Q1. A string that is stretched between fixed supports separated by 85.0 cm has resonant frequencies of 176 and 235 Hz, with no intermediate resonant frequencies. What is the speed of waves on this string?

A) 100 m/s
B) 200 m/s
C) 150 m/s
D) 215 m/s
E) 85.0 m/s

Q2. Water in a vertical well is at a depth of 12.4 m. What is the lowest resonant frequency of this well? The speed of sound in the well is 348 m/s.

A) 7.00 Hz
B) 6.20 Hz
C) 4.10 Hz
D) 12.4 Hz
E) 16.1 Hz

Q3. Calculate the minimum amount of energy required to completely melt 100 g of silver that is initially at 30.0 ^{o}C. (For silver: Specific heat = 236 J/kg.K, heat of fusion = 105 kJ/kg and the melting point = 962 ^{o}C)

A) 32.5 kJ
B) 10.5 kJ
C) 20.0 kJ
D) 45.3 kJ
E) 9.45 kJ

Q4. An ideal gas is changed slowly from state 1 to state 2. During this process no work is done on or by the gas. This process must be:

A) isochoric
B) adiabatic
C) isothermal
D) isobaric
E) a closed cycle with state 1 coinciding with state 2

Q5. Calculate the change in entropy of 100 g of ice at 0.00 ^{o}C when it is converted to water at 80.0 ^{o}C in a reversible process. Assume there is no change in volume during the melting process.

A) 230 J/K
B) 330 J/K
C) 128 J/K
D) 45.0 J/K
E) 109 J/K

Q6. Three charged particles are fixed on the x-axis as shown in Figure 1. The net electrostatic force on particle 3 due to the other two particles is zero. If $L_{23} = 1.36L_{12}$, what is the ratio q_1/q_2?

Fig#
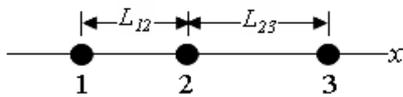
A) −3.00
B) +3.00
C) −1.85
D) +1.85
E) +5.57

Q7.
A proton is accelerated along the negative x-axis at 2.30×10^{10} m/s^2 by a uniform electric field. Determine the magnitude of the electric field.

A) 240 N/C
B) 120 N/C
C) 350 N/C
D) 490 N/C
E) 190 N/C

Q8.
Figure 2 shows 5 possible directions labeled 1, 2, 3, 4, and 5 of the net electric field at point P due to the charges shown. The correct direction of the net electric field at point P is:
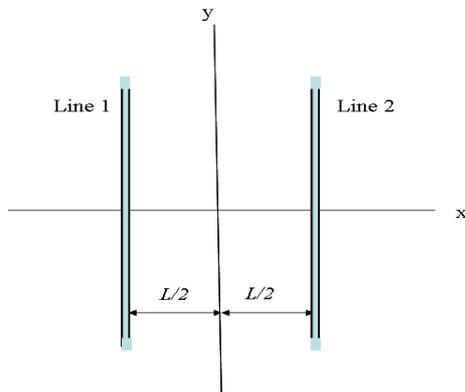
Fig#
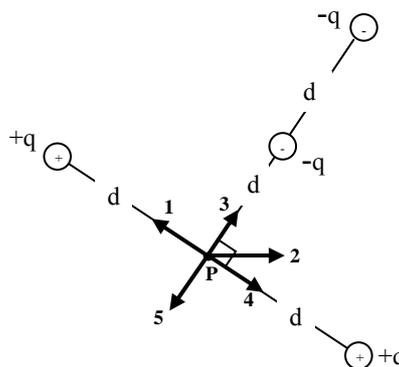
A) 3
B) 2
C) 1
D) 5
E) 4

Q9.
Figure 3 shows two long parallel lines of charges, fixed in place, separated by a distance L=10.0 cm. The uniform linear charge densities are +6.00 μC/m for line 1 and −4.00 μC/m for line 2. Where along the x-axis, measured from the origin, is the net electric field from the two lines zero?
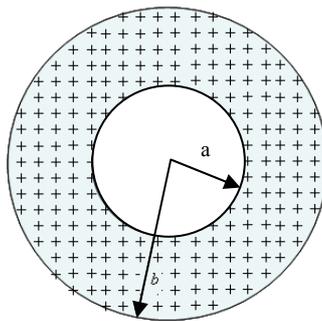
Fig#

