Q1.

A wave travelling along a string is described by

$$y(x,t) = 0.00327\sin(72.1x - 2.72t)$$

In which all numerical constants are in SI units. Find the transverse speed of a point on the string at x = 22.5 cm at t = 18.9 s.

A) 0.720 cm/s
B) 0.889 cm/s
C) 0.520 cm/s
D) 0.952 cm/s
E) 0.372 cm/s

Q2.

A point source emits 30.0 W of sound isotropically. A small microphone intercepts the sound in an area of 0.750 cm^2. Calculate the power intercepted by the microphone placed perpendicular to the radial direction and 200 m away from the sound source.

A) 4.48×10^{-9} W
B) 2.25×10^{-3} W
C) 4.48×10^{-5} W
D) 4.48×10^{-7} W
E) 8.24×10^{-9} W

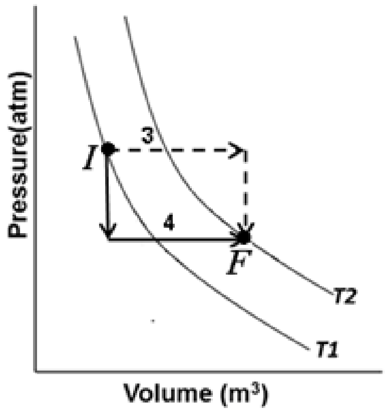
Q3.

A metallic rod has a length of 10.000 cm at 25.000 ^oC and a length of 10.025 cm at the boiling point of water. What is the temperature if the length of the rod is 10.010 cm?

A) 55 ^oC
B) 40 ^oC
C) 80 ^oC
D) 20 ^oC
E) 65 ^oC

Q4.
FIGURE 1 shows two p-V isothermal curves at temperature T_1 and T_2 and the system is taken from state '***I*** ' to '***F*** ' along path 3 (dotted lines) and path 4 (dark lines). If the area of the rectangle enclosed by paths 3 and 4 is 400 J, find the difference in heat energy absorbed by the system along paths 3 and 4 (i.e. Q_3-Q_4)

Fig#

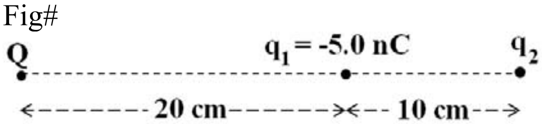


A) 400 J
B) 0.0 J
C) 200 J
D) 800 J
E) 100 J

Q5.
A Carnot engine whose low temperature reservoir is fixed at 20 ^oC has an efficiency of 35 %. By how much should the temperature of the high-temperature reservoir be increased to increase the efficiency to 55 %.
A) 200 ^oC
B) 473 ^oC
C) 150 ^oC
D) 400 ^oC
E) 300 ^oC

Q6.
In **FIGURE 2**, charge $q_1 = -5.00$ nC. For what value of charge q_2 will charge Q be in static equilibrium?

Fig#

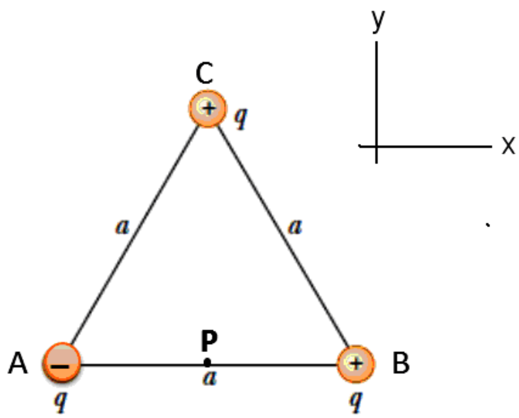


A) +11.3 nC
B) −11.3 nC
C) −0.55 nC
D) +0.55 nC
E) −5.00 nC

Q7.

Three charges of same magnitude q = 10 μC are fixed at the corners of an equilateral triangle ABC, where a = 6 cm, charge signs are shown in **FIGURE 3**. In unit vector notation find the resultant electric field at mid-point P, between points A and B.

