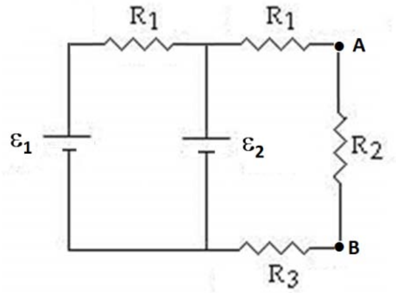
Q1.
What is the potential difference V_B-V_A in the circuit shown in **Figure 1** if R_1=70.0 **Ω**, R_2=105 **Ω**, R_3=140 **Ω**, ε_1=2.0 V and ε_2=7.0 V?

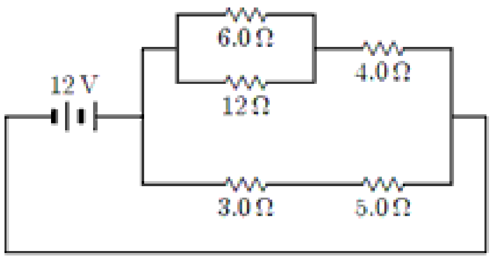
Fig#



A) −2.3 V
B) +2.3 V
C) +3.6 V
D) −1.1 V
E) +1.1 V

Q2.
The current in the 12- Ω resistor shown in the circuit of **Figure 2** is:

Fig#



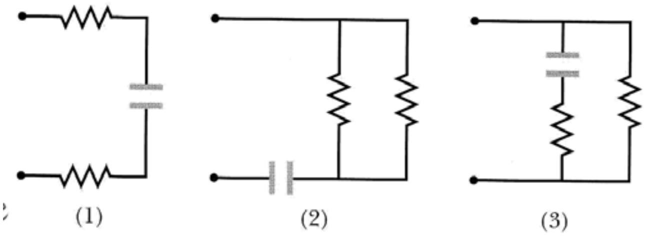
A) 0.50 A
B) 1.5 A
C) 2.5 A
D) 2.0 A
E) 0.30 A

Q3.
A 120-V power line is protected by a 15-A fuse. What is the maximum number of "120 V, 500 W" light bulbs, connected in parallel, that can be operated at full brightness from this line?

A) 3
B) 5
C) 4
D) 2
E) 6

Q4.
Figure 3 shows three sections of a circuit that are to be connected in turn to the same battery via a switch. The resistors as well as the capacitors are all identical. Rank the sections according to the time required for the capacitor to reach 50% of its final charge, **greatest first**.

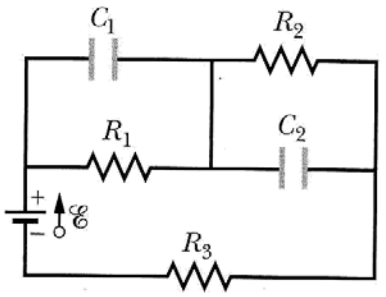
Fig#



A) 1, 3, 2
B) 2, 1, 3
C) 3, 1, 2
D) 1, 2, 3
E) 2, 3, 1

Q5.
In **Figure 4**, $R_1 = 5.0\ \Omega$, $R_2 = 10\ \Omega$, $R_3 = 15\ \Omega$, $C_1 = C_2 = 5.0\ \mu F$, and $\mathcal{E} = 24$ V. Assume the circuit is in the steady state. What is the power dissipated, in Watts, in the resistor R_3?

Fig#



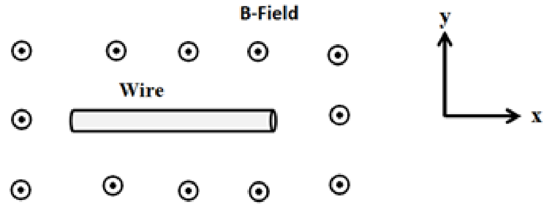
A) 9.6
B) 4.4
C) 11
D) 33
E) 5.5

Q6.
A particle with a charge of -2.48×10^{-8} C is moving in a magnetic field $\vec{B} = (2.80 \text{ T})\ \hat{i}$ at an instant with velocity $\vec{v} = (4.19 \times 10^4 \text{ m/s})\ \hat{i} + (-3.85 \times 10^4 \text{ m/s})\ \hat{j}$ ($\hat{i}$, $\hat{j}$, and $\hat{k}$ are the unit vectors in x, y and z directions, respectively). What is the force, in Newton, exerted on the particle by the magnetic field?

