^{-13}\ \hat{j}$
C) $2.1 \times 10^{-13}\ \hat{k}$
D) $9.6 \times 10^{-13}\ \hat{i}$
E) $2.1 \times 10^{-13}\ \hat{j}$

Q21.
The following figure shows a straight horizontal length of copper wire of mass m = 50 g and length L = 1.0 m lies in a uniform magnetic field B = 0.5 T directed out of the page. What is the magnitude and direction of the current in the wire to balance the gravitational force?



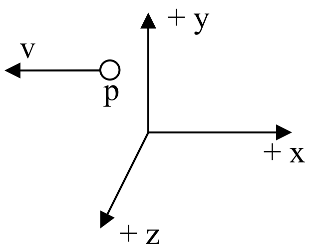
A) 0.98 A, to the left
B) 0.98 A, to the right
C) 0.35 A, to the right
D) 0.35 A, to the left
E) 1.51 A, to the right

Q22.
A 100 turns coil, lies in xz-plane, has an area of 2.0 m^2 and carries a current I = 0.3 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?



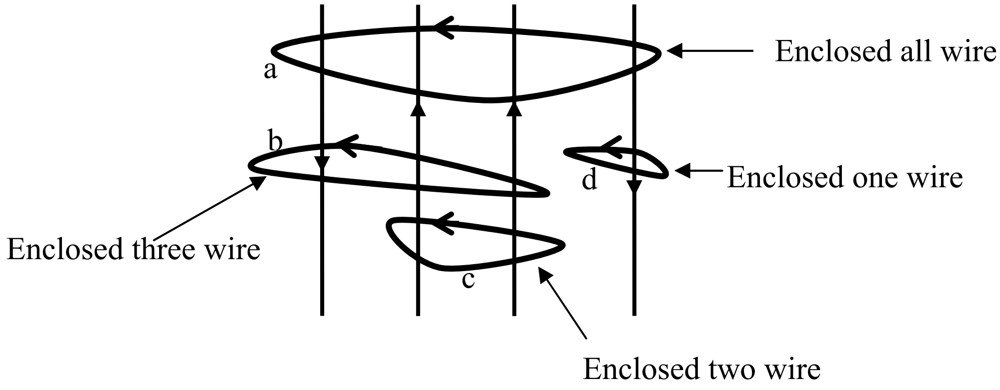
A) 90 N.m along the positive z axis
B) 90 N.m along the negative z axis
C) 30 N.m along the negative z axis
D) 30 N.m along the positive z axis
E) zero

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?



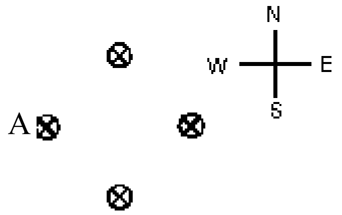
A) 3.0 T, along the negative z axis
B) 3.0 T, along the positive z axis
C) 0.3 T, along the negative x axis
D) 0.3 T, along the negative x axis
E) 0.1 T, along the negative y axis

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.



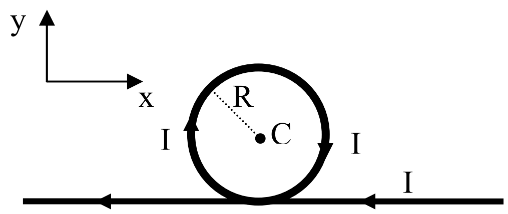
A) c, b and d tie, then a
B) a, b and a tie, then c
C) c, a, b, d
D) c, d, a, b
E) a, b, c, d

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?



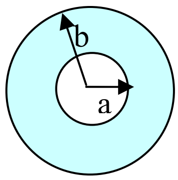
A) 16.6 μT, into the page

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 30^0 with the z axis. The magnetic flux through an area of 4.0-m^2 lying in the xy-plane is:

A) 6.0 $T.m^2$
B) 4. 0 $T.m^2$
C) 3.4 $T.m^2$
D) 8. 0 $T.m^2$
E) 1. 2 $T.m^2$

Q30.
A uniform magnetic filed B is perpendicular to a loop of an area 1.5 m^2. The resistance of the wire forming the loop is 2.50 Ω. 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

$v=\sqrt{\frac{\tau}{\mu}}$, $v = \lambda f$ $v=\sqrt{\frac{B}{\rho}}$

$S = S_m\cos(kx-\omega t)$

$I=\frac{Power}{Area}$

$y = y_m\sin(kx-\omega t-\varphi)$

$P=\frac{1}{2}\mu\omega^2 y_m^2 v$

$\Delta P=\Delta P_m\sin(kx-\omega t)$

$\Delta P_m=\rho v\omega S_m$

$I=\frac{1}{2}\rho(\omega S_m)^2 v$

$\beta = 10\log\frac{I}{I_0}$, $I_0=10^{-12}W/m^2$

$f'=f\left(\frac{v\pm v_D}{v\mp v_s}\right)$

$y=\left(2y_m\cos\frac{\varphi}{2}\right)\sin\left(kx-\omega t-\frac{\varphi}{2}\right)$

$\Delta L = \frac{\lambda}{2\pi}\varphi$

$\Delta L = n\frac{\lambda}{2}$ $n = 0,1,2,3,..$ ...