Fig#



A) $(-2.0\ \hat{i} - 0.33\hat{j})10^8\, N/C$

B) $(-2.0\hat{i} + 0.33\hat{j})10^8\, N/C$

C) $(-4.0\hat{i} - 0.75\hat{j})10^8\, N/C$

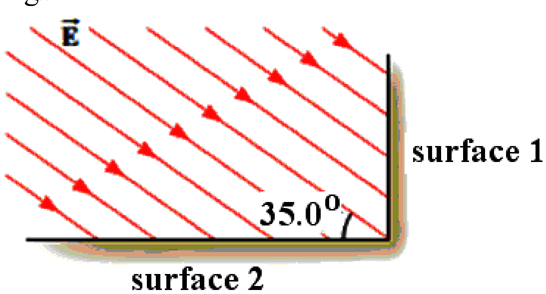
D) $(-2.0\hat{i} + 0.75\hat{j})10^8\, N/C$

E) $(-1.0\hat{i} - 0.33\hat{j})10^8\, N/C$

Q8.

FIGURE 4 shows an edge-on view of two planar surfaces that intersect and are mutually perpendicular. Surface 1 has an area of 1.70 m^2. The uniform electric field $\vec{E}$ has a magnitude of 250 N/C and is directed 35.0° above the horizontal. Find the magnitude of the electric flux through surface 1.

Fig#



A) 348 $N.m^2/C$

B) 405 $N.m^2/C$

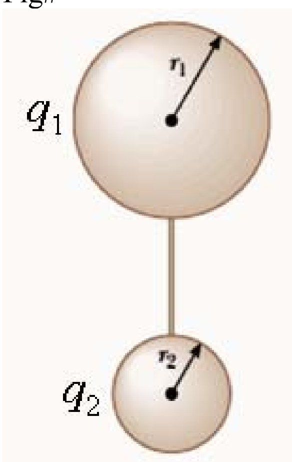
C) 459 $N.m^2/C$

D) 155 $N.m^2/C$

E) 540 $N.m^2/C$

Q9.
Two spherical conductors of radii r_1 and r_2 are connected by a long conducting wire as shown in **FIGURE 5**. The charges on the spheres in equilibrium are q_1 and q_2, respectively, and are uniformly distributed. If $r_1 = 2r_2$ find the ratio of magnitude of the electric fields at the surfaces of the spheres (i.e. E_1/E_2)

Fig#



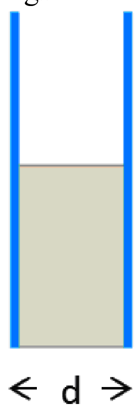
A) 1/2
B) 2
C) 4
D) 1/4
E) 1

Q10.
Over a certain region of space, the electric potential is $V = 5x - 3x^2y + 2yz^2$, in volts. Find the x component of the electric field at the point P that has coordinates (1, 0, −2) m?

A) −5 V/m
B) +5 V/m
C) +1 V/m
D) −1 V/m
E) +2 V/m

Q11.
FIGURE 6 shows a parallel plate capacitor with a plate area A = 7.89 cm^2 and plate separation d = 4.62 cm. The lower half of the gap is filled with dielectric (κ = 9.50). What is the capacitance?

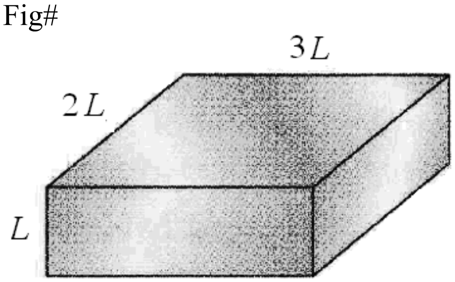
Fig#



A) 7.93×10^{-13} F
B) 2.23×10^{-13} F
C) 4.20×10^{-13} F
D) 6.40×10^{-13} F
E) 9.23×10^{-12} F

Q12.
FIGURE 7 shows a rectangular solid metal block of edge lengths L, 2L and 3L. If the resistance between the left-right faces is 20.0 Ω, find the resistance between front-back faces.