A) $-2.67 \times 10^{-3}\ \hat{k}$
B) $+2.67 \times 10^{-3}\ \hat{k}$
C) $-6.68 \times 10^{-4}\ \hat{k}$
D) $+6.68 \times 10^{-4}\ \hat{k}$
E) $-3.86 \times 10^{-2}\ \hat{k}$

Q7.
A straight horizontal length of copper wire is located in a magnetic field of strength 0.5×10^{-4} T directed out of the page, as shown in the **Figure 5**. What is direction and magnitude of the minimum current in the wire needed to balance the gravitational force on the wire? [The linear density of the wire is 60.0 gram/m]

Fig#



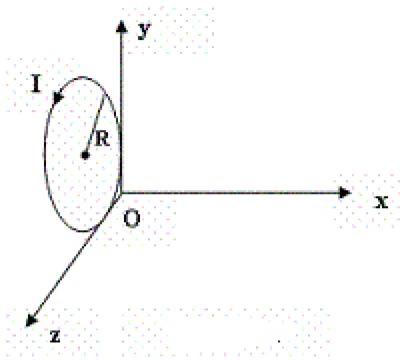
A) 1.2×10^4 A, towards negative x
B) 3.2×10^4 A, towards negative x
C) 1.2×10^4 A, towards positive x
D) 4.3×10^4 A, towards positive x
E) 4.3×10^4 A, towards negative x

Q8.
Two electrons 1 and 2 are trapped in a uniform magnetic field **B** and they move in a plane perpendicular to the magnetic field in circular paths of radii R_1 and R_2, respectively. The electron 1 has kinetic energy K_1= 500 eV and electron 2 has kinetic energy K_2= 300 eV. What is the value of R_1/R_2?

A) 1.3
B) 2.8
C) 1.7
D) 4.0
E) 1.0

Q9.
A current I = 17.0 mA is maintained in a circular loop of 0.320 m radius which is parallel to the y-z plane (see **Figure 6).** A magnetic field B = ($-$ 0.800 $\hat{k}$) T is applied. Calculate the torque, in units of N.m, exerted on the loop by the magnetic field. ($\hat{i}$, $\hat{j}$, and $\hat{k}$ are the unit vectors in x, y and z directions, respectively).

Fig#



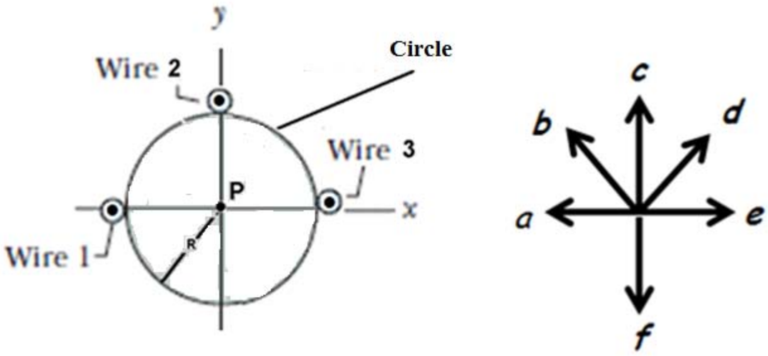
A) $+ 4.33\times10^{-3}$ $\hat{j}$
B) $- 4.33\times10^{-3}$ $\hat{j}$
C) $+ 7.32\times10^{-4}$ $\hat{j}$
D) $- 7.32\times10^{-4}$ $\hat{j}$
E) $+ 2.32\times10^{-2}$ $\hat{j}$

Q10.
A charged particle is projected with velocity $\vec{v}$ into a region where there exists a uniform electric field of strength $\vec{E}$ perpendicular to a uniform magnetic field of strength $\vec{B}$. If the velocity of the charged particle is to remain constant, the minimum velocity must be

A) of magnitude E/B and perpendicular to both E and B.
B) of magnitude B/E and perpendicular to both E and B.
C) of any magnitude but at 45 degrees to both E and B.
D) of magnitude E/B and parallel to E.
E) of magnitude E/B and parallel to B.

Q11.
Figure 7 shows cross-sectional view of three long parallel straight wires held along a circumference of a circle of radius R = 20.0 cm, located in the plane of the page. All wires are perpendicular to the plane of the page and each wire carries 60.0 mA current out of the page. Determine the magnitude and direction of net magnetic field at point P at the center of the circle.