A) +25.0 cm
B) zero
C) −15.0 cm
D) +5.00 cm
E) −5.00 cm

Q10. Figure 4 shows a non-conducting spherical shell with uniform volume charge density ρ = 1.84×10^{-9} C/m^3, inner radius a = 10.0 cm, and outer radius b = 25.0 cm. What is the magnitude of the electric field at radial distance r = 8.50 cm.
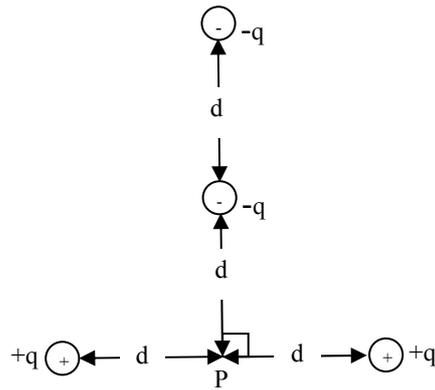
Fig#

A) 0.00 N/C
B) 2.58 N/C
C) 1.00 N/C
D) 15.0 N/C
E) 7.32 N/C

Q11. In Figure 5, what is the net electric potential at point P due to the four particles if V= 0 at infinity, q = 5.00×10^{-9} C, and d = 4.00 cm.
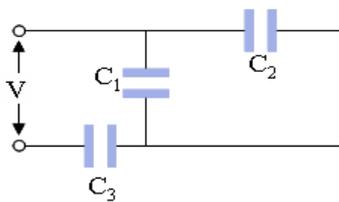
Fig#

A) 563 V
B) 685 V
C) 200 V
D) 127 V
E) 0.00 V

Q12. In Figure 6, a potential difference V = 100 V is applied across a capacitor arrangement with capacitances C_1 = 10.0 μF, C_2 = 5.00 μF, and C_3 = 4.00 μF. What is the total energy stored in the three capacitors?
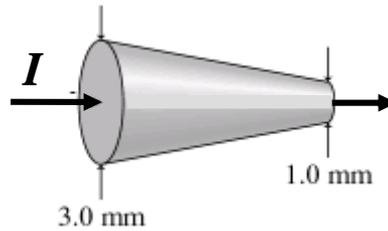
Fig#

A) 15.8 mJ
B) 23.5 mJ
C) 12.6 mJ
D) 56.3 mJ
E) 42.0 mJ

Q13. Figure 7 shows a current entering a solid conducting cone made of a metal with faces having diameters 3.000 mm and 1.000 mm. If the magnitude of current density at the 3.000 mm diameter face is 140.0 A/m^2, find the magnitude of current density at the 1.000 mm diameter face.

Fig#

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I

1.0 mm

3.0 mm

A) 1260 A/m^2
B) 1442 A/m^2
C) 1510 A/m^2
D) 190.0 A/ m^2
E) 110.0 A/ m^2

Q14. Consider two copper wires; one has twice the length and twice the cross-sectional area of the other. How do the resistances of these two wires compare?

A) Both wires have the same resistance.
B) The longer wire has four times the resistance of the shorter wire.
C) The longer wire has twice the resistance of the shorter wire.
D) The longer wire has eight times the resistance of the shorter wire.
E) The longer wire has half the resistance of the shorter wire

Q15. What maximum power can be generated by a 15-V battery in any combination of a 5.0 Ω resistor and a 7.0 Ω resistor?

A) 77 W
B) 97 W
C) 53 W
D) 27 W
E) 17 W

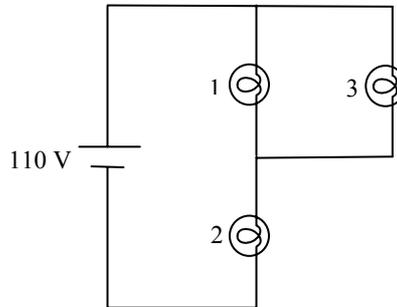Q16. Determine R when $I = 0.20$ A and $\varepsilon = 18$ V in the circuit shown in Figure 8.

Fig#

R   I   4R

ε

3R

2R

A) 30 Ω
B) 50 Ω
C) 8.0 Ω

D) 10 Ω
E) 20 Ω
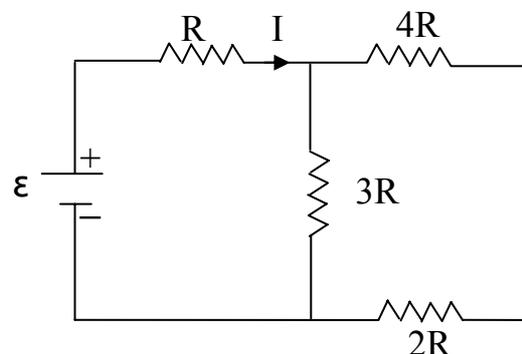
Q17. The circuit shown in Figure 9 has three 100-Ω light bulbs connected to a 110 V battery. Which light bulb(s) is(are) brightest?

