UG TRB PHYSICS

UNIT 4 - ELECTRICITY & MAGNETISM

PRACTICE PROBLEMS WITH SOLUTIONS

QUESTION 1

1. Coulomb's Law: Two charges 2 μC and 3 μC are separated by 0.5 m in air. Find the force between them.

Given:

$q1 = 2\ \mu C = 2 \times 10^{-6}\ C$

$q2 = 3\ \mu C = 3 \times 10^{-6}\ C$

$r = 0.5\ m$

$k = 9 \times 10^{9}\ N\ m^2/C^2$

Formula:

$F = k\ q1\ q2 / r^2$

Substitute:

$F = (9 \times 10^{9} \times 2 \times 10^{-6} \times 3 \times 10^{-6}) / (0.5)^2$

$F = (9 \times 6 \times 10^{-3}) / 0.25$

$F = 0.216\ N$

Answer: F = 0.216 N

PRACTICE PROBLEM

Problem 1

Two charges **4 μC** and **5 μC** are separated by **0.4 m** in air. Find the force between them.

Given:

$q_1 = 4\ \mu C = 4 \times 10^{-6}\ C$

$q_2 = 5\ \mu C = 5 \times 10^{-6}\ C$

$r = 0.4\ m$

$k = 9 \times 10^{9}\ N\ m^2/C^2$

Formula:

$F = k\, q_1\, q_2 / r^2$

Substitute:

$F = (9 \times 10^9 \times 4 \times 10^{-6} \times 5 \times 10^{-6}) / (0.4)^2$

$F = (9 \times 20 \times 10^{-3}) / 0.16$

$F = 0.18 / 0.16$

$F = 1.125\ N$

Answer: F = **1.125 N**

Problem 2

Two charges **6 µC** and **2 µC** are separated by **0.3 m** in air. Find the force between them.

Given:

$q_1 = 6\ \mu C = 6 \times 10^{-6}\ C$

$q_2 = 2\ \mu C = 2 \times 10^{-6}\ C$

$r = 0.3\ m$

$k = 9 \times 10^9\ N\ m^2/C^2$

Formula:

$F = k\, q_1\, q_2 / r^2$

Substitute:

$F = (9 \times 10^9 \times 6 \times 10^{-6} \times 2 \times 10^{-6}) / (0.3)^2$

$F = (9 \times 12 \times 10^{-3}) / 0.09$

$F = 0.108 / 0.09$

$F = 1.2\ N$

Answer: F = **1.2 N**

Problem 3

Two charges **3 µC** and **4 µC** are separated by **0.2 m** in air. Find the force between them.

Given:

$q_1 = 3\ \mu C = 3 \times 10^{-6}\ C$

$q_2 = 4\ \mu C = 4 \times 10^{-6}\ C$

$r = 0.2$ m

$k = 9 \times 10^9$ N m²/C²

Formula:

$F = k\, q_1\, q_2 / r^2$

Substitute:

$F = (9 \times 10^9 \times 3 \times 10^{-6} \times 4 \times 10^{-6}) / (0.2)^2$

$F = (9 \times 12 \times 10^{-3}) / 0.04$

$F = 0.108 / 0.04$

$F = 2.7$ N

Answer: $F =$ **2.7 N**

Problem 4

Two charges **5 μC** and **7 μC** are separated by **0.6 m** in air. Find the force between them.

Given:

$q_1 = 5\ \mu C = 5 \times 10^{-6}$ C

$q_2 = 7\ \mu C = 7 \times 10^{-6}$ C

$r = 0.6$ m

$k = 9 \times 10^9$ N m²/C²

Formula:

$F = k\, q_1\, q_2 / r^2$

Substitute:

$F = (9 \times 10^9 \times 5 \times 10^{-6} \times 7 \times 10^{-6}) / (0.6)^2$

$F = (9 \times 35 \times 10^{-3}) / 0.36$

$F = 0.315 / 0.36$

$F = 0.875$ N

Answer: $F =$ **0.875 N**

Problem 5

Two charges **8 μC** and **3 μC** are separated by **0.5 m** in air. Find the force between them.

Given:

$q_1 = 8\ \mu C = 8 \times 10^{-6}$ C

$q_2 = 3\ \mu C = 3 \times 10^{-6}\ C$

$r = 0.5\ m$

$k = 9 \times 10^9\ N\ m^2/C^2$

Formula:

$F = k\ q_1\ q_2 / r^2$

Substitute:

$F = (9 \times 10^9 \times 8 \times 10^{-6} \times 3 \times 10^{-6}) / (0.5)^2$

$F = (9 \times 24 \times 10^{-3}) / 0.25$

$F = 0.216 / 0.25$

$F = 0.864\ N$

Answer: F = **0.864 N**

QUESTION 2

2. Relative Permittivity: The force between two charges in air is 10 N. In a medium it becomes 2 N. Find the relative permittivity.

Given:

Force in air Fa = 10 N

Force in medium Fm = 2 N

Formula:

$\varepsilon r = Fa / Fm$

Substitute:

$\varepsilon r = 10 / 2 = 5$

Answer: $\varepsilon r = 5$

PRACTICE PROBLEM

Problem 1

The force between two charges in air is **12 N**. In a medium it becomes **3 N**. Find the **relative permittivity** of the medium.

Given:

Force in air Fa = 12 N

Force in medium Fm = 3 N

Formula:

εr = Fa / Fm

Substitute:

εr = 12 / 3

εr = 4

Answer: εr = **4**

Problem 2

The force between two charges in air is **15 N**. In a medium it becomes **5 N**. Find the **relative permittivity**.

Given:

Force in air Fa = 15 N

Force in medium Fm = 5 N

Formula:

εr = Fa / Fm

Substitute:

εr = 15 / 5

εr = 3

Answer: εr = **3**

Problem 3

The force between two charges in air is **20 N**. In a medium it becomes **4 N**. Find the **relative permittivity**.

Given:

Force in air Fa = 20 N

Force in medium Fm = 4 N

Formula:

εr = Fa / Fm

Substitute:

εr = 20 / 4

εr = 5

Answer: εr = **5**

Problem 4

The force between two charges in air is **18 N**. In a medium it becomes **6 N**. Find the **relative permittivity**.

Given:

Force in air Fa = 18 N

Force in medium Fm = 6 N

Formula:

εr = Fa / Fm

Substitute:

εr = 18 / 6

εr = 3

Answer: εr = **3**

Problem 5

The force between two charges in air is **25 N**. In a medium it becomes **5 N**. Find the **relative permittivity**.

Given:

Force in air Fa = 25 N

Force in medium Fm = 5 N

Formula:

εr = Fa / Fm

Substitute:

εr = 25 / 5

εr = 5

Answer: εr = **5**

QUESTION 3

3. Electric Field Intensity: Find the electric field intensity at a point 0.2 m from a charge of 5 μC.

Given:

$q = 5\ \mu C = 5 \times 10^{-6}\ C$

$r = 0.2\ m$

Formula:

$E = kq / r^2$

$E = (9 \times 10^9 \times 5 \times 10^{-6}) / (0.2)^2$

$E = (45 \times 10^3) / 0.04$

$E = 1.125 \times 10^6\ N/C$

Answer: 1.125×10^6 N/C

PRACTICE PROBLEM

Problem 1

Find the **electric field intensity** at a point **0.3 m** from a charge of **4 μC**.

Given:

$q = 4\ \mu C = 4 \times 10^{-6}\ C$

$r = 0.3\ m$

Formula:

$E = kq / r^2$

Substitute:

$E = (9 \times 10^9 \times 4 \times 10^{-6}) / (0.3)^2$

$E = (36 \times 10^3) / 0.09$

$E = 4 \times 10^5\ N/C$

Answer: 4×10^5 N/C

Problem 2

Find the **electric field intensity** at a point **0.4 m** from a charge of **6 μC**.

Given:

$q = 6\ \mu C = 6 \times 10^{-6}\ C$

$r = 0.4\ m$

Formula:

$E = kq / r^2$

Substitute:

$E = (9 \times 10^9 \times 6 \times 10^{-6}) / (0.4)^2$

$E = (54 \times 10^3) / 0.16$

$E = 3.375 \times 10^5\ N/C$

Answer: 3.375×10^5 N/C

Problem 3

Find the **electric field intensity** at a point **0.25 m** from a charge of **8 µC**.

Given:

$q = 8\ \mu C = 8 \times 10^{-6}\ C$

$r = 0.25\ m$

Formula:

$E = kq / r^2$

Substitute:

$E = (9 \times 10^9 \times 8 \times 10^{-6}) / (0.25)^2$

$E = (72 \times 10^3) / 0.0625$

$E = 1.152 \times 10^6\ N/C$

Answer: 1.152×10^6 N/C

Problem 4

Find the **electric field intensity** at a point **0.5 m** from a charge of **3 µC**.

Given:

$q = 3\ \mu C = 3 \times 10^{-6}\ C$

$r = 0.5\ m$

Formula:

$E = kq / r^2$

Substitute:

$E = (9 \times 10^9 \times 3 \times 10^{-6}) / (0.5)^2$

$E = (27 \times 10^3) / 0.25$

$E = 1.08 \times 10^5$ N/C

Answer: 1.08×10^5 N/C

Problem 5

Find the **electric field intensity** at a point **0.15 m** from a charge of **7 µC**.

Given:

$q = 7\ \mu C = 7 \times 10^{-6}$ C

$r = 0.15$ m

Formula:

$E = kq / r^2$

Substitute:

$E = (9 \times 10^9 \times 7 \times 10^{-6}) / (0.15)^2$

$E = (63 \times 10^3) / 0.0225$

$E = 2.8 \times 10^6$ N/C

Answer: 2.8×10^6 N/C

QUESTION 4

4. Electric Potential: Find the electric potential at a point 0.5 m from a charge of 4 µC.

Given:

$q = 4\ \mu C = 4 \times 10^{-6}$ C

$r = 0.5$ m

Formula:

$V = kq / r$

$V = (9 \times 10^9 \times 4 \times 10^{-6}) / 0.5$

$V = 36 \times 10^3 / 0.5$

$V = 7.2 \times 10^4$ V

Answer: 7.2×10^4 V

PRACTICE PROBLEM

Problem 1

Find the **electric potential** at a point **0.4 m** from a charge of **5 µC**.

Given:

$q = 5\ \mu C = 5 \times 10^{-6}$ C

$r = 0.4$ m

Formula:

$V = kq / r$

Substitute:

$V = (9 \times 10^9 \times 5 \times 10^{-6}) / 0.4$

$V = 45 \times 10^3 / 0.4$

$V = 1.125 \times 10^5$ V

Answer: 1.125×10^5 V

Problem 2

Find the **electric potential** at a point **0.3 m** from a charge of **6 µC**.

Given:

$q = 6\ \mu C = 6 \times 10^{-6}$ C

$r = 0.3$ m

Formula:

$V = kq / r$

Substitute:

$V = (9 \times 10^9 \times 6 \times 10^{-6}) / 0.3$

$V = 54 \times 10^3 / 0.3$

$V = 1.8 \times 10^5$ V

Answer: 1.8×10^5 V

Problem 3

Find the **electric potential** at a point **0.6 m** from a charge of **3 µC**.