$\Delta L = m\lambda$

$\Delta L = \left(m+\frac{1}{2}\right)\lambda$

$f_n = \frac{nv}{2L}$, $n = 1,2,3,...$

$f_n = \frac{nv}{4L}$, $n = 1,3,5,...$

$y = 2y_m\sin(kx)\cos(\omega t)$

$\alpha=\frac{\Delta L}{L}\frac{1}{\Delta T}$, $PV = nRT = NkT$

$n=\frac{m}{M}=\frac{N}{N_A}$, $\beta=\frac{1}{V}\frac{\Delta V}{\Delta T}$

$Q = mL$, $W=\int PdV$,

$P=\frac{2}{3}\frac{N}{V}(\frac{1}{2}m\vec{v}^2)$, $C_p - C_v = R$

$Q = m c \Delta T$,

$\Delta E_{int} = Q - W$, $\Delta E_{int} = nc_v\Delta T$

$v_{rms}=\sqrt{\frac{3RT}{M}}$, $\frac{1}{2}m\vec{v}^2=\frac{3}{2}k_BT$,

$P_{cond}=\frac{Q}{t}=\kappa A\frac{T_H-T_C}{L}$

$Q = n c_p \Delta T$, $Q = n c_v \Delta T$

PV^{γ} = constant , $TV^{\gamma-1}$ = constant

$T_F=\frac{9}{5}T_c+32$, $T_K = T_c + 273$

$W = Q_H - Q_L$, $\varepsilon=\frac{W}{Q_H}=1-\frac{Q_L}{Q_H}$

$\frac{Q_L}{Q_H}=\frac{T_L}{T_H}$, $K=\frac{Q_L}{W}$, $\Delta S=\int\frac{dQ_r}{T}$

$F=\frac{kq_1q_2}{r^2}$, $F = q_0 E$

$\varphi=\int_{Surface}\vec{E}.d\vec{A}$, $E=\frac{kq}{r^2}$

$E=\frac{kQ}{R^3}r$, $E=\frac{2k\lambda}{r}$

$\varphi_c=\oint\vec{E}.d\vec{A}=\frac{q_{in}}{\varepsilon_0}$

$E=\frac{\sigma}{2\varepsilon_o}$, $E=\frac{\sigma}{\varepsilon_o}$

$V=\frac{kQ}{r}$, $W = \Delta K = -\Delta U$

$\Delta V = V_B - V_A = -\int_A^B\vec{E}.d\vec{S}=\frac{\Delta U}{q_0}$,

$E_x=-\frac{\partial V}{\partial x}$, $E_y=-\frac{\partial V}{\partial y}$, $E_z=-\frac{\partial V}{\partial z}$

$U=\frac{kq_1q_2}{r_{12}}$, $C=\frac{Q}{V}$, $C_o=\frac{\varepsilon_0 A}{d}$

$C=4\pi\varepsilon_o\frac{ab}{b-a}$, $U=\frac{1}{2}CV^2$

$u=\frac{1}{2}\varepsilon_o E^2$, $C = \kappa C_0$,

$E=\frac{E_0}{\kappa}$, $V=\frac{V_o}{\kappa}$, $I=\frac{dQ}{dt}$,

$I = JA$, $R=\frac{V}{I}=\rho\frac{L}{A}$

$\rho=\rho_0[1+\alpha(T-T_0)]$, $P = IV$

$q(t) = C\varepsilon[1-e^{-t/RC}]$,

$q(t) = q_o e^{-t/RC}$

$\tau = N i AB\sin\theta$

$\vec{F}=q(\vec{v}\times\vec{B})$, $\vec{F}=i(\vec{L}\times\vec{B})$

$F_{ba}=\frac{\mu_o L i_a i_b}{2\pi d}$, $d\vec{B}=\frac{\mu_0}{4\pi}\frac{i\,d\vec{s}\times\vec{r}}{r^3}$,

$\oint\vec{B}.d\vec{s}=\mu_0 i_{enc}$

$B=\frac{\mu_0 i}{4\pi R}\varphi$, $B=\frac{\mu_0 i}{2\pi r}$,

$B=\frac{\mu_0 i}{2\pi R^2}r$

$B_s = \mu_0 n i$, $\varphi_B=\int_{Surface}\vec{B}.d\vec{A}$

$\varepsilon=-\frac{d\varphi_B}{dt}$, $\varepsilon = BLv$

$v = v_o + at$

$x - x_o = v_o t + \frac{1}{2}at^2$

$v^2 = v_o^2 + 2a(x - x_o)$

$\varepsilon_0 = 8.85\times10^{-12}\ C^2/N.m^2$

$k = 9.0\times10^9\ N.m^2/C^2$

$q_e = -1.6\times10^{-19}\ C$

$m_e = 9.11\times10^{-31}$ kg

$m_p = 1.67\times10^{-27}$ kg

1 eV = 1.6×10^{-19} J

$\mu_0 = 4\pi\times10^{-7}$ Wb/A. m

$k_B = 1.38\times10^{-23}$ J/K

$N_A = 6.02\times10^{23}$ molecues/mole

1 atm = $1.013\times10^5\ N/m^2$

R = 8.31 J/mol. K

g = 9.8 m/s^2, 1 cal = 4.186 J,

for water:

$c=4190\frac{J}{kg.K}$

$L_F=333\frac{kJ}{kg}$, $L_V=2256\frac{kJ}{kg}$