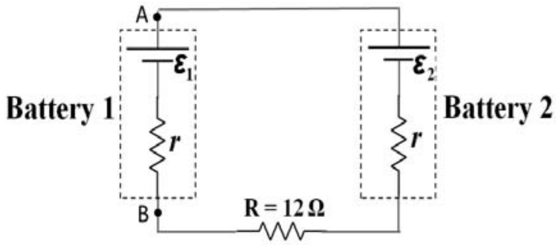
Fig#



A) 8.89 Ω
B) 20.0 Ω
C) 13.3 Ω
D) 30.0 Ω
E) 5.30 Ω

Q13.
FIGURE 8 shows a single loop circuit where $\varepsilon_1 = 12\ V$, $\varepsilon_2 = 20\ V$, $r = 2.0\ \Omega$, and $R = 12\ \Omega$. Find the potential difference $V_A - V_B$ between points A and B.

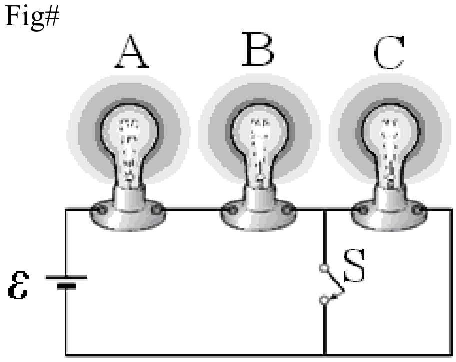
Fig#



A) 13 V
B) 12 V
C) 11 V
D) 6.0 V
E) 18 V

Q14.
Three identical lamps are connected in a circuit shown in **FIGURE 9**. If you close switch S, which of the lamp(s) will turn off (assume after closing the switch that the currents through lamps remain in safe limit).

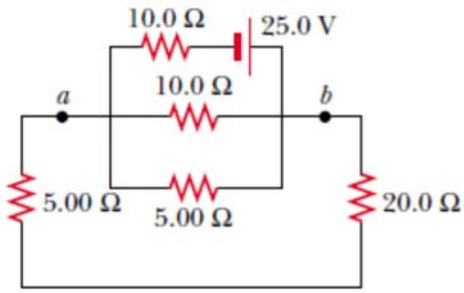
Fig#



A) C only
B) A and B
C) A only
D) B and C
E) None of them

Q15.
Consider the circuit shown in **FIGURE 10**. Find the current in the 20.0 Ω resistor.

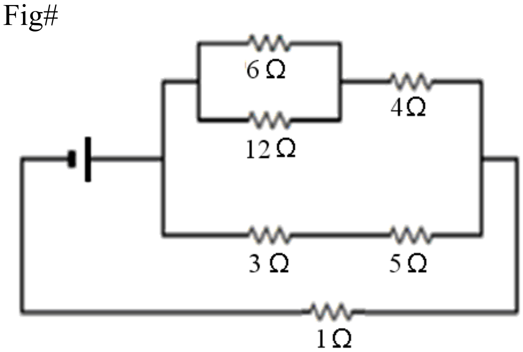
Fig#



A) 0.227 A
B) 0.453 A
C) 0.921 A
D) 0.125 A
E) 0.723 A

Q16.
In **FIGURE 11** if the current through the 6 Ω resistor is 2 A find the current through 3 Ω resistor.

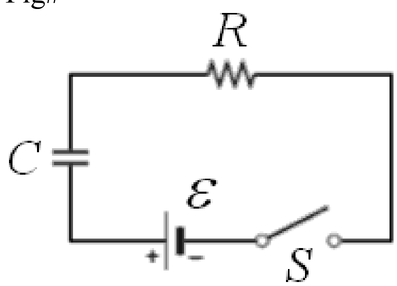
Fig#



A) 3 A
B) 1 A
C) 4 A
D) 2 A
E) 8 A

Q17.
A capacitor is charged by closing the switch S as shown in the **FIGURE 12**. Just after closing the switch, during the charging process, what will happen to voltage V_C across the capacitor, voltage V_R across the resistor, and current I in the circuit?