Given:

$q = 3\ \mu C = 3 \times 10^{-6}\ C$

$r = 0.6\ m$

Formula:

$V = kq / r$

Substitute:

$V = (9 \times 10^{9} \times 3 \times 10^{-6}) / 0.6$

$V = 27 \times 10^{3} / 0.6$

$V = 4.5 \times 10^{4}\ V$

Answer: 4.5×10^{4} V

Problem 4

Find the **electric potential** at a point **0.2 m** from a charge of **7 μC**.

Given:

$q = 7\ \mu C = 7 \times 10^{-6}\ C$

$r = 0.2\ m$

Formula:

$V = kq / r$

Substitute:

$V = (9 \times 10^{9} \times 7 \times 10^{-6}) / 0.2$

$V = 63 \times 10^{3} / 0.2$

$V = 3.15 \times 10^{5}\ V$

Answer: 3.15×10^{5} V

Problem 5

Find the **electric potential** at a point **0.8 m** from a charge of **2 μC**.

Given:

$q = 2\ \mu C = 2 \times 10^{-6}\ C$

$r = 0.8\ m$

Formula:

$V = kq / r$

Substitute:

$V = (9 \times 10^9 \times 2 \times 10^{-6}) / 0.8$

$V = 18 \times 10^3 / 0.8$

$V = 2.25 \times 10^4$ V

Answer: 2.25×10^4 V

QUESTION 5

5. Relation between E and V: If potential changes by 100 V over a distance of 0.02 m, find electric field.

Given:

$\Delta V = 100$ V

$d = 0.02$ m

Formula:

$E = \Delta V / d$

$E = 100 / 0.02$

$E = 5000$ V/m

Answer: 5000 V/m

PRACTICE PROBLEM

Problem 1

If the potential changes by **200 V** over a distance of **0.04 m**, find the **electric field**.

Given:

$\Delta V = 200$ V

$d = 0.04$ m

Formula:

$E = \Delta V / d$

Substitute:

$E = 200 / 0.04$

$E = 5000$ V/m

Answer: 5000 V/m

Problem 2

If the potential changes by **150 V** over a distance of **0.03 m**, find the **electric field**.

Given:

$\Delta V = 150$ V

$d = 0.03$ m

Formula:

$E = \Delta V / d$

Substitute:

$E = 150 / 0.03$

$E = 5000$ V/m

Answer: 5000 V/m

Problem 3

If the potential changes by **120 V** over a distance of **0.04 m**, find the **electric field**.

Given:

$\Delta V = 120$ V

$d = 0.04$ m

Formula:

$E = \Delta V / d$

Substitute:

$E = 120 / 0.04$

$E = 3000$ V/m

Answer: 3000 V/m

Problem 4

If the potential changes by **300 V** over a distance of **0.05 m**, find the **electric field**.

Given:

$\Delta V = 300$ V

$d = 0.05$ m

Formula:

$E = \Delta V / d$

Substitute:

$E = 300 / 0.05$

$E = 6000$ V/m

Answer: 6000 V/m

Problem 5

If the potential changes by **80 V** over a distance of **0.02 m**, find the **electric field**.

Given:

$\Delta V = 80$ V

$d = 0.02$ m

Formula:

$E = \Delta V / d$

Substitute:

$E = 80 / 0.02$

$E = 4000$ V/m

Answer: 4000 V/m

QUESTION 6

6. Electric Dipole Moment: Two charges ±2 μC are separated by 0.1 m. Find dipole moment.

Given:

$q = 2\ \mu C = 2 \times 10^{-6}$ C

Separation $d = 0.1$ m

Formula:

$p = qd$

$p = 2 \times 10^{-6} \times 0.1$

$p = 2 \times 10^{-7}$ C·m

Answer: 2×10^{-7} C·m

PRACTICE PROBLEM

Problem 1

Two charges **±3 μC** are separated by **0.2 m**. Find the **electric dipole moment**.

Given:

$q = 3\ \mu C = 3 \times 10^{-6}\ C$

Separation $d = 0.2\ m$

Formula:

$p = qd$

Substitute:

$p = 3 \times 10^{-6} \times 0.2$

$p = 6 \times 10^{-7}\ C \cdot m$

Answer: $6 \times 10^{-7}\ C \cdot m$

Problem 2

Two charges **±5 μC** are separated by **0.1 m**. Find the **electric dipole moment**.

Given:

$q = 5\ \mu C = 5 \times 10^{-6}\ C$

Separation $d = 0.1\ m$

Formula:

$p = qd$

Substitute:

$p = 5 \times 10^{-6} \times 0.1$

$p = 5 \times 10^{-7}\ C \cdot m$

Answer: $5 \times 10^{-7}\ C \cdot m$

Problem 3

Two charges **±4 μC** are separated by **0.15 m**. Find the **electric dipole moment**.

Given:

$q = 4\ \mu C = 4 \times 10^{-6}\ C$

Separation $d = 0.15\ m$

Formula:

$p = qd$

Substitute:

$p = 4 \times 10^{-6} \times 0.15$

$p = 6 \times 10^{-7}$ C·m

Answer: 6×10^{-7} C·m

Problem 4

Two charges **±6 μC** are separated by **0.08 m**. Find the **electric dipole moment**.

Given:

$q = 6\ \mu C = 6 \times 10^{-6}$ C

Separation d = 0.08 m

Formula:

$p = qd$

Substitute:

$p = 6 \times 10^{-6} \times 0.08$

$p = 4.8 \times 10^{-7}$ C·m

Answer: 4.8×10^{-7} C·m

Problem 5

Two charges **±7 μC** are separated by **0.12 m**. Find the **electric dipole moment**.

Given:

$q = 7\ \mu C = 7 \times 10^{-6}$ C

Separation d = 0.12 m

Formula:

$p = qd$

Substitute:

$p = 7 \times 10^{-6} \times 0.12$

$p = 8.4 \times 10^{-7}$ C·m

Answer: 8.4×10^{-7} C·m

QUESTION 7

7. Potential due to Dipole: A dipole of moment 3 ×10^-8 C·m produces potential at distance 0.2 m along axis. Find V.

Given:

$p = 3 \times 10^{-8}$ C·m

$r = 0.2$ m

Formula (axial):

$V = (1 / 4\pi\varepsilon_0)\,(p / r^2)$

$= k\,p / r^2$

$V = (9 \times 10^9 \times 3 \times 10^{-8}) / (0.2)^2$

$V = (27 \times 10^1) / 0.04$

$V \approx 6.75 \times 10^3$ V

Answer: 6.75×10^3 V

PRACTICE PROBLEM

Problem 1

A dipole of moment **4×10^{-8} C·m** produces potential at a distance **0.3 m** along the axis. Find **V**.

Given:

$p = 4 \times 10^{-8}$ C·m

$r = 0.3$ m

Formula (axial):

$V = (1 / 4\pi\varepsilon_0)\,(p / r^2)$

$= k\,p / r^2$

Substitute:

$V = (9 \times 10^9 \times 4 \times 10^{-8}) / (0.3)^2$

$V = (36 \times 10^1) / 0.09$

$V = 4000$ V

Answer: 4×10^3 V

Problem 2

A dipole of moment **5×10^{-8} C·m** produces potential at a distance **0.25 m** along the axis. Find **V**.

Given:

$p = 5 \times 10^{-8}$ C·m

r = 0.25 m

Formula (axial):

$V = k\,p / r^2$

Substitute:

$V = (9 \times 10^9 \times 5 \times 10^{-8}) / (0.25)^2$

$V = (45 \times 10^1) / 0.0625$

V = 7200 V

Answer: 7.2×10^3 V

Problem 3

A dipole of moment **2×10^{-8} C·m** produces potential at a distance **0.1 m** along the axis. Find **V**.

Given:

$p = 2 \times 10^{-8}$ C·m

r = 0.1 m

Formula (axial):

$V = k\,p / r^2$

Substitute:

$V = (9 \times 10^9 \times 2 \times 10^{-8}) / (0.1)^2$

$V = (18 \times 10^1) / 0.01$

V = 18000 V

Answer: 1.8×10^4 V

Problem 4

A dipole of moment **6×10^{-8} C·m** produces potential at a distance **0.4 m** along the axis. Find **V**.

Given:

$p = 6 \times 10^{-8}$ C·m

r = 0.4 m

Formula (axial):

$V = k\,p / r^2$

Substitute:

$V = (9 \times 10^9 \times 6 \times 10^{-8}) / (0.4)^2$

$V = (54 \times 10^1) / 0.16$

V = 3375 V

Answer: 3.375×10^3 V

Problem 5

A dipole of moment **7×10^{-8} C·m** produces potential at a distance **0.35 m** along the axis. Find **V**.

Given:

$p = 7 \times 10^{-8}$ C·m

r = 0.35 m

Formula (axial):

$V = k\,p / r^2$

Substitute:

$V = (9 \times 10^9 \times 7 \times 10^{-8}) / (0.35)^2$

$V = (63 \times 10^1) / 0.1225$

$V \approx 5143$ V

Answer: 5.14×10^3 V

QUESTION 8

8. Capacitance: A capacitor stores 5 μC charge at 10 V. Find capacitance.

Given:

$Q = 5\ \mu C = 5 \times 10^{-6}$ C

V = 10 V

Formula:

$C = Q / V$

$C = (5 \times 10^{-6}) / 10$

$C = 0.5 \times 10^{-6}$ F

$C = 0.5$ μF

Answer: 0.5 μF

PRACTICE PROBLEM

Problem 1

A capacitor stores **8 μC** charge at **16 V**. Find the **capacitance**.

Given:

$Q = 8$ μC $= 8 \times 10^{-6}$ C

$V = 16$ V

Formula:

$C = Q / V$

Substitute:

$C = (8 \times 10^{-6}) / 16$

$C = 0.5 \times 10^{-6}$ F

$C = 0.5$ μF

Answer: 0.5 μF

Problem 2

A capacitor stores **6 μC** charge at **12 V**. Find the **capacitance**.

Given:

$Q = 6$ μC $= 6 \times 10^{-6}$ C

$V = 12$ V

Formula:

$C = Q / V$

Substitute:

$C = (6 \times 10^{-6}) / 12$

$C = 0.5 \times 10^{-6}$ F

$C = 0.5$ μF

Answer: 0.5 μF

Problem 3

A capacitor stores **10 μC** charge at **20 V**. Find the **capacitance**.

Given:

$Q = 10$ μC $= 10 \times 10^{-6}$ C

$V = 20$ V

Formula:

$C = Q / V$

Substitute:

$C = (10 \times 10^{-6}) / 20$

$C = 0.5 \times 10^{-6}$ F

$C = 0.5$ μF

Answer: 0.5 μF

Problem 4

A capacitor stores **4 μC** charge at **8 V**. Find the **capacitance**.

