BBMerlion

Physics A Level

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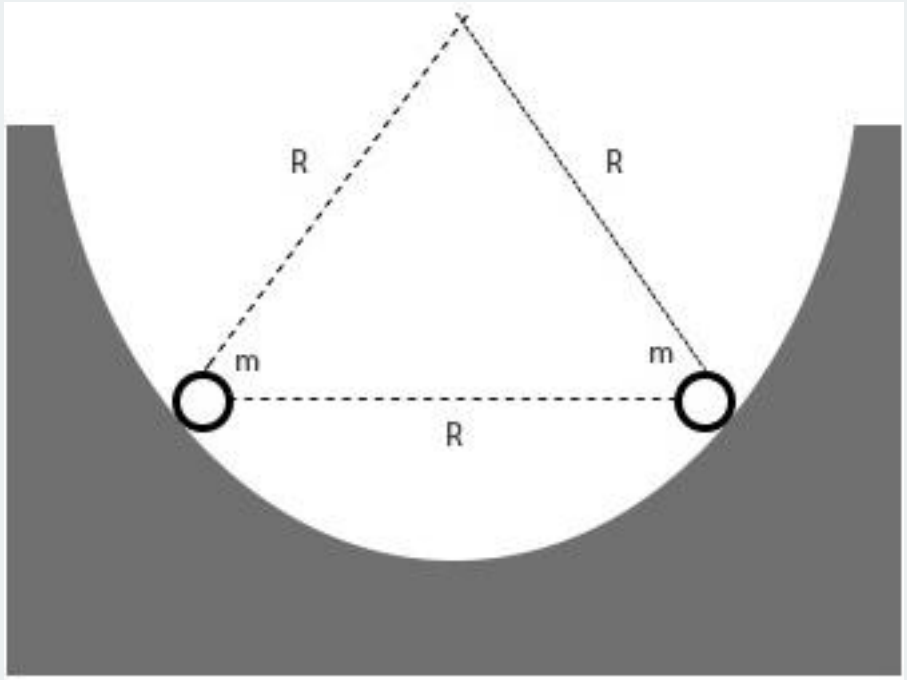
QUIZ 3

Electricity and Magnetism

Question 1

A. Two identical beads each have a mass m and charge q. When placed in a hemispherical bowl of radius R with frictionless, non-conducting walls, the beads move, and at equilibrium they are a distance R apart as shown in figure below. Determine the charge on each bead

Question 1



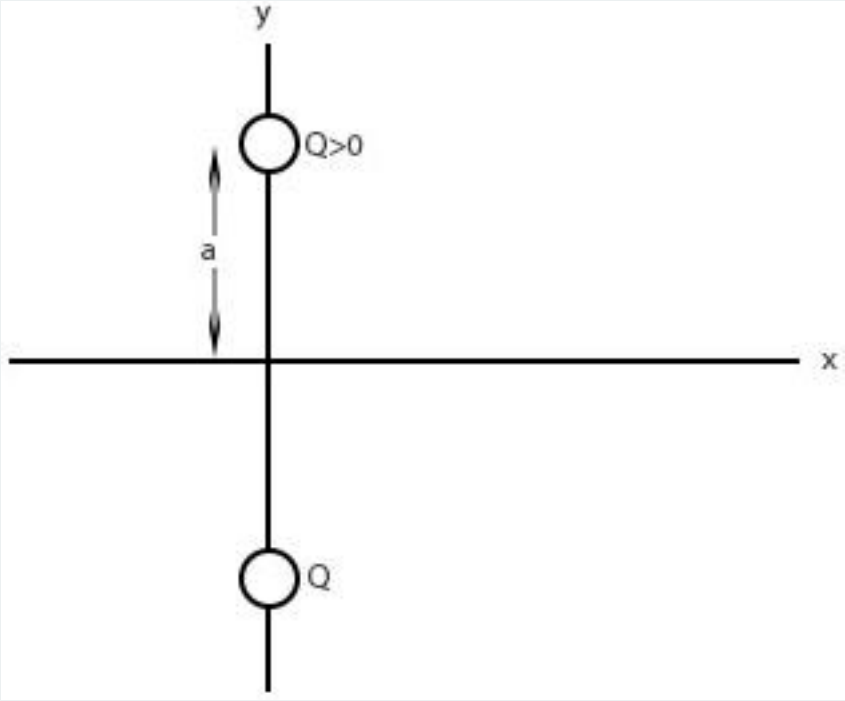
Question 1

B. Two charged particles of equal magnitude are located along the y-axis equal distances above and below the x-axis as shown in figure below.

i. Plot a graph of the potential at points along the x axis over the interval $-3a < x < 3a$. You should plot the potential in units of k_eQ/a.

ii. Let the charge of the particle located at $y = -a$ be negative. Plot the potential along the y axis over the interval $-4a < y < 4a$.