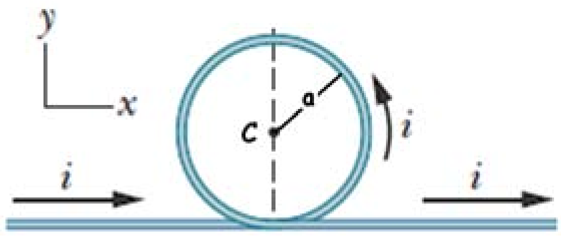
Fig#



A) 6.00×10^{-8} T along direction of e
B) 4.23×10^{-8} T along direction of e
C) 6.11×10^{-3} T along direction of e
D) 1.23×10^{-7} T along direction of c
E) 2.00×10^{-5} T along direction of a

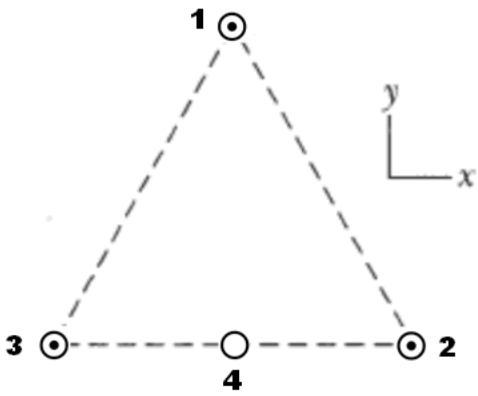
Q12.
A single piece of wire carrying current ***i*** =3.2 A is bent so it to form a circular loop of radius *a*, as shown in **Figure 8**. If magnitude of the net magnetic field at the loop center is 5.0×10^{-5} T, determine the radius *a* of the circular loop.

Fig#



A) 5.3 cm
B) 7.5 cm
C) 8.2 cm
D) 9.1 cm
E) 1.3 cm

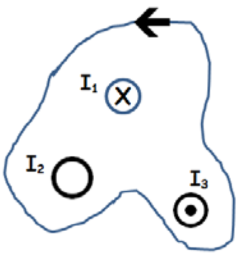
Q13.
Three long wires **1**,**2** and **3** are parallel to a z axis, and each carries a current of 2.0 A in the positive z direction (out of page). Their point of intersection with the xy plane form an equilateral triangle with sides of 50 cm, as shown in **Figure 9**. A fourth wire (wire **4**) passes through the midpoint of the base of the triangle and is parallel to the other three wires. If the net magnetic force on wire **1** is zero, what is the magnitude and direction of the current in wire **4**?
Fig#



A) 3.0 A, into the page
B) 3.0 A, out of the page
C) 6.0 A, into the page
D) 6.0 A, out of the page
E) 4.3 A, into the page

Q14.
Figure 10 shows cross sectional areas of three conductors that carry current through the plane of the Figure. The currents have the magnitude I_1=6.0 A and I_3=2.0 A and directions as shown. If the value of the line integral $\int \vec{B}.d\vec{s}$ is +3.8 $\times 10^{-6}$ T.m, what is magnitude and direction of current I_2. The integral involves going around the path in the counterclockwise direction, as shown in the figure.

Fig#



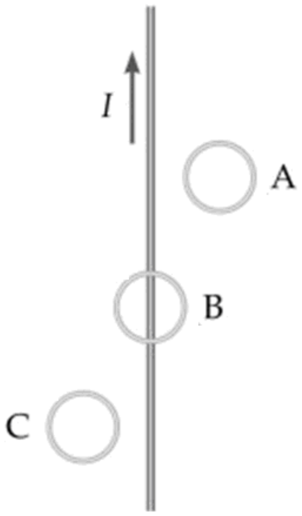
A) 7.0 A out of the page
B) 6.0 A into the page
C) 5.0 A out of the page
D) 8.0 A into the page
E) 9.0 A out of the page

Q15.
A 1.0 m long solenoid is 10.0 cm in diameter and carries 51.9 A current to produce 0.15 Tesla magnetic field inside the solenoid (Assume solenoid to be ideal). Determine the number of turns in the solenoid.