Given:

$Q = 4$ μC $= 4 \times 10^{-6}$ C

$V = 8$ V

Formula:

$C = Q / V$

Substitute:

$C = (4 \times 10^{-6}) / 8$

$C = 0.5 \times 10^{-6}$ F

$C = 0.5$ μF

Answer: 0.5 μF

Problem 5

A capacitor stores **7 μC** charge at **14 V**. Find the **capacitance**.

Given:

$Q = 7\ \mu C = 7 \times 10^{-6}\ C$

$V = 14\ V$

Formula:

$C = Q / V$

Substitute:

$C = (7 \times 10^{-6}) / 14$

$C = 0.5 \times 10^{-6}\ F$

$C = 0.5\ \mu F$

Answer: 0.5 μF

QUESTION 9

9. Parallel Plate Capacitor: Plates area 0.01 m² separated by 1 mm. Find capacitance in air.

Given:

$\varepsilon_0 = 8.85 \times 10^{-12}$

$A = 0.01\ m^2$

$d = 1\ mm = 10^{-3}\ m$

Formula:

$C = \varepsilon_0 A/d$

$C = (8.85 \times 10^{-12} \times 0.01) / 10^{-3}$

$C = 8.85 \times 10^{-11}\ F$

Answer: 8.85×10^{-11} F

PRACTICE PROBLEM

Problem 1

A parallel plate capacitor has plate area **0.02 m²** separated by **2 mm**. Find the **capacitance in air**.

Given:

$\varepsilon_0 = 8.85 \times 10^{-12}$

$A = 0.02\ m^2$

$d = 2\ mm = 2 \times 10^{-3}\ m$

Formula:

$C = \varepsilon_0 A / d$

Substitute:

$C = (8.85 \times 10^{-12} \times 0.02) / (2 \times 10^{-3})$

$C = (1.77 \times 10^{-13}) / (2 \times 10^{-3})$

$C = 8.85 \times 10^{-11}\ F$

Answer: 8.85×10^{-11} F

Problem 2

A parallel plate capacitor has plate area **0.015 m²** separated by **1.5 mm**. Find the **capacitance in air**.

Given:

$\varepsilon_0 = 8.85 \times 10^{-12}$

$A = 0.015\ m^2$

$d = 1.5\ mm = 1.5 \times 10^{-3}\ m$

Formula:

$C = \varepsilon_0 A / d$

Substitute:

$C = (8.85 \times 10^{-12} \times 0.015) / (1.5 \times 10^{-3})$

$C = (1.3275 \times 10^{-13}) / (1.5 \times 10^{-3})$

$C = 8.85 \times 10^{-11}\ F$

Answer: 8.85×10^{-11} F

Problem 3

A parallel plate capacitor has plate area **0.03 m²** separated by **3 mm**. Find the **capacitance in air**.

Given:

$\varepsilon_0 = 8.85 \times 10^{-12}$

$A = 0.03\ m^2$

$d = 3\ mm = 3 \times 10^{-3}\ m$

Formula:

$C = \varepsilon_0 A / d$

Substitute:

$C = (8.85 \times 10^{-12} \times 0.03) / (3 \times 10^{-3})$

$C = (2.655 \times 10^{-13}) / (3 \times 10^{-3})$

$C = 8.85 \times 10^{-11}\ F$

Answer: 8.85×10^{-11} F

Problem 4

A parallel plate capacitor has plate area **0.025 m²** separated by **2.5 mm**. Find the **capacitance in air**.

Given:

$\varepsilon_0 = 8.85 \times 10^{-12}$

$A = 0.025\ m^2$

$d = 2.5\ mm = 2.5 \times 10^{-3}\ m$

Formula:

$C = \varepsilon_0 A / d$

Substitute:

$C = (8.85 \times 10^{-12} \times 0.025) / (2.5 \times 10^{-3})$

$C = (2.2125 \times 10^{-13}) / (2.5 \times 10^{-3})$

$C = 8.85 \times 10^{-11}\ F$

Answer: 8.85×10^{-11} F

Problem 5

A parallel plate capacitor has plate area **0.04 m²** separated by **4 mm**. Find the **capacitance in air**.

Given:

$\varepsilon_0 = 8.85 \times 10^{-12}$

$A = 0.04\ m^2$

$d = 4\ mm = 4 \times 10^{-3}\ m$

Formula:

$C = \varepsilon_0 A / d$

Substitute:

$C = (8.85 \times 10^{-12} \times 0.04) / (4 \times 10^{-3})$

$C = (3.54 \times 10^{-13}) / (4 \times 10^{-3})$

$C = 8.85 \times 10^{-11}$ F

Answer: 8.85×10^{-11} F

QUESTION 10

10. Spherical Capacitor: Radii 0.1 m and 0.2 m. Find capacitance.

Given:

a = 0.1 m

b = 0.2 m

Formula:

$C = 4\pi\varepsilon_0 ab/(b-a)$

Substitute values:

$C \approx 2.22 \times 10^{-11}$ F

Answer: 2.22×10^{-11} F

PRACTICE PROBLEM

Problem 1

A spherical capacitor has inner radius **0.05 m** and outer radius **0.15 m**. Find the **capacitance**.

Given:

a = 0.05 m

b = 0.15 m

$\varepsilon_0 = 8.85 \times 10^{-12}$

Formula:

$C = 4\pi\varepsilon_0 ab / (b - a)$

Substitute:

$C = 4\pi \times 8.85 \times 10^{-12} \times (0.05 \times 0.15) / (0.15 - 0.05)$

$ab = 0.0075$

$b - a = 0.1$

$C \approx (1.112 \times 10^{-10} \times 0.0075) / 0.1$

$C \approx 8.34 \times 10^{-12}$ F

Answer: 8.34×10^{-12} F

Problem 2

A spherical capacitor has inner radius **0.08 m** and outer radius **0.25 m**. Find the **capacitance**.

Given:

$a = 0.08$ m

$b = 0.25$ m

$\varepsilon_0 = 8.85 \times 10^{-12}$

Formula:

$C = 4\pi\varepsilon_0 ab / (b - a)$

Substitute:

$ab = 0.02$

$b - a = 0.17$

$C = (1.112 \times 10^{-10} \times 0.02) / 0.17$

$C \approx 1.31 \times 10^{-11}$ F

Answer: 1.31×10^{-11} F

Problem 3

A spherical capacitor has inner radius **0.12 m** and outer radius **0.3 m**. Find the **capacitance**.

Given:

$a = 0.12$ m

$b = 0.3$ m

$\varepsilon_0 = 8.85 \times 10^{-12}$

Formula:

$C = 4\pi\varepsilon_0 ab / (b - a)$

Substitute:

$ab = 0.036$

$b - a = 0.18$

$C = (1.112 \times 10^{-10} \times 0.036) / 0.18$

$C \approx 2.22 \times 10^{-11}$ F

Answer: 2.22×10^{-11} F

Problem 4

A spherical capacitor has inner radius **0.06 m** and outer radius **0.18 m**. Find the **capacitance**.

Given:

$a = 0.06$ m

$b = 0.18$ m

$\varepsilon_0 = 8.85 \times 10^{-12}$

Formula:

$C = 4\pi\varepsilon_0 ab / (b - a)$

Substitute:

$ab = 0.0108$

$b - a = 0.12$

$C = (1.112 \times 10^{-10} \times 0.0108) / 0.12$

$C \approx 1.00 \times 10^{-11}$ F

Answer: 1.00×10^{-11} F

Problem 5

A spherical capacitor has inner radius **0.15 m** and outer radius **0.35 m**. Find the **capacitance**.

Given:

$a = 0.15$ m

$b = 0.35$ m

$\varepsilon_0 = 8.85 \times 10^{-12}$

Formula:

$C = 4\pi\varepsilon_0 ab / (b - a)$

Substitute:

$ab = 0.0525$

$b - a = 0.20$

$C = (1.112 \times 10^{-10} \times 0.0525) / 0.20$

$C \approx 2.92 \times 10^{-11}$ F

Answer: 2.92×10^{-11} F

QUESTION 11

11. Cylindrical Capacitor: Inner radius 1 cm, outer radius 2 cm, length 0.5 m. Find capacitance.

Given:

a = 1 cm = 0.01 m

b = 2 cm = 0.02 m

L = 0.5 m

Formula:

$C = 2\pi\varepsilon_0 L / \ln(b/a)$

Substitute values:

$C \approx 4.0 \times 10^{-11}$ F

Answer: 4.0×10^{-11} F

PRACTICE PROBLEM

Problem 1

A cylindrical capacitor has inner radius **2 cm**, outer radius **4 cm**, and length **0.4 m**. Find the **capacitance**.

Given:

a = 2 cm = 0.02 m

b = 4 cm = 0.04 m

L = 0.4 m

$\varepsilon_0 = 8.85 \times 10^{-12}$

Formula:

$C = 2\pi\varepsilon_0 L / \ln(b/a)$

Substitute:

$C = (2\pi \times 8.85 \times 10^{-12} \times 0.4) / \ln(0.04 / 0.02)$

$\ln(2) = 0.693$

$C = (2\pi \times 8.85 \times 10^{-12} \times 0.4) / 0.693$

$C \approx 3.2 \times 10^{-11}$ F

Answer: 3.2×10^{-11} F

Problem 2

A cylindrical capacitor has inner radius **1.5 cm**, outer radius **3 cm**, and length **0.6 m**. Find the **capacitance**.

Given:

$a = 1.5$ cm $= 0.015$ m

$b = 3$ cm $= 0.03$ m

$L = 0.6$ m

$\varepsilon_0 = 8.85 \times 10^{-12}$

Formula:

$C = 2\pi\varepsilon_0 L / \ln(b/a)$

Substitute:

$C = (2\pi \times 8.85 \times 10^{-12} \times 0.6) / \ln(0.03 / 0.015)$

$\ln(2) = 0.693$

$C = (2\pi \times 8.85 \times 10^{-12} \times 0.6) / 0.693$

$C \approx 4.8 \times 10^{-11}$ F

Answer: 4.8×10^{-11} F

Problem 3

A cylindrical capacitor has inner radius **1 cm**, outer radius **3 cm**, and length **0.5 m**. Find the **capacitance**.

Given:

$a = 1$ cm $= 0.01$ m

$b = 3$ cm $= 0.03$ m

$L = 0.5$ m

$\varepsilon_0 = 8.85 \times 10^{-12}$

Formula:

$C = 2\pi\varepsilon_0 L / \ln(b/a)$

Substitute:

$C = (2\pi \times 8.85 \times 10^{-12} \times 0.5) / \ln(3)$

$\ln(3) = 1.099$

$C = (2\pi \times 8.85 \times 10^{-12} \times 0.5) / 1.099$

$C \approx 2.53 \times 10^{-11}$ F

Answer: 2.53×10^{-11} F

Problem 4

A cylindrical capacitor has inner radius **2 cm**, outer radius **5 cm**, and length **0.3 m**. Find the **capacitance**.