Fig#

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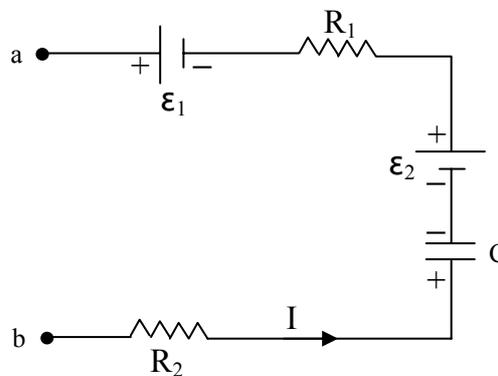B) 1
C) 3
D) 1 and 2
E) 2 and 3

Q18. In Figure 10, $\varepsilon_1 = 4.0$ V, $\varepsilon_2 = 12$ V, $R_1 = 4.0$ Ω, $R_2 = 12$ Ω, C = 3.0 μF, Q = 18 μC, and I = 2.5 A. What is the potential difference $V_a - V_b$?

Fig#

A) –30 V
B) +30 V
C) +5.0 V
D) –5.0 V
E) –1.0 V

Q19. In an *RC* circuit, how much time (in terms of the time constant τ) does it require an initially uncharged capacitor to reach 80 % of its maximum potential difference?

A) 1.6 τ
B) 2.2 τ

C) 4.3 τ

D) 3.0 τ

E) 5.0 τ

Q20. A uniform magnetic field of magnitude 2.0 T, directed along the positive *y* axis, crosses an electric field $\vec{E}$. What is magnitude and direction of the electric field needed to guide an electron with a speed of 30 m/s along a straight line in the positive *x* axis direction?
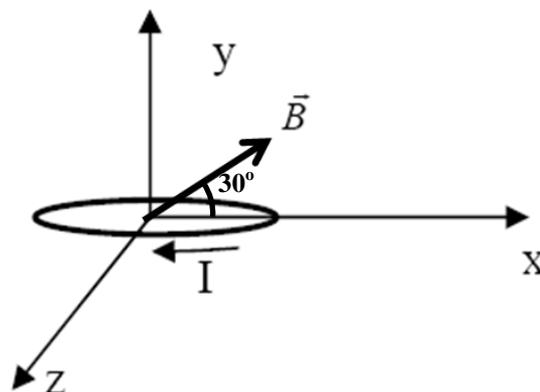
A) 60 V/m along the negative z direction

B) 60 V/m along the positive z direction

C) 80 mV/m along the positive z direction

D) 80 mV/m along the negative z direction

E) 20 V/m along the positive x direction

Q21. A wire of length 2.0 m carries a current of 2.0 A in the direction of the positive y axis. The wire is placed in a uniform magnetic field. To produce a maximum magnetic force of 1.0 N directed along the positive x axis, the magnetic field must be

A) 0.25 T along the positive z direction

B) 0.25 T along the negative z direction

C) 4.0 T along the positive z direction

D) 4.0 T along the negative z direction

E) 1.0 T along the negative z direction

Q22. A 20-turn coil, with an area of 1.5 m^2, lies in the *xz* plane and carries a current $I = 0.20$ A in the direction indicated in Figure 11. The coil is placed in a uniform magnetic field that lies in the xy plane and makes an angle of 30° with the + x-axis, and has a magnitude of 0.50 T. What is the torque on the coil?

Fig#

A) 2.6 N.m along the positive z direction

B) 2.6 N.m along the positive x direction

C) 1.5 N.m along the positive x direction

D) 1.5 N.m along the negative z direction

E) Zero

Q23. A charged particle enters a region of uniform magnetic field with its velocity perpendicular to the field, which of the following quantities is independent of the speed of the particle?

A) Period of revolution
B) Kinetic energy
C) Magnetic force
D) Radius of the orbit
E) Linear momentum

Q24. Two long parallel wires carry currents in opposite directions, as shown in Figure 12, with $i_1 = 2.0$ A and $i_2 = 1.0$ A. At what point on the x axis, measured from the origin, is the net magnetic field due to these two wires equal to zero?
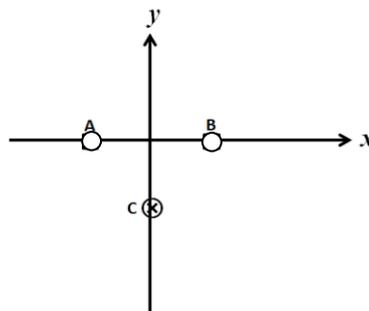
Fig#
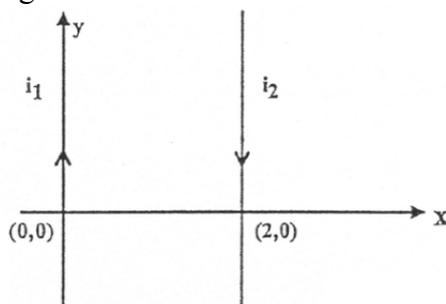
A) x = + 4.0 m
B) x = + 2.0 m
C) x = − 4.0 m
D) x = − 2.0 m
E) x = + 10 m

Q25. Three current-carrying wires A, B and C are placed as shown in Figure 13. All currents have the same value. Wire C has a current that flows into the page. The three wires are at equal distances from the origin. If the net magnetic force on wire C due to wires A and B is in the positive y direction, then

Fig#

A) Wires A and B must have currents flowing into the page.
B) Wires A and B must have currents flowing out of the page.
C) Wire A has a current flowing out of the page, and wire B has a current flowing into the page.