Question 1



Question 2

A. A high-voltage transmission line with a diameter of 2.00 cm and a length of 200 km carries a steady current of 1 000 A. If the conductor is copper wire with a free charge density of 8.46 × 1028 electrons/m^3, over what time interval does one electron travel the full length of the line?

Electron drift velocity: $v_d = \frac{I}{nq\pi r^2}$

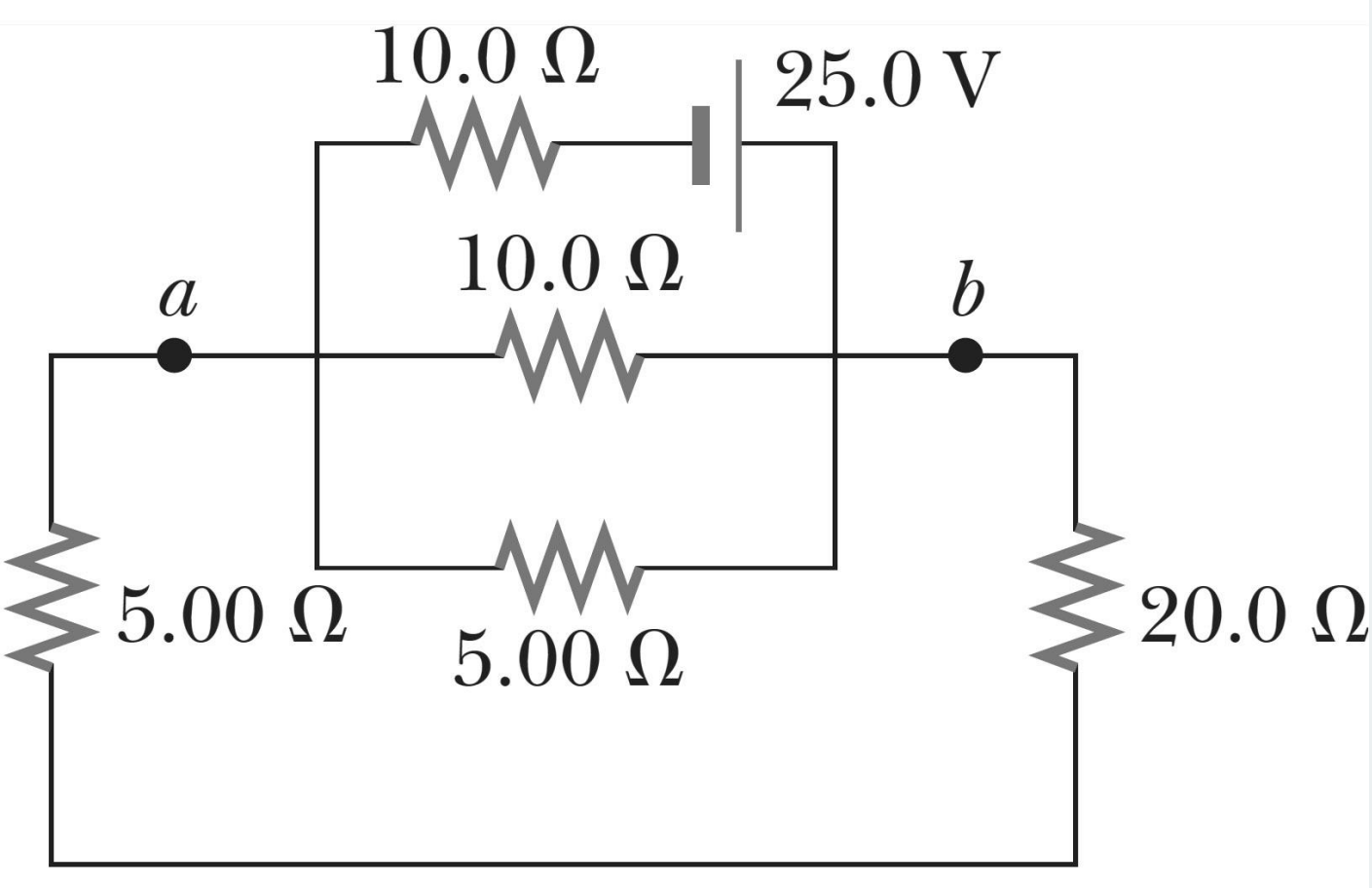
Question 2

B. Consider the circuit shown in figure below. Find

i. The current in the 20.0-Ω resistor and

ii. The potential difference between points a and b.