Given:

$a = 2$ cm $= 0.02$ m

$b = 5$ cm $= 0.05$ m

$L = 0.3$ m

$\varepsilon_0 = 8.85 \times 10^{-12}$

Formula:

$C = 2\pi\varepsilon_0 L / \ln(b/a)$

Substitute:

$C = (2\pi \times 8.85 \times 10^{-12} \times 0.3) / \ln(2.5)$

$\ln(2.5) = 0.916$

$C = (2\pi \times 8.85 \times 10^{-12} \times 0.3) / 0.916$

$C \approx 1.82 \times 10^{-11}$ F

Answer: 1.82×10^{-11} F

Problem 5

A cylindrical capacitor has inner radius **0.5 cm**, outer radius **2 cm**, and length **0.4 m**. Find the **capacitance**.

Given:

$a = 0.5$ cm $= 0.005$ m

$b = 2$ cm $= 0.02$ m

$L = 0.4$ m

$\varepsilon_0 = 8.85 \times 10^{-12}$

Formula:

$C = 2\pi\varepsilon_0 L / \ln(b/a)$

Substitute:

$C = (2\pi \times 8.85 \times 10^{-12} \times 0.4) / \ln(4)$

$\ln(4) = 1.386$

$C = (2\pi \times 8.85 \times 10^{-12} \times 0.4) / 1.386$

$C \approx 1.60 \times 10^{-11}$ F

Answer: 1.60×10^{-11} F

QUESTION 12

12. Energy Stored: A capacitor of 2 μF charged to 100 V. Find energy stored.

Given:

$C = 2\ \mu F = 2 \times 10^{-6}$ F

$V = 100$ V

Formula:

$U = \frac{1}{2} CV^2$

$U = 0.5 \times 2 \times 10^{-6} \times (100)^2$

$U = 0.01$ J

Answer: 0.01 J

PRACTICE PROBLEM

Problem 1

A capacitor of **3 μF** is charged to **120 V**. Find the energy stored.

Given:

$C = 3\ \mu F = 3 \times 10^{-6}$ F

$V = 120$ V

Formula:

$U = \frac{1}{2} CV^2$

Substitute:

$U = 0.5 \times 3 \times 10^{-6} \times (120)^2$

$U = 0.0216\ J$

Answer: 0.0216 J

Problem 2

A capacitor of **5 µF** is charged to **80 V**. Find the energy stored.

Given:

$C = 5\ \mu F = 5 \times 10^{-6}\ F$

$V = 80\ V$

Formula:

$U = ½\ CV^2$

Substitute:

$U = 0.5 \times 5 \times 10^{-6} \times (80)^2$

$U = 0.016\ J$

Answer: 0.016 J

Problem 3

A capacitor of **4 µF** is charged to **150 V**. Find the energy stored.

Given:

$C = 4\ \mu F = 4 \times 10^{-6}\ F$

$V = 150\ V$

Formula:

$U = ½\ CV^2$

Substitute:

$U = 0.5 \times 4 \times 10^{-6} \times (150)^2$

$U = 0.045\ J$

Answer: 0.045 J

Problem 4

A capacitor of **6 µF** is charged to **90 V**. Find the energy stored.

Given:

$C = 6\ \mu F = 6 \times 10^{-6}\ F$

$V = 90\ V$

Formula:

$U = \frac{1}{2} CV^2$

Substitute:

$U = 0.5 \times 6 \times 10^{-6} \times (90)^2$

$U = 0.0243\ J$

Answer: 0.0243 J

Problem 5

A capacitor of **8 μF** is charged to **60 V**. Find the energy stored.

Given:

$C = 8\ \mu F = 8 \times 10^{-6}\ F$

$V = 60\ V$

Formula:

$U = \frac{1}{2} CV^2$

Substitute:

$U = 0.5 \times 8 \times 10^{-6} \times (60)^2$

$U = 0.0144\ J$

Answer: 0.0144 J

QUESTION 13

13. Ohm's Law: A potential difference of 12 V produces current 3 A. Find resistance.

Given:

$V = 12\ V$

$I = 3\ A$

Formula:

$R = V/I$

$R = 12/3$

R = 4 Ω

Answer: 4 Ω

PRACTICE PROBLEM

Problem 1

A potential difference of **24 V** produces current **6 A**. Find the resistance.

Given:

V = 24 V

I = 6 A

Formula:

R = V/I

Substitute:

R = 24 / 6

R = 4 Ω

Answer: 4 Ω

Problem 2

A potential difference of **30 V** produces current **5 A**. Find the resistance.

Given:

V = 30 V

I = 5 A

Formula:

R = V/I

Substitute:

R = 30 / 5

R = 6 Ω

Answer: 6 Ω

Problem 3

A potential difference of **18 V** produces current **3 A**. Find the resistance.

Given:

V = 18 V

I = 3 A

Formula:

R = V/I

Substitute:

R = 18 / 3

R = 6 Ω

Answer: 6 Ω

Problem 4

A potential difference of **20 V** produces current **4 A**. Find the resistance.

Given:

V = 20 V

I = 4 A

Formula:

R = V/I

Substitute:

R = 20 / 4

R = 5 Ω

Answer: 5 Ω

Problem 5

A potential difference of **36 V** produces current **9 A**. Find the resistance.

Given:

V = 36 V

I = 9 A

Formula:

R = V/I

Substitute:

R = 36 / 9

$R = 4\ \Omega$

Answer: $4\ \Omega$

QUESTION 14

14. Resistivity: Wire length 2 m, area 1×10^-6 m², resistance 3 Ω. Find resistivity.

Given:

$R = 3\ \Omega$

$L = 2\ m$

$A = 1 \times 10^{-6}\ m^2$

Formula:

$\rho = RA/L$

$\rho = (3 \times 1 \times 10^{-6})/2$

$\rho = 1.5 \times 10^{-6}\ \Omega \cdot m$

Answer: $1.5 \times 10^{-6}\ \Omega \cdot m$

PRACTICE PROBLEM

Problem 1

A wire of resistance **4.5 Ω**, length **1.8 m**, and cross-sectional area **2×10^{-6} m²**. Find the resistivity.

Given:

$R = 4.5\ \Omega$

$L = 1.8\ m$

$A = 2 \times 10^{-6}\ m^2$

Formula:

$\rho = RA/L$

Substitute:

$\rho = (4.5 \times 2 \times 10^{-6}) / 1.8$

$\rho = 5 \times 10^{-6}\ \Omega \cdot m$

Answer: $5 \times 10^{-6}\ \Omega \cdot m$

Problem 2

A wire has resistance **6 Ω**, length **3 m**, and cross-sectional area **1.5×10^{-6} m²**. Find the resistivity.

Given:

R = 6 Ω

L = 3 m

A = 1.5×10^{-6} m²

Formula:

ρ = RA/L

Substitute:

ρ = $(6 \times 1.5 \times 10^{-6}) / 3$

ρ = 3×10^{-6} Ω·m

Answer: 3×10^{-6} Ω·m

Problem 3

A conductor of length **2.5 m**, resistance **8 Ω**, and cross-sectional area **1.2×10^{-6} m²**. Find the resistivity.

Given:

R = 8 Ω

L = 2.5 m

A = 1.2×10^{-6} m²

Formula:

ρ = RA/L

Substitute:

ρ = $(8 \times 1.2 \times 10^{-6}) / 2.5$

ρ = 3.84×10^{-6} Ω·m

Answer: 3.84×10^{-6} Ω·m

Problem 4

A metal wire has resistance **10 Ω**, length **4 m**, and cross-sectional area **2×10^{-6} m²**. Find the resistivity.

Given:

$R = 10\ \Omega$

$L = 4\ m$

$A = 2 \times 10^{-6}\ m^2$

Formula:

$\rho = RA/L$

Substitute:

$\rho = (10 \times 2 \times 10^{-6}) / 4$

$\rho = 5 \times 10^{-6}\ \Omega \cdot m$

Answer: $5 \times 10^{-6}\ \Omega \cdot m$

Problem 5

A wire of resistance **7.5 Ω**, length **2.5 m**, and cross-sectional area **2×10^{-6} m²**. Find the resistivity.

Given:

$R = 7.5\ \Omega$

$L = 2.5\ m$

$A = 2 \times 10^{-6}\ m^2$

Formula:

$\rho = RA/L$

Substitute:

$\rho = (7.5 \times 2 \times 10^{-6}) / 2.5$

$\rho = 6 \times 10^{-6}\ \Omega \cdot m$

Answer: $6 \times 10^{-6}\ \Omega \cdot m$

QUESTION 15

15. Conductivity: If resistivity is 2×10^-6 Ω·m, find conductivity.

Given:

$\rho = 2 \times 10^{-6}\ \Omega \cdot m$

Formula:

$\sigma = 1/\rho$

$\sigma = 1/(2 \times 10^{-6})$

$\sigma = 5 \times 10^{5}$ S/m

Answer: 5×10^{5} S/m

PRACTICE PROBLEM

Problem 1

If resistivity is **4×10^{-6} Ω·m**, find the conductivity.

Given:

$\rho = 4 \times 10^{-6}$ Ω·m

Formula:

$\sigma = 1/\rho$

Substitute:

$\sigma = 1 / (4 \times 10^{-6})$

$\sigma = 2.5 \times 10^{5}$ S/m

Answer: 2.5×10^{5} S/m

Problem 2

If resistivity is **5×10^{-7} Ω·m**, find the conductivity.

Given:

$\rho = 5 \times 10^{-7}$ Ω·m

Formula:

$\sigma = 1/\rho$

Substitute:

$\sigma = 1 / (5 \times 10^{-7})$

$\sigma = 2 \times 10^{6}$ S/m

Answer: 2×10^{6} S/m

Problem 3

If resistivity is **1.25×10^{-6} Ω·m**, find the conductivity.

Given:

$\rho = 1.25 \times 10^{-6}$ Ω·m

Formula:

$\sigma = 1/\rho$

Substitute:

$\sigma = 1 / (1.25 \times 10^{-6})$

$\sigma = 8 \times 10^{5}$ S/m

Answer: 8×10^{5} S/m

Problem 4

If resistivity is **3.2×10^{-6} Ω·m**, find the conductivity.

Given:

$\rho = 3.2 \times 10^{-6}$ Ω·m

Formula:

$\sigma = 1/\rho$

Substitute:

$\sigma = 1 / (3.2 \times 10^{-6})$

$\sigma = 3.125 \times 10^{5}$ S/m

Answer: 3.125×10^{5} S/m

Problem 5

If resistivity is **8×10^{-7} Ω·m**, find the conductivity.

Given:

$\rho = 8 \times 10^{-7}$ Ω·m

Formula:

$\sigma = 1/\rho$

Substitute:

$\sigma = 1 / (8 \times 10^{-7})$

$\sigma = 1.25 \times 10^{6}$ S/m

Answer: 1.25×10^{6} S/m

QUESTION 16

16. Kirchhoff Junction: Currents 2 A and 3 A enter a junction. One current leaving is 4 A. Find the other.

Sum of currents entering = sum leaving

Entering currents = 2 A + 3 A = 5 A

Leaving currents = 4 A + I

5 = 4 + I

I = 1 A

Answer: 1 A

PRACTICE PROBLEM

Problem 1

Currents **4 A** and **5 A** enter a junction. One current leaving is **6 A**. Find the other current.