Fig#



A) V_C (Increase), V_R (Decrease), I (Decrease)
B) V_C (Increase), V_R (Decrease), I (Increase)
C) V_C (Increase), V_R (Increase), I (Decrease)
D) V_C (Decrease), V_R (Decrease), I (Increase)
E) V_C (Decrease), V_R (Increase), I (Increase)

Q18.
A particle with charge +3.0 C moves through a uniform magnetic field $\vec{B}$. At one instant the velocity of the particle is ($2.0\hat{i} + 6.0\hat{k}$) m/s and the magnetic force on the particle is $(36\hat{i} + 24\hat{j} - 12\hat{k})$ N. If the x and y components of the magnetic field $\vec{B}$ are equal, find $\vec{B}$.

A) $(-2.0\hat{i} - 2.0\hat{j} - 10\hat{k})T$

B) $(-4.0\hat{i} - 4.0\hat{j} + 1.0\hat{k})T$

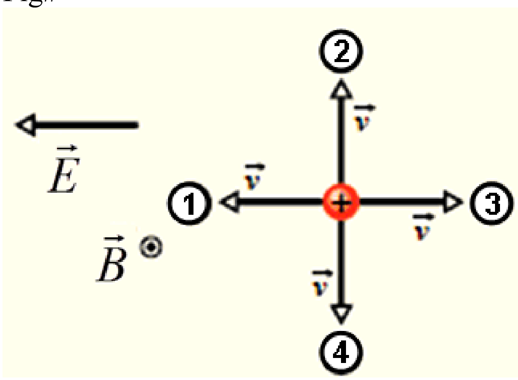
C) $(2.0\hat{i} + 2.0\hat{j} + 10\hat{k})T$

D) $(-3.0\hat{i} - 3.0\hat{j} + 4.0\hat{k})T$

E) $(3.0\hat{i} + 3.0\hat{j} + 4.0\hat{k})T$

Q19.
FIGURE 13 shows four directions for the velocity vector $\vec{v}$ of a positively charged particle moving through a uniform magnetic field $\vec{B}$ (directed out of the page) and a uniform electric field $\vec{E}$. Rank directions 1, 2, 3, and 4 according to magnitude of the net force on the particle, **GREATEST FIRST**.

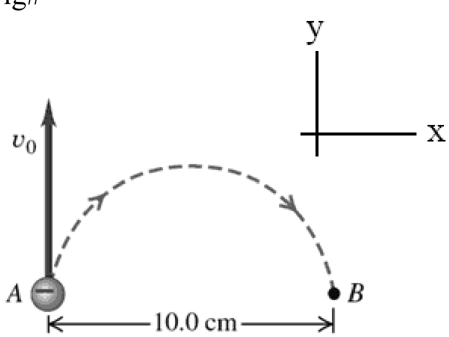
Fig#



A) 4, 1 and 3 tie, 2
B) 4, 3, 1, 2
C) 4, 1, 2, 3
D) 4 and 2 tie, 3, 1
E) 1, 3, 2, 4

Q20.
An electron at point A in **FIGURE 14** has a speed $v_0 = 1.41 \times 10^6$ m/s. Find the magnitude and direction of the magnetic field that will cause the electron to follow the semicircular path (of diameter 10.0 cm) from A to B.

Fig#

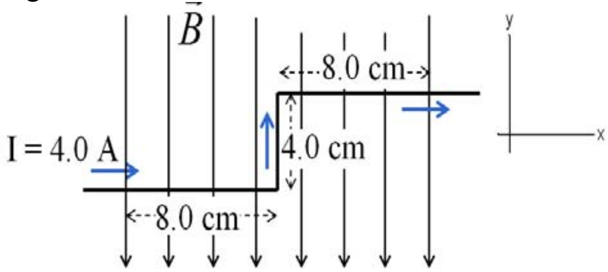


A) 1.60×10^{-4} T, into the page
B) 3.20×10^{-4} T, out of the page
C) 3.20×10^{-4} T, into the page
D) 0.800×10^{-4} T, out of the page
E) 0.800×10^{-4} T, into the page

Q21.
A long wire carrying 4.0 A current makes two 90° bends in xy-plane and is placed in a uniform magnetic field of 0.25 T along the negative y-axis, as shown in **FIGURE 15**.