Question 2



Question 3

A. A proton having an initial velocity of $20.0\hat{i}$ Mm/s enters a uniform magnetic field of magnitude 0.300 T with a direction perpendicular to the proton's velocity. It leaves the field-filled region with velocity $-20.0\hat{j}$ Mm/s. Determine

i. The direction of the magnetic field,

ii. The radius of curvature of the proton's path while in the field,

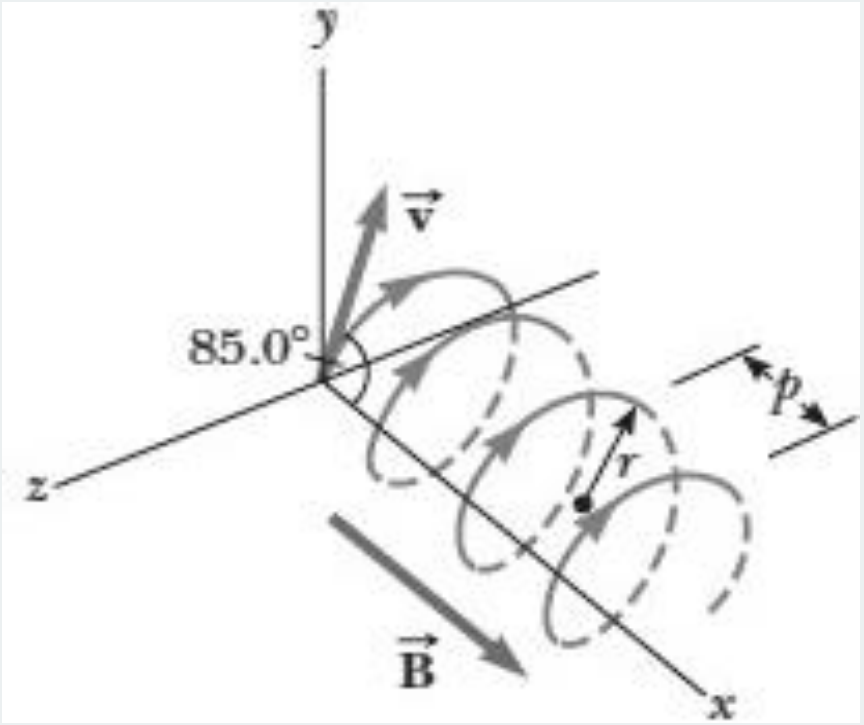
iii. The distance the proton traveled in the field, and

iv. The time interval for which the proton is in the field.

Question 3

A. A uniform magnetic field of magnitude 0.150 T is directed along the positive x-axis. A positron moving at 5.00 × 106 m/s enters the field along a direction that makes an angle of 85.0° with the x-axis (see figure below). The motion of the particle is expected to be a helix. Calculate (i) the pitch p and (ii) the radius r of the trajectory.

Question 3



Question 4

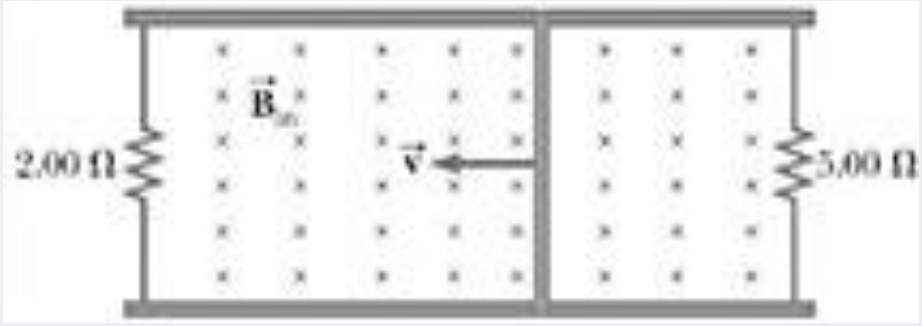
A. A conducting rod of length l = 35.0 cm is free to slide on two parallel conducting bars as shown in Figure below. Two resistors R1 = 2.00 Ω and R2 = 5.00 Ω are connected across the ends of the bars to form a loop. A constant magnetic field B = 2.50 T is directed perpendicularly into the page. An external agent pulls the rod to the left with a constant speed of v = 8.00 m/s. Find

i. The currents in both resistors,

ii. The total power delivered to the resistance of the circuit, and

iii. The magnitude of the applied force that is needed to move the rod with this constant velocity.

Question 4



Question 4

B. Consider a uniformly wound solenoid having N turns and length l. Assume l is much longer than the radius of the windings and the core of the solenoid is air.

i. Find the inductance of the solenoid.

ii. Calculate the inductance of the solenoid if it contains 300 turns, its length is 25.0 cm, and its cross-sectional area is 4.00 cm2.

iii. Calculate the self-induced emf in the solenoid if the current it carries decreases at the rate of 50.0 A/s.

Reference

- Physics for Scientist and Engineer, 6th ed, Serway Jewett