Given:

$I_1 = 4$ A

$I_2 = 5$ A

$I_3 = 6$ A

Formula:

$I_1 + I_2 = I_3 + I$

Substitute:

4 + 5 = 6 + I

9 = 6 + I

I = 3 A

Answer: 3 A

Problem 2

Currents **7 A** and **3 A** enter a junction. One current leaving is **5 A**. Find the other current.

Given:

$I_1 = 7$ A

$I_2 = 3$ A

$I_3 = 5$ A

Formula:

$I_1 + I_2 = I_3 + I$

Substitute:

$7 + 3 = 5 + I$

$10 = 5 + I$

$I = 5\ A$

Answer: 5 A

Problem 3

Currents **6 A** and **8 A** enter a junction. One current leaving is **9 A**. Find the other current.

Given:

$I_1 = 6\ A$

$I_2 = 8\ A$

$I_3 = 9\ A$

Formula:

$I_1 + I_2 = I_3 + I$

Substitute:

$6 + 8 = 9 + I$

$14 = 9 + I$

$I = 5\ A$

Answer: 5 A

Problem 4

Currents **10 A** and **4 A** enter a junction. One current leaving is **8 A**. Find the other current.

Given:

$I_1 = 10\ A$

$I_2 = 4\ A$

$I_3 = 8\ A$

Formula:

$I_1 + I_2 = I_3 + I$

Substitute:

$10 + 4 = 8 + I$

$14 = 8 + I$

$I = 6\ A$

Answer: 6 A

Problem 5

Currents **5 A** and **9 A** enter a junction. One current leaving is **7 A**. Find the other current.

Given:

$I_1 = 5\ A$

$I_2 = 9\ A$

$I_3 = 7\ A$

Formula:

$I_1 + I_2 = I_3 + I$

Substitute:

$5 + 9 = 7 + I$

$14 = 7 + I$

$I = 7\ A$

Answer: 7 A

QUESTION 17

17. Kirchhoff Loop: In a loop battery 12 V and resistances 2 Ω and 4 Ω. Find current.

Total resistance:

$R = 2 + 4 = 6\ \Omega$

Using Ohm's law:

$I = V/R$

$I = 12/6$

$I = 2\ A$

Answer: 2 A

PRACTICE PROBLEM

Problem 1

A circuit has a **battery of 18 V** connected in series with resistors **3 Ω** and **6 Ω**. Find the current.

Given:

V = 18 V

R_1 = 3 Ω

R_2 = 6 Ω

Total resistance:

R = 3 + 6 = 9 Ω

Formula:

I = V/R

Substitute:

I = 18 / 9

I = 2 A

Answer: 2 A

Problem 2

A circuit contains a **battery of 24 V** and two resistors **4 Ω** and **8 Ω** connected in series. Find the current.

Given:

V = 24 V

R_1 = 4 Ω

R_2 = 8 Ω

Total resistance:

R = 4 + 8 = 12 Ω

Formula:

I = V/R

Substitute:

I = 24 / 12

I = 2 A

Answer: 2 A

Problem 3

A loop contains a **battery of 30 V** and resistors **5 Ω** and **10 Ω** in series. Find the current.

Given:

V = 30 V

R_1 = 5 Ω

R_2 = 10 Ω

Total resistance:

R = 5 + 10 = 15 Ω

Formula:

I = V/R

Substitute:

I = 30 / 15

I = 2 A

Answer: 2 A

Problem 4

A circuit has a **battery of 20 V** and resistors **2 Ω** and **3 Ω** connected in series. Find the current.

Given:

V = 20 V

R_1 = 2 Ω

R_2 = 3 Ω

Total resistance:

R = 2 + 3 = 5 Ω

Formula:

I = V/R

Substitute:

I = 20 / 5

I = 4 A

Answer: 4 A

Problem 5

A circuit contains a **battery of 36 V** and resistors **4 Ω** and **5 Ω** in series. Find the current.

Given:

V = 36 V

R_1 = 4 Ω

R_2 = 5 Ω

Total resistance:

R = 4 + 5 = 9 Ω

Formula:

I = V/R

Substitute:

I = 36 / 9

I = 4 A

Answer: 4 A

QUESTION 18

18. Internal Resistance: Cell emf 1.5 V gives current 0.3 A through 4 Ω resistor. Find internal resistance.

Given:

E = 1.5 V

I = 0.3 A

R = 4 Ω

Formula:

E = I(R + r)

1.5 = 0.3 (4 + r)

Divide:

5 = 4 + r

r = 1 Ω

Answer: 1 Ω

PRACTICE PROBLEM

Problem 1

A cell of emf **2 V** supplies current **0.25 A** through a resistor of **6 Ω**. Find the internal resistance.

Given:

E = 2 V

I = 0.25 A

R = 6 Ω

Formula:

E = I(R + r)

Substitute:

2 = 0.25 (6 + r)

Divide by 0.25:

8 = 6 + r

r = 2 Ω

Answer: 2 Ω

Problem 2

A cell of emf **3 V** gives current **0.5 A** through an external resistance **4 Ω**. Find the internal resistance.

Given:

E = 3 V

I = 0.5 A

R = 4 Ω

Formula:

E = I(R + r)

Substitute:

3 = 0.5 (4 + r)

Divide by 0.5:

6 = 4 + r

r = 2 Ω

Answer: 2 Ω

Problem 3

A battery of emf **6 V** sends current **0.4 A** through a resistor of **10 Ω**. Find the internal resistance.

Given:

E = 6 V

I = 0.4 A

R = 10 Ω

Formula:

E = I(R + r)

Substitute:

6 = 0.4 (10 + r)

Divide by 0.4:

15 = 10 + r

r = 5 Ω

Answer: 5 Ω

Problem 4

A cell of emf **4 V** produces current **0.2 A** through an external resistance **15 Ω**. Find the internal resistance.

Given:

E = 4 V

I = 0.2 A

R = 15 Ω

Formula:

E = I(R + r)

Substitute:

4 = 0.2 (15 + r)

Divide by 0.2:

20 = 15 + r

r = 5 Ω

Answer: 5 Ω

Problem 5

A cell of emf **5 V** sends current **0.25 A** through a resistor of **16 Ω**. Find the internal resistance.

Given:

E = 5 V

I = 0.25 A

R = 16 Ω

Formula:

E = I(R + r)

Substitute:

5 = 0.25 (16 + r)

Divide by 0.25:

20 = 16 + r

r = 4 Ω

Answer: 4 Ω

QUESTION 19

19. EMF Calculation: Current 0.5 A flows through total resistance 10 Ω. Find emf.

Given:

I = 0.5 A

R = 10 Ω

Formula:

E = IR

E = 0.5 × 10

E = 5 V

Answer: 5 V

PRACTICE PROBLEM

Problem 1

A current of **0.8 A** flows through a circuit having total resistance **15 Ω**. Find the emf.

Given:

I = 0.8 A

R = 15 Ω

Formula:

E = IR

Substitute:

E = 0.8 × 15

E = 12 V

Answer: 12 V

Problem 2

A current of **0.25 A** flows through a circuit having resistance **24 Ω**. Find the emf.

Given:

I = 0.25 A

R = 24 Ω

Formula:

E = IR

Substitute:

E = 0.25 × 24

E = 6 V

Answer: 6 V

Problem 3

A current of **1.2 A** flows through a circuit of total resistance **8 Ω**. Find the emf.

Given:

I = 1.2 A

R = 8 Ω

Formula:

$E = IR$

Substitute:

$E = 1.2 \times 8$

$E = 9.6\ V$

Answer: 9.6 V

Problem 4

A current of **0.6 A** flows through a circuit having resistance **18 Ω**. Find the emf.

Given:

$I = 0.6\ A$

$R = 18\ \Omega$

Formula:

$E = IR$

Substitute:

$E = 0.6 \times 18$

$E = 10.8\ V$

Answer: 10.8 V

Problem 5

A current of **0.4 A** flows through a circuit of resistance **30 Ω**. Find the emf.

Given:

$I = 0.4\ A$

$R = 30\ \Omega$

Formula:

$E = IR$

Substitute:

$E = 0.4 \times 30$

$E = 12\ V$

Answer: 12 V

QUESTION 20

20. Thermoelectric EMF: If Seebeck coefficient is 40 μV/K and temperature difference is 50 K, find emf.

Given:

Seebeck coefficient $S = 40\ \mu V/K$

$\Delta T = 50\ K$

Formula:

$E = S\ \Delta T$

$E = 40 \times 50\ \mu V$

$E = 2000\ \mu V$

$E = 2\ mV$

Answer: 2 mV

PRACTICE PROBLEM

Problem 1

If the Seebeck coefficient is **60 μV/K** and the temperature difference is **80 K**, find the thermoelectric emf.

Given:

$S = 60\ \mu V/K$

$\Delta T = 80\ K$

Formula:

$E = S\ \Delta T$

Substitute:

$E = 60 \times 80\ \mu V$

$E = 4800\ \mu V$

$E = 4.8\ mV$

Answer: 4.8 mV

Problem 2

If the Seebeck coefficient is **25 μV/K** and the temperature difference is **120 K**, find the thermoelectric emf.

Given:

$S = 25\ \mu V/K$

$\Delta T = 120\ K$

Formula:

$E = S\ \Delta T$

Substitute:

$E = 25 \times 120\ \mu V$

$E = 3000\ \mu V$

$E = 3\ mV$

Answer: 3 mV

Problem 3

If the Seebeck coefficient is **75 µV/K** and the temperature difference is **40 K**, find the thermoelectric emf.

Given:

$S = 75\ \mu V/K$

$\Delta T = 40\ K$

Formula:

$E = S\ \Delta T$

Substitute:

$E = 75 \times 40\ \mu V$

$E = 3000\ \mu V$

$E = 3\ mV$

Answer: 3 mV

Problem 4

If the Seebeck coefficient is **32 µV/K** and the temperature difference is **150 K**, find the thermoelectric emf.

Given:

$S = 32\ \mu V/K$

$\Delta T = 150\ K$

Formula:

$E = S\,\Delta T$

Substitute:

$E = 32 \times 150\ \mu V$

$E = 4800\ \mu V$

$E = 4.8\ mV$

Answer: 4.8 mV

Problem 5

If the Seebeck coefficient is **55 µV/K** and the temperature difference is **90 K**, find the thermoelectric emf.

Given:

$S = 55\ \mu V/K$

$\Delta T = 90\ K$

Formula:

$E = S\,\Delta T$

Substitute:

$E = 55 \times 90\ \mu V$

$E = 4950\ \mu V$

$E = 4.95\ mV$

Answer: 4.95 mV

QUESTION 21

21. Peltier Coefficient: If emf 0.002 V at temperature 300 K, find Peltier coefficient.

Relation:

$\Pi = S \times T$

Given:

$S = 0.002/50 = 4\times10^{-5}\ V/K$

$T = 300\ K$

$\Pi = 4\times10^{-5} \times 300$

$\Pi \approx 0.6$ V

Answer: 0.6 V

PRACTICE PROBLEM

Problem 1

A thermocouple produces emf **0.003 V** for temperature difference **60 K**. If the junction temperature is **320 K**, find the Peltier coefficient.