Including the bent part, the total length of the wire in magnetic field is 20 cm. Find the magnitude of the net force that the magnetic field exerts on the wire.

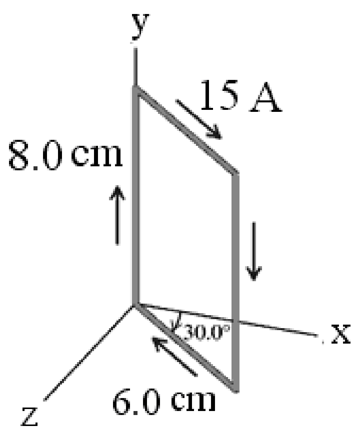
Fig#



A) 0.16 N
B) 16 N
C) 0.24 N
D) 0.30 N
E) 0.50 N

Q22.
A rectangular conducting current-carrying loop is placed as shown in **FIGURE 16** in a region of uniform magnetic field $\vec{B} = 0.48\ \hat{i}$ (T). The torque on the loop is

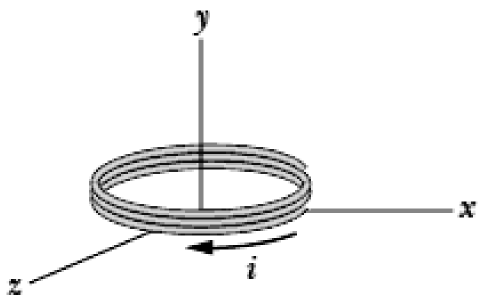
Fig#



A) $-0.030\hat{j}$ (N.m)
B) $+0.030\hat{j}$ (N.m)
C) $-0.017\hat{j}$ (N.m)
D) $+0.017\hat{j}$ (N.m)
E) zero

Q23.
The coil in **Figure 17** carries current i = 5.50 A in the direction indicated, is parallel to xz plane. It has 4.00 turns and an area of 5.00 x 10^{-3} m^2, and lies in uniform magnetic field $\vec{B} = (3.00\,\hat{i} + 5.50\,\hat{j} - 4.00\,\hat{k})$ mT. Find the magnetic potential energy of the coil-magnetic field system.

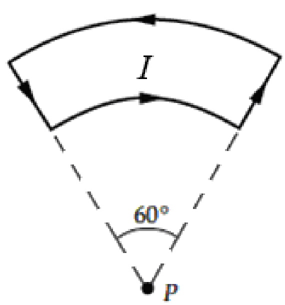
Fig#



A) 0.605 mJ
B) 0.440 mJ
C) 1.23 mJ
D) 0.151 mJ
E) 0.330 mJ

Q24.
Two semicircular arcs, in the plane of paper, carry a current I = 8.00 A, shown in **FIGURE 18**. The radius of outer arc is 0.600 m and that of the inner arc is 0.400 m. Find the magnetic field at point P.

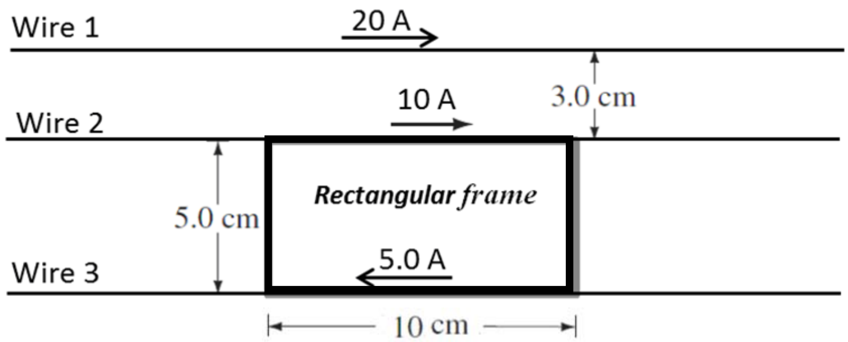
Fig#



A) 6.98×10^{-7} T into the page
B) 6.98×10^{-7} T out of the page
C) 4.32×10^{-7} T into the page
D) 3.49×10^{-6} T out of the page
E) 0

Q25.
Three long parallel wires 1, 2, and 3 carrying currents of 20 A, 10 A, and 5.0 A, respectively, are placed in the plane of the page, shown in **FIGURE 19**. Parts of wire 2 and wire 3 are fixed on a hard ***insulating*** rectangular frame of dimensions 10 cm × 5.0 cm. Find the net force on the rectangular loop.