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D) Wire A has a current flowing into the page, and wire B has a current flowing out of the page.

E) The net magnetic force can never be along the positive y axis.

Q26. In Figure 14, what current I_2 will make the net magnetic field at P equal to zero?

Fig#
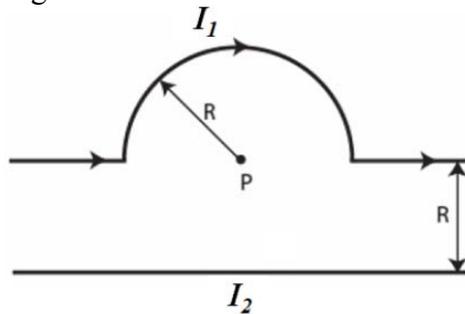

A) $I_2 = (\pi/2) I_1$, to the right
B) $I_2 = (\pi/2) I_1$, to the left
C) $I_2 = (2/\pi) I_1$, to the right
D) $I_2 = (2/\pi) I_1$, to the left
E) $I_2 = 2\pi I_1$, to the right

Q27. A cylindrical infinitely long wire has a radius of 4.0 mm. What current will produce a maximum magnetic field of 0.50 mT?

A) 10 A
B) 5.0 A
C) 20 A
D) 2.5 A
E) 15 A

Q28. A conducting loop with an area of 12 cm^2 and a resistance of 0.010 Ω lies in the xy plane as shown in Figure 15. The loop is in a region of uniform magnetic field that is directed in the negative z direction. The magnitude of the magnetic field decreases from 0.80 to 0.50 T in 1.5 s. The current induced in the loop is
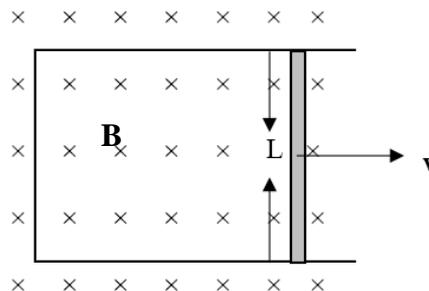
Fig#
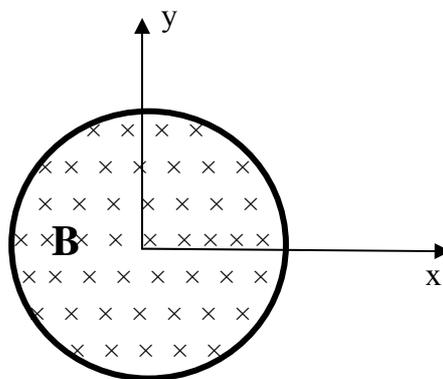
A) 24 mA, clockwise

B) 24 mA, counterclockwise
C) 68 mA, clockwise
D) 68 mA, counterclockwise
E) 54 mA, clockwise

Q29. Figure 16 shows a bar of length L = 35 cm moving to the right on two parallel rails at a constant speed of 5.0 m/s in a uniform magnetic field B = 0.40 T. If the induced current in the circuit is 1.2 A, the power dissipated in the circuit is

Fig#

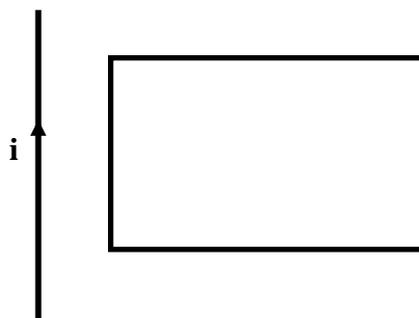

A) 0.84 W
B) 0.58 W
C) 6.0 W
D) 0.70 W
E) 2.4 W

Q30. A long straight wire carries a current i and is in the plane of a rectangular conducting loop, as shown in Figure 17. Which of the following will induce a clockwise current in the loop?

Fig#

A) Moving the loop to the right away from the wire, keeping the current in the wire constant
B) Moving the loop to the left toward the wire, keeping the current in the wire constant
C) Moving the loop upward parallel to the wire, keeping the current in the wire constant
D) Moving the loop downward parallel to the wire, keeping the current in the wire constant
E) Increasing the current in the wire, keeping the loop stationary