Given:

$S = 0.003 / 60 = 5 \times 10^{-5}$ V/K

$T = 320$ K

Formula:

$\Pi = S\,T$

Substitute:

$\Pi = 5 \times 10^{-5} \times 320$

$\Pi = 0.016$ V

Answer: 0.016 V

Problem 2

A thermocouple produces emf **0.004 V** for temperature difference **80 K**. If the junction temperature is **300 K**, find the Peltier coefficient.

Given:

$S = 0.004 / 80 = 5 \times 10^{-5}$ V/K

$T = 300$ K

Formula:

$\Pi = S\,T$

Substitute:

$\Pi = 5 \times 10^{-5} \times 300$

$\Pi = 0.015$ V

Answer: 0.015 V

Problem 3

A thermocouple produces emf **0.0025 V** for temperature difference **50 K**. If the junction temperature is **350 K**, find the Peltier coefficient.

Given:

$S = 0.0025 / 50 = 5 \times 10^{-5}$ V/K

$T = 350$ K

Formula:

$\Pi = S\,T$

Substitute:

$\Pi = 5 \times 10^{-5} \times 350$

$\Pi = 0.0175$ V

Answer: 0.0175 V

Problem 4

A thermocouple produces emf **0.0036 V** for temperature difference **90 K**. If the junction temperature is **310 K**, find the Peltier coefficient.

Given:

$S = 0.0036 / 90 = 4 \times 10^{-5}$ V/K

$T = 310$ K

Formula:

$\Pi = S\,T$

Substitute:

$\Pi = 4 \times 10^{-5} \times 310$

$\Pi = 0.0124$ V

Answer: 0.0124 V

Problem 5

A thermocouple produces emf **0.005 V** for temperature difference **100 K**. If the junction temperature is **300 K**, find the Peltier coefficient.

Given:

$S = 0.005 / 100 = 5 \times 10^{-5}$ V/K

$T = 300$ K

Formula:

$\Pi = S\,T$

Substitute:

$\Pi = 5 \times 10^{-5} \times 300$

$\Pi = 0.015\ V$

Answer: 0.015 V

QUESTION 22

22. Thomson Coefficient: If heat produced is 0.02 J for 2 A current and 5 K gradient, estimate coefficient.

Given approximate relation:

$\tau \approx \text{heat}/(I \times \Delta T)$

Given:

$Q = 0.02\ J$

$I = 2\ A$

$\Delta T = 5\ K$

Substitute values:

$\tau = 0.02 / (2 \times 5)$

$\tau = 0.02 / 10$

$\tau = 0.002\ V/K$

Answer: $\tau \approx 0.002$ V/K

PRACTICE PROBLEM

Problem 1

Heat produced is **0.03 J** when current **3 A** flows through a conductor with temperature gradient **6 K**. Estimate the Thomson coefficient.

Given:

$Q = 0.03\ J$

$I = 3\ A$

$\Delta T = 6\ K$

Formula:

$\tau \approx Q / (I \Delta T)$

Substitute:

$\tau = 0.03 / (3 \times 6)$

$\tau = 0.03 / 18$

$\tau \approx 0.00167$ V/K

Answer: 1.67×10^{-3} V/K

Problem 2

Heat produced is **0.05 J** for current **4 A** and temperature gradient **10 K**. Estimate the Thomson coefficient.

Given:

$Q = 0.05$ J

$I = 4$ A

$\Delta T = 10$ K

Formula:

$\tau \approx Q / (I \Delta T)$

Substitute:

$\tau = 0.05 / (4 \times 10)$

$\tau = 0.05 / 40$

$\tau = 0.00125$ V/K

Answer: 1.25×10^{-3} V/K

Problem 3

Heat produced is **0.012 J** when current **1.5 A** flows through a conductor with temperature gradient **4 K**. Estimate the Thomson coefficient.

Given:

$Q = 0.012$ J

$I = 1.5$ A

$\Delta T = 4$ K

Formula:

$\tau \approx Q / (I \Delta T)$

Substitute:

$\tau = 0.012 / (1.5 \times 4)$

$\tau = 0.012 / 6$

$\tau = 0.002$ V/K

Answer: 0.002 V/K

Problem 4

Heat produced is **0.08 J** for current **5 A** and temperature gradient **8 K**. Estimate the Thomson coefficient.

Given:

$Q = 0.08$ J

$I = 5$ A

$\Delta T = 8$ K

Formula:

$\tau \approx Q / (I \Delta T)$

Substitute:

$\tau = 0.08 / (5 \times 8)$

$\tau = 0.08 / 40$

$\tau = 0.002$ V/K

Answer: 0.002 V/K

Problem 5

Heat produced is **0.06 J** when current **4 A** flows through a conductor with temperature gradient **12 K**. Estimate the Thomson coefficient.

Given:

$Q = 0.06$ J

$I = 4$ A

$\Delta T = 12$ K

Formula:

$\tau \approx Q / (I \Delta T)$

Substitute:

$\tau = 0.06 / (4 \times 12)$

$\tau = 0.06 / 48$

$\tau \approx 0.00125$ V/K

Answer: 1.25×10^{-3} V/K

QUESTION 23

23. A long straight conductor carries a current of 5 A. Find the magnetic field at a point 4 cm from the wire.

Solution:

Formula: $B = (\mu_o I) / (2\pi r)$

$\mu_o = 4\pi \times 10^{-7}$ Tm/A

$I = 5$ A

$r = 4$ cm $= 0.04$ m

$B = (4\pi \times 10^{-7} \times 5) / (2\pi \times 0.04)$

$B = (20\pi \times 10^{-7}) / (0.08\pi)$

$B = 2.5 \times 10^{-5}$ Tesla

PRACTICE PROBLEM

Problem 1

A long straight conductor carries a current of **8 A**. Find the magnetic field at a distance **5 cm** from the wire.

Given:

$\mu_o = 4\pi \times 10^{-7}$ T m/A

$I = 8$ A

$r = 5$ cm $= 0.05$ m

Formula:

$B = (\mu_o I) / (2\pi r)$

Substitute:

$B = (4\pi \times 10^{-7} \times 8) / (2\pi \times 0.05)$

$B = (32\pi \times 10^{-7}) / (0.10\pi)$

$B = 3.2 \times 10^{-5}$ T

Answer: 3.2×10^{-5} T

Problem 2

A straight wire carries a current of **10 A**. Find the magnetic field at a distance **6 cm** from the wire.

Given:

$\mu_o = 4\pi \times 10^{-7}$ T m/A

I = 10 A

r = 6 cm = 0.06 m

Formula:

$B = (\mu_o I) / (2\pi r)$

Substitute:

$B = (4\pi \times 10^{-7} \times 10) / (2\pi \times 0.06)$

$B = (40\pi \times 10^{-7}) / (0.12\pi)$

$B \approx 3.33 \times 10^{-5}$ T

Answer: 3.33×10^{-5} T

Problem 3

A conductor carries a current of **12 A**. Find the magnetic field at a distance **3 cm** from the wire.

Given:

$\mu_o = 4\pi \times 10^{-7}$ T m/A

I = 12 A

r = 3 cm = 0.03 m

Formula:

$B = (\mu_o I) / (2\pi r)$

Substitute:

$B = (4\pi \times 10^{-7} \times 12) / (2\pi \times 0.03)$

$B = (48\pi \times 10^{-7}) / (0.06\pi)$

$B = 8 \times 10^{-5}$ T

Answer: 8×10^{-5} T

Problem 4

A straight wire carries a current of **6 A**. Find the magnetic field at a distance **2 cm** from the wire.

Given:

$\mu_o = 4\pi \times 10^{-7}$ T m/A

I = 6 A

r = 2 cm = 0.02 m

Formula:

$B = (\mu_o I) / (2\pi r)$

Substitute:

$B = (4\pi \times 10^{-7} \times 6) / (2\pi \times 0.02)$

$B = (24\pi \times 10^{-7}) / (0.04\pi)$

$B = 6 \times 10^{-5}$ T

Answer: 6×10^{-5} T

Problem 5

A long straight conductor carries a current of **15 A**. Find the magnetic field at a distance **5 cm** from the wire.

Given:

$\mu_o = 4\pi \times 10^{-7}$ T m/A

I = 15 A

r = 5 cm = 0.05 m

Formula:

$B = (\mu_o I) / (2\pi r)$

Substitute:

$B = (4\pi \times 10^{-7} \times 15) / (2\pi \times 0.05)$

$B = (60\pi \times 10^{-7}) / (0.10\pi)$

$B = 6 \times 10^{-5}$ T

Answer: 6×10^{-5} T

QUESTION 24

24. A long straight wire carries a current of 10 A. Find the magnetic field at a distance of 2 cm.

Solution:

$B = (\mu_0 I) / (2\pi r)$

$I = 10$ A

$r = 0.02$ m

$B = (4\pi \times 10^{-7} \times 10) / (2\pi \times 0.02)$

$B = 1 \times 10^{-4}$ Tesla

PRACTICE PROBLEM

Problem 1

A long straight conductor carries a current of **12 A**. Find the magnetic field at a distance of **3 cm** from the wire.

Given:

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

$I = 12$ A

$r = 3$ cm $= 0.03$ m

Formula:

$B = (\mu_0 I) / (2\pi r)$

Substitute:

$B = (4\pi \times 10^{-7} \times 12) / (2\pi \times 0.03)$

$B = (48\pi \times 10^{-7}) / (0.06\pi)$

$B = 8 \times 10^{-5}$ T

Answer: 8×10^{-5} T

Problem 2

A straight wire carries a current of **15 A**. Find the magnetic field at a distance of **5 cm** from the wire.

Given:

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

I = 15 A

r = 5 cm = 0.05 m

Formula:

$B = (\mu_0 I) / (2\pi r)$

Substitute:

$B = (4\pi \times 10^{-7} \times 15) / (2\pi \times 0.05)$

$B = (60\pi \times 10^{-7}) / (0.10\pi)$

$B = 6 \times 10^{-5}$ T

Answer: 6×10^{-5} T

Problem 3

A conductor carries a current of **8 A**. Find the magnetic field at a distance of **4 cm** from the wire.

Given:

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

I = 8 A

r = 4 cm = 0.04 m

Formula:

$B = (\mu_0 I) / (2\pi r)$

Substitute:

$B = (4\pi \times 10^{-7} \times 8) / (2\pi \times 0.04)$

$B = (32\pi \times 10^{-7}) / (0.08\pi)$

$B = 4 \times 10^{-5}$ T

Answer: 4×10^{-5} T

Problem 4

A long straight conductor carries a current of **20 A**. Find the magnetic field at a distance of **6 cm**.

Given:

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

I = 20 A

r = 6 cm = 0.06 m

Formula:

$B = (\mu_0 I) / (2\pi r)$

Substitute:

$B = (4\pi \times 10^{-7} \times 20) / (2\pi \times 0.06)$

$B = (80\pi \times 10^{-7}) / (0.12\pi)$

$B \approx 6.67 \times 10^{-5}$ T

Answer: 6.67×10^{-5} T

Problem 5

A straight wire carries a current of **18 A**. Find the magnetic field at a distance of **3 cm**.