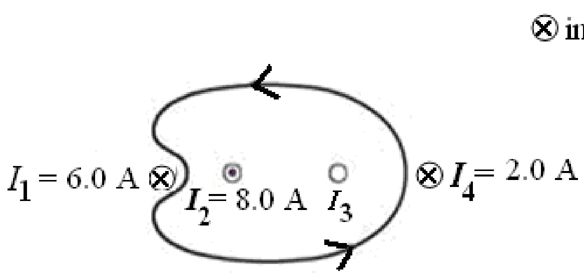
Fig#



A) 1.1×10^{-4} N toward wire 1
B) 1.1×10^{-4} N away from wire 1
C) 1.6×10^{-4} N toward wire 1
D) 1.6×10^{-4} N away from wire 1
E) 1.6×10^{-3} N toward wire 1

Q26.
The value of the line integral of $\vec{B}$ around the closed loop in **FIGURE 20** is 1.38×10^{-5} T.m. What is the direction and magnitude of current I_3?

Fig#



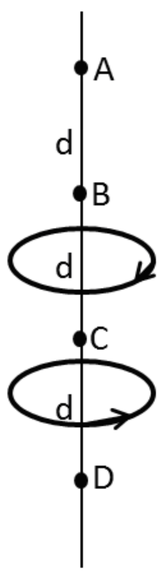
A) 2.98 A out of the page
B) 19.0 A out of the page
C) 2.98 A into the page
D) 4.20 A into the page
E) 5.65 A out of the page

Q27.
A solenoid that is 85.0 cm long has a radius of 2.50 cm and a winding of 1.5×10^{3} turns. If the solenoid carries a current of 4.20 A, calculate the magnitude of magnetic field inside the solenoid.

A) 9.31×10^{-3} T
B) 3.50×10^{-5} T
C) 4.20×10^{-3} T
D) 2.31×10^{-5} T
E) 6.47×10^{-5} T

Q28.
FIGURE 21 Shows two circular loops of same radius, centered on vertical axes (perpendicular to the loops) and carrying same current but in opposite directions indicated. Assume the separation between the coils is much greater than their radii and point C is the midpoint between the coils. If the separation between all successive points A, B, C, D is same, rank the points A, B, C, and D, on the vertical axis according to the magnitude of the net magnetic field, **GREATEST FIRST.**

Fig#



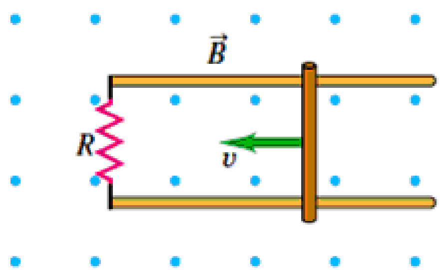
A) B and D tie, A, C
B) C, B and D tie, A
C) B and A tie, C, D
D) A, B and D tie, C
E) A, B, C, D

Q29.
A coil of radius 10 cm is placed in a region where the magnetic field is perpendicular to the plane of the coil. If the magnetic field decreases at constant rate from 1.00 T to 0.40 T in 1.2 ms, find the magnitude of induced emf in the coil?

A) 15.7 V
B) 500 V
C) 160 V
D) 25.7 V
E) 269 V

Q30.
A metal bar of length 0.32 m is pulled to the left with a speed of 5.5 m/s by an applied force, as shown in **FIGURE 22**. The bar rides on parallel metal rails connected through R = 45 Ω resistor. The circuit is in a uniform magnetic field of magnitude 0.65 T. What is the rate at which the applied force is doing work?

Fig#



A) 29 mW
B) 11 mW
C) 59 mW
D) 45 mW
E) 32 mW