A) 2.30×10^3
B) 3.73×10^3
C) 1.81×10^2
D) 5.33×10^6
E) 1.01×10^2

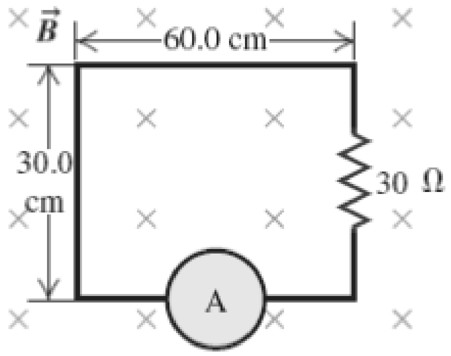
Q16.
The wire in **Figure 11** carries a current *I* that is decreasing with time at a constant rate. Loop A is located to the right of the wire, loop C is located to the left of the wire and loop B is centered on the wire. The induced emf in each of the loops is such that

Fig#



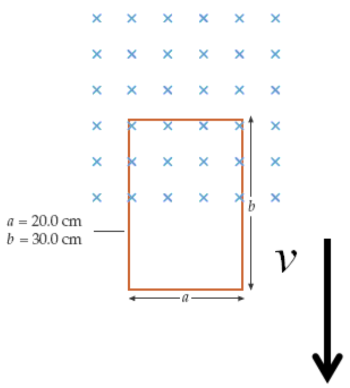
A) loop A has clockwise induced current, loop B has no induced current, and loop C has counterclockwise induced current
B) no emf is induced in any loop
C) All loops experience counterclockwise induced current
D) loop A has counterclockwise induced current, loop B has no induced current, and loop C has clockwise induced current
E) All loops experience clockwise induced current

Q17.
A rectangular circuit, of area 30 cm × 60 cm, containing a 30 Ω resistor is perpendicular to a uniform magnetic field that starts out at 3.0 T and steadily decreases at 0.5 T/s, as shown in **Figure 12**. What is the current measured by the ammeter, due to this change in magnetic field?
Fig#



A) 3.00 mA
B) 1.00 mA
C) 9.00 mA
D) 10.0 mA
E) 1.85 mA

Q18.
Consider a rectangular loop of width a = 20.0 cm and length b = 30.0 cm. Half the loop is located in a region that has a magnetic field of magnitude B= 0.90 T directed into the page, as shown in **Figure 13** (Over head view). The resistance of the coil is R= 30.0 Ω. At what rate energy is transferred to thermal energy of the loop; if it is moved at constant speed of v = 5.00 m/s down the page.
Fig#



A) 0.027 J/s
B) 0.003 J/s
C) 0.810 J/s
D) 0.337 J/s
E) 0.006 J/s

Q19.
The speed of a transverse wave on a string is 200 m/s when the string tension is 150 N. What is the needed tension in order to raise the wave speed to 400 m/s?

A) 600 N
B) 300 N
C) 150 N
D) 175 N
E) 700 N

Q20.
An air column 2.00 m in length is open at both ends. The frequency of a certain harmonic is 400 Hz, and the frequency of the next higher harmonic is 500 Hz. Determine the speed of sound in the air column.

A) 400 m/s
B) 300 m/s
C) 150 m/s
D) 575 m/s
E) 600 m/s

Q21.
What mass of steam at 100 ^{0}C must be mixed with 100 g of ice at its melting point, in a thermally insulated container, to produce liquid water at 25 ^{0}C.
[L_F= 333 kJ/kg, L_V = 2256 kJ/kg]

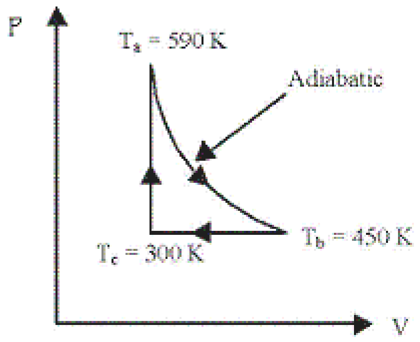
A) 17.0 g
B) 14.8 g
C) 9.65 g
D) 4.64 g
E) 29.6 g

Q22.
Under constant pressure, the temperature of 3.00 mol of an ideal monatomic gas is raised by 20.0 K. What is the change in the internal energy of the gas?

A) 748 J
B) 247 J
C) 499 J
D) 249 J
E) 997 J

Q23.
One mole of an ideal monatomic gas is taken through the cycle shown in **Figure 14**. If T_a = 590 K, T_b = 450 K and T_c = 300 K, calculate the efficiency of an engine operating in this cycle.

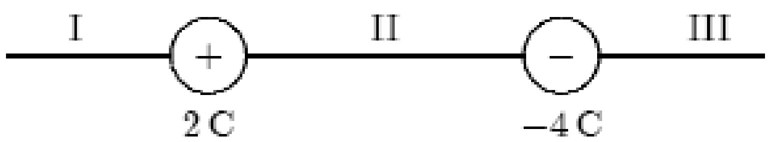
Fig#



A) 0.14
B) 0.28
C) 0.08
D) 0.55
E) 0.45

Q24.
Two particles with charges +2 C and −4 C are arranged as shown in **Figure 15**. In which region could a third particle, with charge +1 C, be placed so that the net electrostatic force on it is zero?