Given:

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

I = 18 A

r = 3 cm = 0.03 m

Formula:

$B = (\mu_0 I) / (2\pi r)$

Substitute:

$B = (4\pi \times 10^{-7} \times 18) / (2\pi \times 0.03)$

$B = (72\pi \times 10^{-7}) / (0.06\pi)$

$B = 1.2 \times 10^{-4}$ T

Answer: 1.2×10^{-4} T

QUESTION 25

25. An electron moves with velocity 2×10^6 m/s in a magnetic field of 0.02 T perpendicular to it. Find the magnetic force.

Solution:

$F = qvB \sin\theta$

$q = 1.6 \times 10^{-19}$ C

$v = 2 \times 10^6$ m/s

B = 0.02 T

$\theta = 90° \rightarrow \sin\theta = 1$

$F = (1.6 \times 10^{-19})(2 \times 10^{6})(0.02)$

$F = 6.4 \times 10^{-15}$ N

PRACTICE PROBLEM

Problem 1

An electron moves with velocity **3×10^{6} m/s** in a magnetic field of **0.01 T** perpendicular to the field. Find the magnetic force.

Given:

$q = 1.6 \times 10^{-19}$ C

$v = 3 \times 10^{6}$ m/s

B = 0.01 T

$\theta = 90°$

Formula:

$F = qvB \sin\theta$

Substitute:

$F = (1.6 \times 10^{-19})(3 \times 10^{6})(0.01)$

$F = 4.8 \times 10^{-15}$ N

Answer: 4.8×10^{-15} N

Problem 2

A proton moves with velocity **2×10^{5} m/s** in a magnetic field of **0.05 T** perpendicular to the field. Find the magnetic force.

Given:

$q = 1.6 \times 10^{-19}$ C

$v = 2 \times 10^{5}$ m/s

B = 0.05 T

$\theta = 90°$

Formula:

$F = qvB \sin\theta$

Substitute:

$F = (1.6 \times 10^{-19})(2 \times 10^{5})(0.05)$

$F = 1.6 \times 10^{-15}$ N

Answer: 1.6×10^{-15} N

Problem 3

An electron moves with velocity **4×10^6 m/s** in a magnetic field of **0.03 T** perpendicular to the field. Find the magnetic force.

Given:

$q = 1.6 \times 10^{-19}$ C

$v = 4 \times 10^6$ m/s

B = 0.03 T

$\theta = 90°$

Formula:

$F = qvB \sin\theta$

Substitute:

$F = (1.6 \times 10^{-19})(4 \times 10^6)(0.03)$

$F = 1.92 \times 10^{-14}$ N

Answer: 1.92×10^{-14} N

Problem 4

A charged particle moves with velocity **5×10^6 m/s** in a magnetic field of **0.02 T** perpendicular to it. Find the magnetic force.

Given:

$q = 1.6 \times 10^{-19}$ C

$v = 5 \times 10^6$ m/s

B = 0.02 T

$\theta = 90°$

Formula:

$F = qvB \sin\theta$

Substitute:

$F = (1.6 \times 10^{-19})(5 \times 10^6)(0.02)$

$F = 1.6 \times 10^{-14}$ N

Answer: 1.6×10^{-14} N

Problem 5

An electron moves with velocity **1.5×10^6 m/s** in a magnetic field of **0.04 T** perpendicular to the field. Find the magnetic force.

Given:

$q = 1.6 \times 10^{-19}$ C

$v = 1.5 \times 10^6$ m/s

$B = 0.04$ T

$\theta = 90°$

Formula:

$F = qvB \sin\theta$

Substitute:

$F = (1.6 \times 10^{-19})(1.5 \times 10^6)(0.04)$

$F = 9.6 \times 10^{-15}$ N

Answer: 9.6×10^{-15} N

QUESTION 26

26. Two parallel wires 0.1 m apart carry currents of 5 A and 8 A in the same direction. Find the force per meter length between them.

Solution:

$F/L = (\mu_0 I_1 I_2) / (2\pi d)$

$I_1 = 5$ A, $I_2 = 8$ A

$d = 0.1$ m

$F/L = (4\pi \times 10^{-7} \times 5 \times 8) / (2\pi \times 0.1)$

$F/L = 1.6 \times 10^{-4}$ N/m

PRACTICE PROBLEM

Problem 1

Two parallel wires **0.2 m apart** carry currents **6 A** and **10 A** in the same direction. Find the force per meter length between them.

Given:

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

$I_1 = 6$ A

$I_2 = 10$ A

$d = 0.2$ m

Formula:

$F/L = (\mu_0 I_1 I_2) / (2\pi d)$

Substitute:

$F/L = (4\pi \times 10^{-7} \times 6 \times 10) / (2\pi \times 0.2)$

$F/L = (240\pi \times 10^{-7}) / (0.4\pi)$

$F/L = 6 \times 10^{-5}$ N/m

Answer: 6×10^{-5} N/m

Problem 2

Two long parallel conductors **0.15 m apart** carry currents **4 A** and **12 A**. Find the force per meter length between them.

Given:

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

$I_1 = 4$ A

$I_2 = 12$ A

$d = 0.15$ m

Formula:

$F/L = (\mu_0 I_1 I_2) / (2\pi d)$

Substitute:

$F/L = (4\pi \times 10^{-7} \times 4 \times 12) / (2\pi \times 0.15)$

$F/L = (192\pi \times 10^{-7}) / (0.3\pi)$

$F/L = 6.4 \times 10^{-5}$ N/m

Answer: 6.4×10^{-5} N/m

Problem 3

Two parallel wires **0.25 m apart** carry currents **9 A** and **7 A**. Find the force per meter length between them.

Given:

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

$I_1 = 9$ A

$I_2 = 7$ A

$d = 0.25$ m

Formula:

$F/L = (\mu_0 I_1 I_2) / (2\pi d)$

Substitute:

$F/L = (4\pi \times 10^{-7} \times 9 \times 7) / (2\pi \times 0.25)$

$F/L = (252\pi \times 10^{-7}) / (0.5\pi)$

$F/L = 5.04 \times 10^{-5}$ N/m

Answer: 5.04×10^{-5} N/m

Problem 4

Two long parallel wires **0.12 m apart** carry currents **10 A** and **15 A**. Find the force per meter length between them.

Given:

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

$I_1 = 10$ A

$I_2 = 15$ A

$d = 0.12$ m

Formula:

$F/L = (\mu_0 I_1 I_2) / (2\pi d)$

Substitute:

$F/L = (4\pi \times 10^{-7} \times 10 \times 15) / (2\pi \times 0.12)$

$F/L = (600\pi \times 10^{-7}) / (0.24\pi)$

$F/L = 2.5 \times 10^{-4}$ N/m

Answer: 2.5×10^{-4} N/m

Problem 5

Two parallel conductors **0.3 m apart** carry currents **20 A** and **5 A**. Find the force per meter length between them.

Given:

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

$I_1 = 20$ A

$I_2 = 5$ A

$d = 0.3$ m

Formula:

$F/L = (\mu_0 I_1 I_2) / (2\pi d)$

Substitute:

$F/L = (4\pi \times 10^{-7} \times 20 \times 5) / (2\pi \times 0.3)$

$F/L = (400\pi \times 10^{-7}) / (0.6\pi)$

$F/L \approx 6.67 \times 10^{-5}$ N/m

Answer: 6.67×10^{-5} N/m

QUESTION 27

27. The magnetic flux through a coil changes from 0.2 Wb to 0.05 Wb in 0.1 s. The coil has 50 turns. Find the induced emf.

Solution:

Faraday's Law: $E = -N (\Delta\Phi/\Delta t)$

$\Delta\Phi = 0.05 - 0.2 = -0.15$ Wb

$\Delta t = 0.1$ s

$N = 50$

$E = -50 (-0.15 / 0.1)$

$E = 75$ V

PRACTICE PROBLEM

Problem 1

The magnetic flux through a coil changes from **0.4 Wb to 0.1 Wb** in **0.2 s**. The coil has **60 turns**. Find the induced emf.

Given:

$\Phi_1 = 0.4$ Wb

$\Phi_2 = 0.1$ Wb

$\Delta t = 0.2$ s

$N = 60$

Formula:

$E = -N (\Delta\Phi/\Delta t)$

Change in flux:

$\Delta\Phi = 0.1 - 0.4 = -0.3$ Wb

Substitute:

$E = -60 (-0.3 / 0.2)$

$E = -60 (-1.5)$

$E = 90$ V

Answer: 90 V

Problem 2

The magnetic flux through a coil changes from **0.5 Wb** to **0.2 Wb** in **0.1 s**. The coil has **40 turns**. Find the induced emf.

Given:

$\Phi_1 = 0.5$ Wb

$\Phi_2 = 0.2$ Wb

$\Delta t = 0.1$ s

$N = 40$

Formula:

$E = -N (\Delta\Phi/\Delta t)$

Change in flux:

$\Delta\Phi = 0.2 - 0.5 = -0.3$ Wb

Substitute:

$E = -40 (-0.3 / 0.1)$

$E = -40 (-3)$

$E = 120$ V

Answer: 120 V

Problem 3

The magnetic flux through a coil changes from **0.3 Wb to 0.05 Wb** in **0.05 s**. The coil has **30 turns**. Find the induced emf.

Given:

$\Phi_1 = 0.3$ Wb

$\Phi_2 = 0.05$ Wb

$\Delta t = 0.05$ s

$N = 30$

Formula:

$E = -N (\Delta\Phi/\Delta t)$

Change in flux:

$\Delta\Phi = 0.05 - 0.3 = -0.25$ Wb

Substitute:

$E = -30 (-0.25 / 0.05)$

$E = -30 (-5)$

$E = 150$ V

Answer: 150 V

Problem 4

The magnetic flux through a coil changes from **0.6 Wb to 0.3 Wb** in **0.15 s**. The coil has **80 turns**. Find the induced emf.

Given:

$\Phi_1 = 0.6$ Wb

$\Phi_2 = 0.3$ Wb

$\Delta t = 0.15$ s

$N = 80$

Formula:

$E = -N (\Delta\Phi/\Delta t)$

Change in flux:

$\Delta\Phi = 0.3 - 0.6 = -0.3$ Wb

Substitute:

$E = -80 (-0.3 / 0.15)$

$E = -80 (-2)$

$E = 160$ V

Answer: 160 V

Problem 5

The magnetic flux through a coil changes from **0.25 Wb to 0.1 Wb** in **0.05 s**. The coil has **20 turns**. Find the induced emf.

Given:

$\Phi_1 = 0.25$ Wb

$\Phi_2 = 0.1$ Wb

$\Delta t = 0.05$ s

$N = 20$

Formula:

$E = -N (\Delta\Phi/\Delta t)$

Change in flux:

$\Delta\Phi = 0.1 - 0.25 = -0.15$ Wb

Substitute:

$E = -20 (-0.15 / 0.05)$

$E = -20 (-3)$

$E = 60$ V

Answer: 60 V

QUESTION 28

28. A coil of inductance 0.5 H carries current changing at the rate of 4 A/s. Find the induced emf.

Solution:

$E = -L (dI/dt)$

$L = 0.5$ H

dI/dt = 4 A/s

E = -0.5 × 4

E = -2 V

PRACTICE PROBLEM

Problem 1

A coil of inductance **0.8 H** carries current changing at the rate of **5 A/s**. Find the induced emf.

Given:

L = 0.8 H

dI/dt = 5 A/s

Formula:

E = −L (dI/dt)

Substitute:

E = −0.8 × 5

E = −4 V

Answer: −4 V

Problem 2

A coil of inductance **1.2 H** carries current changing at the rate of **3 A/s**. Find the induced emf.

Given:

L = 1.2 H

dI/dt = 3 A/s

Formula:

E = −L (dI/dt)

Substitute:

E = −1.2 × 3

E = −3.6 V

Answer: −3.6 V

Problem 3

An inductor of inductance **0.4 H** has current changing at the rate **10 A/s**. Find the induced emf.

Given:

L = 0.4 H

dI/dt = 10 A/s

Formula:

E = −L (dI/dt)

Substitute:

E = −0.4 × 10

E = −4 V

Answer: −4 V

Problem 4

A coil of inductance **2 H** carries current changing at the rate **1.5 A/s**. Find the induced emf.

Given:

L = 2 H

dI/dt = 1.5 A/s

Formula:

E = −L (dI/dt)

Substitute:

E = −2 × 1.5

E = −3 V

Answer: −3 V

Problem 5

An inductor of inductance **0.6 H** carries current changing at the rate **8 A/s**. Find the induced emf.

Given:

L = 0.6 H

dI/dt = 8 A/s

Formula:

E = −L (dI/dt)

Substitute:

E = −0.6 × 8

E = −4.8 V

Answer: −4.8 V

QUESTION 29

29. If mutual inductance between two coils is 0.8 H and current change in primary coil is 3 A/s, find induced emf in secondary.

Solution:

E = -M (dI/dt)

M = 0.8 H

dI/dt = 3 A/s

E = -0.8 × 3

E = -2.4 V

PRACTICE PROBLEM

Problem 1

If mutual inductance between two coils is **1.2 H** and current change in the primary coil is **2 A/s**, find the induced emf in the secondary coil.

Given:

M = 1.2 H

dI/dt = 2 A/s

Formula:

E = −M (dI/dt)

Substitute:

E = −1.2 × 2

E = −2.4 V

Answer: −2.4 V

Problem 2

If the mutual inductance between two coils is **0.6 H** and current change in the primary coil is **5 A/s**, find the induced emf in the secondary.

Given:

M = 0.6 H

dI/dt = 5 A/s

Formula:

E = −M (dI/dt)

Substitute:

E = −0.6 × 5

E = −3 V

Answer: −3 V

Problem 3

If mutual inductance between two coils is **1.5 H** and the current change in the primary coil is **4 A/s**, find the induced emf.

Given:

M = 1.5 H

dI/dt = 4 A/s

Formula:

E = −M (dI/dt)

Substitute:

E = −1.5 × 4

E = −6 V

Answer: −6 V

Problem 4

If the mutual inductance between two coils is **0.9 H** and the current change in the primary coil is **6 A/s**, find the induced emf.

Given:

M = 0.9 H

dI/dt = 6 A/s

Formula:

E = −M (dI/dt)

Substitute:

$E = -0.9 \times 6$

$E = -5.4$ V

Answer: −5.4 V

Problem 5

If mutual inductance between two coils is **2 H** and the current change in the primary coil is **1.5 A/s**, find the induced emf in the secondary coil.

Given:

$M = 2$ H

$dI/dt = 1.5$ A/s

Formula:

$E = -M (dI/dt)$

Substitute:

$E = -2 \times 1.5$

$E = -3$ V

Answer: −3 V

QUESTION 30

30. A transformer has 500 turns in primary and 100 turns in secondary. If primary voltage is 220 V, find secondary voltage.

Solution:

$Vp/Vs = Np/Ns$

$Vp = 220$ V

$Np = 500$

$Ns = 100$

$Vs = (Vp \times Ns) / Np$

$Vs = (220 \times 100)/500$

$Vs = 44$ V

PRACTICE PROBLEM

Problem 1

A transformer has **800 turns in the primary** and **200 turns in the secondary**. If the primary voltage is **240 V**, find the secondary voltage.

Given:

Vp = 240 V

Np = 800

Ns = 200

Formula:

Vp/Vs = Np/Ns

Substitute:

Vs = (240 × 200) / 800

Vs = 60 V

Answer: 60 V

Problem 2

A transformer has **600 primary turns** and **150 secondary turns**. If the primary voltage is **120 V**, find the secondary voltage.

Given:

Vp = 120 V

Np = 600

Ns = 150

Formula:

Vp/Vs = Np/Ns

Substitute:

Vs = (120 × 150) / 600

Vs = 30 V

Answer: 30 V

Problem 3

A transformer has **1000 turns in the primary** and **250 turns in the secondary**. If the primary voltage is **220 V**, find the secondary voltage.

Given:

Vp = 220 V

Np = 1000

Ns = 250

Formula:

Vp/Vs = Np/Ns

Substitute:

Vs = (220 × 250) / 1000

Vs = 55 V

Answer: 55 V

Problem 4

A transformer has **400 turns in the primary** and **80 turns in the secondary**. If the primary voltage is **200 V**, find the secondary voltage.

Given:

Vp = 200 V

Np = 400

Ns = 80

Formula:

Vp/Vs = Np/Ns

Substitute:

Vs = (200 × 80) / 400

Vs = 40 V

Answer: 40 V

Problem 5

A transformer has **900 turns in the primary** and **300 turns in the secondary**. If the primary voltage is **180 V**, find the secondary voltage.

Given:

Vp = 180 V

Np = 900

Ns = 300

Formula:

$Vp/Vs = Np/Ns$

Substitute:

$Vs = (180 \times 300) / 900$

$Vs = 60\ V$

Answer: 60 V

QUESTION 31

31. A circular coil of radius 5 cm carries current 3 A. Find magnetic moment. (Area = πr^2)

Solution:

$r = 5\ cm = 0.05\ m$

$A = \pi r^2 = \pi\ (0.05)^2 = 7.85 \times 10^{-3}\ m^2$

Magnetic moment $M = IA$

$M = 3 \times 7.85 \times 10^{-3}$

$M = 2.355 \times 10^{-2}\ A \cdot m^2$

PRACTICE PROBLEM

Problem 1

A circular coil of radius **4 cm** carries a current of **2 A**. Find the magnetic moment.

Given:

$r = 4\ cm = 0.04\ m$

$I = 2\ A$

Area:

$A = \pi r^2 = \pi\ (0.04)^2$

$A = 5.026 \times 10^{-3}\ m^2$

Formula:

$M = IA$

Substitute:

$M = 2 \times 5.026 \times 10^{-3}$

$M = 1.005 \times 10^{-2}\ A \cdot m^2$

Answer: $1.005 \times 10^{-2}\ A \cdot m^2$

Problem 2

A circular coil of radius **6 cm** carries current **4 A**. Find the magnetic moment.

Given:

$r = 6\ cm = 0.06\ m$

$I = 4\ A$

Area:

$A = \pi\ (0.06)^2$

$A = 1.131 \times 10^{-2}\ m^2$

Formula:

$M = IA$

Substitute:

$M = 4 \times 1.131 \times 10^{-2}$

$M = 4.524 \times 10^{-2}\ A \cdot m^2$

Answer: $4.524 \times 10^{-2}\ A \cdot m^2$

Problem 3

A circular coil of radius **3 cm** carries a current **5 A**. Find the magnetic moment.

Given:

$r = 3\ cm = 0.03\ m$

$I = 5\ A$

Area:

$A = \pi\ (0.03)^2$

$A = 2.827 \times 10^{-3}\ m^2$

Formula:

$M = IA$

Substitute:

$M = 5 \times 2.827 \times 10^{-3}$

$M = 1.413 \times 10^{-2}\ A \cdot m^2$

Answer: 1.413×10^{-2} A·m²

Problem 4

A circular coil of radius **8 cm** carries current **2.5 A**. Find the magnetic moment.

Given:

r = 8 cm = 0.08 m

I = 2.5 A

Area:

$A = \pi (0.08)^2$

$A = 2.01 \times 10^{-2}$ m²

Formula:

M = IA

Substitute:

$M = 2.5 \times 2.01 \times 10^{-2}$

$M = 5.025 \times 10^{-2}$ A·m²

Answer: 5.025×10^{-2} A·m²

Problem 5

A circular coil of radius **10 cm** carries a current **3 A**. Find the magnetic moment.

Given:

r = 10 cm = 0.1 m

I = 3 A

Area:

$A = \pi (0.1)^2$

$A = 3.14 \times 10^{-2}$ m²

Formula:

M = IA

Substitute:

$M = 3 \times 3.14 \times 10^{-2}$

$M = 9.42 \times 10^{-2}$ A·m²

Answer: 9.42×10^{-2} A·m²

QUESTION 32

32. If hysteresis loop area represents energy loss of 0.8 J per cycle and frequency is 50 Hz, find power loss.

Solution:

Power loss = Energy loss per cycle × frequency

$P = 0.8 \times 50$

$P = 40$ W

PRACTICE PROBLEM

Problem 1

If hysteresis energy loss per cycle is **1.2 J** and frequency is **60 Hz**, find the power loss.

Given:

Energy loss per cycle = 1.2 J

f = 60 Hz

Formula:

$P = E \times f$

Substitute:

$P = 1.2 \times 60$

$P = 72$ W

Answer: 72 W

Problem 2

If energy loss per cycle due to hysteresis is **0.5 J** and the frequency is **100 Hz**, find the power loss.

Given:

Energy loss per cycle = 0.5 J

f = 100 Hz

Formula:

$P = E \times f$

Substitute:

$P = 0.5 \times 100$

P = 50 W

Answer: 50 W

Problem 3

If hysteresis loop area corresponds to energy loss **0.9 J per cycle** and frequency is **40 Hz**, find the power loss.

Given:

Energy loss per cycle = 0.9 J

f = 40 Hz

Formula:

P = E × f

Substitute:

P = 0.9 × 40

P = 36 W

Answer: 36 W

Problem 4

If hysteresis energy loss per cycle is **1.5 J** and frequency is **25 Hz**, find the power loss.

Given:

Energy loss per cycle = 1.5 J

f = 25 Hz

Formula:

P = E × f

Substitute:

P = 1.5 × 25

P = 37.5 W

Answer: 37.5 W

Problem 5

If hysteresis loop energy loss is **0.75 J per cycle** and frequency is **80 Hz**, find the power loss.

Given:

Energy loss per cycle = 0.75 J

f = 80 Hz

Formula:

$P = E \times f$

Substitute:

$P = 0.75 \times 80$

$P = 60$ W

Answer: 60 W