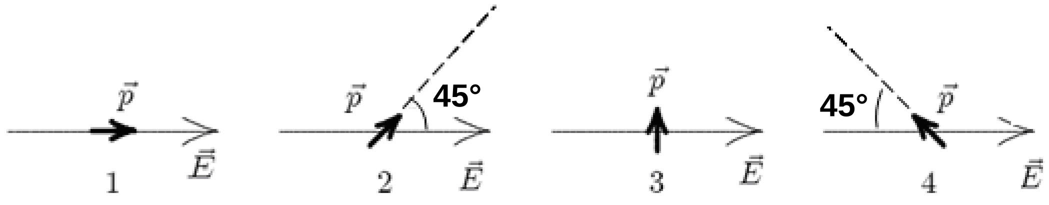
Fig#



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

Q25.
Figure 16 shows four possible orientations of an electric dipole $\vec{p}$ in a uniform electric field $\vec{E}$. Rank them according to the magnitude of the torque exerted on the dipole by the field, **least to greatest.**

Fig#



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

Q26.
A solid non-conducting sphere of radius R carries a charge Q distributed uniformly throughout its volume. At a radius r (r < R) from the center of the sphere the electric field has a value E. If the same charge Q were distributed uniformly throughout a sphere of radius R′ = R/2, the magnitude of the electric field at the radius r(r < R′) would be equal to:

A) 8E
B) E/2
C) 2E
D) E/8
E) 4E

Q27.
If the electric field is 15 V/m in the positive y-direction, what is the potential difference $V_B - V_A$ between points A and B? Point A is located at x = 0.0 m, y = 0.0 m and point B is located at x = 3.0 m, y = 5.0 m.

A) −75 V
B) +75 V
C) +45 V
D) −45 V
E) −88 V

Q28.

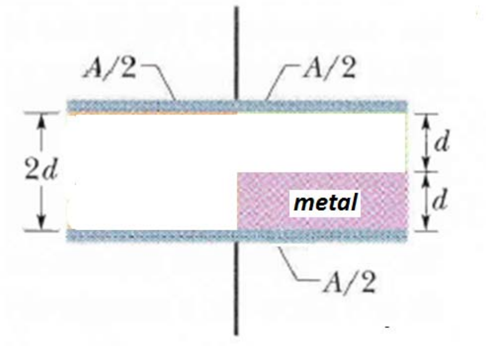
Two electric charges Q_A = + 1.0 μC and Q_B= − 2.0 μC are located 0.50 m apart. How much work is needed, by an external agent, to increase the distance between the charges to 1.50 m?

A) $+24 \times 10^{-3}$ J
B) -24×10^{-3} J
C) -18×10^{-3} J
D) $+18 \times 10^{-3}$ J
E) $+36 \times 10^{-3}$ J

Q29.

A parallel plate capacitor, with plate area A and 2d separation, has capacitance C_0. A metallic slab has been inserted into the gap between the plates of the capacitor halfway between the plates filling half of the gap between the plates, as shown in the **Figure 17**. What is the resulting new capacitance?

Fig#



A) $\frac{3}{2}C_o$

B) $\frac{4}{3}C_o$

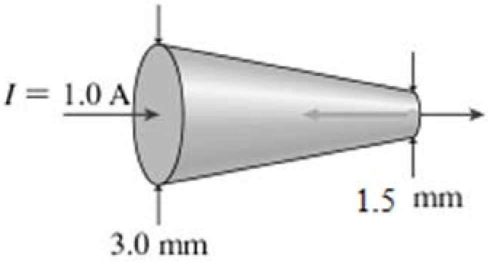
C) $\frac{3}{4}C_o$

D) $\frac{16}{9}C_o$

E) $\frac{5}{4}C_o$

Q30.
Figure 18 shows a current I = 1.0 A entering a truncated solid cone made of a conducting metal. The electron drift speed at the 3.0 mm diameter end of the cone is 4.0×10^{-4} m/s. What is the electron drift speed at the 1.5 mm diameter end of the wire?

Fig#



A) 1.6×10^{-3} m/s
B) 1.0×10^{-3} m/s
C) 2.3×10^{-4} m/s
D) 4.4×10^{-5} m/s
E) 4.4×10^{-4} m/s