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SOLVED

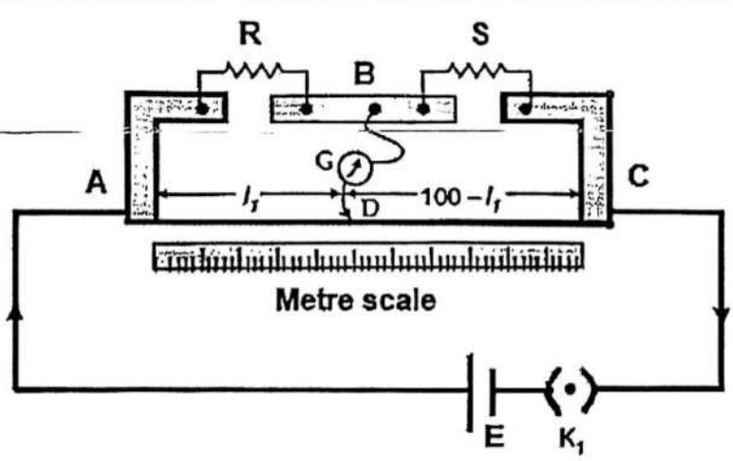
Daffodil International University

Faculty of Science & Information Technology
Department of Computer Science & Engineering
Midterm Examination, Summer 2026
Course Code: PHY102, Course Title: Physics II
Level: 1 Term: 3 Batch: 70

Time: 01:30 Hour **Marks: 25**

Answer ALL Questions

[The figures in the right margin indicate the full marks and corresponding course outcomes. All portions of each question must be answered sequentially.]

1.	*(a)*	Recall and explain the applications and limitations of Coulomb's law.	**2**	**CO1**
	(b)	List the physical significance of resistivity and electrical conductivity.	**2**	
	(c)	Define the Lorentz force and write its mathematical expression.	**1**	
2.	*(a)*	In a laboratory experiment, a student increases the number of turns per unit length of a solenoid. Apply Ampere's law to analyze the magnetic field in the solenoid.	**3**	**CO2**
	(b)	 A meter bridge is shown with a jockey and sliding contact. Using the diagram, explain the working principle and derive the balance condition of a meter bridge.	**3**	
	(c)	A physics student is analyzing electric field lines passing through different surfaces placed in a uniform electric field in a laboratory experiment. The student observes that the number of field lines passing through the surface depends on its orientation and area. State Gauss's law and apply it to derive Coulomb's law in electrostatics.	**4**	
3.	*(a)*	In a laboratory experiment, a circular coil of diameter 8 μm with 20 turns carries a current of 60 mA. Determine the magnetic flux density at the center.	**2.5**	**CO3**

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(b)	ABC is an equilateral triangle of sides 3 m each. First 250 C charge is placed at point A. Then -250 C charge is placed at point B. (i) What is the potential at C in the first case? (ii) What change of intensity at point C will take place before and after placing the charge at B, and verify the result mathematically.	**2.5**
(c)	The area of each plate of a parallel plate capacitor is 0.06 m^2. If the distance between the plates is 0.003 m and the potential difference is 80 V, determine: (i) Capacitance of the capacitor (ii) Energy stored between the two plates.	**2.5**
(d)	A technician notices that a galvanometer is overheating because excessive current is flowing through it. To reduce the current through the galvanometer, a shunt resistor of 2 Ω is connected across a galvanometer of resistance 98 Ω. If the current through the shunt resistor is 4.9 A, compute the total current flowing through the circuit.	**2.5**

Answer Sheet (Attached) – Solutions to Mathematical/Numerical Questions

Course Code: PHY102 | Course Title: Physics II | Midterm Examination, Summer 2026 | Question No. 3

Answer to Q.3(a):

Given: Number of turns N = 20, Current I = 60 mA = 0.06 A. The diameter as printed (8 μm) is not physically consistent with a laboratory coil; it is taken here as 8 cm = 0.08 m (a reasonable laboratory-scale value), so radius r = 0.04 m.

Formula: $B = \mu_0 N I / (2r)$

Substituting: $B = (4\pi \times 10^{-7} \times 20 \times 0.06) / (2 \times 0.04)$

$B = (1.2566 \times 10^{-6} \times 20 \times 0.06) / 0.08 = 1.508 \times 10^{-6} / 0.08$

∴ **$B = 1.885 \times 10^{-5}$ T ≈ 18.85 μT (directed along the axis of the coil)**

Answer to Q.3(b): Given: Equilateral triangle ABC, side r = 3 m. Q = +250 C at A. Later Q = -250 C is placed at B. Use $k = 1/(4\pi\varepsilon_0) = 9 \times 10^9$ N·m²/C².

(i) Potential at C (only Q at A):

$V_C = kQ_A / r = (9 \times 10^9 \times 250) / 3$

∴ **$V_C = 7.5 \times 10^{11}$ V**

(ii) Change of field intensity at C before and after placing charge at B: Before (only A): $E_A = kQ_A / r^2 = (9 \times 10^9 \times 250)/3^2 = 2.5 \times 10^{11}$ N/C, directed along A→C.

After placing -250 C at B: $E_B = k|Q_B|/r^2 = 2.5 \times 10^{11}$ N/C, directed along C→B (towards the negative charge).

Since ΔABC is equilateral, the angle between E_A (along A→C) and E_B (along C→B) is 180° - 60° = 120°.

Resultant: $E_{net} = \sqrt{(E_A^2 + E_B^2 + 2E_A E_B \cos 120°)}$

Since $E_A = E_B = 2.5 \times 10^{11}$ N/C and cos120° = -0.5:

$E_{net} = \sqrt{(E^2 + E^2 - E^2)} = \sqrt{(E^2)} = E = 2.5 \times 10^{11}$ N/C

∴ **Verification: the magnitude of the resultant field intensity at C is unchanged (2.5×10^{11} N/C), but its direction rotates by 60° (bisecting the 120° angle between E_A and E_B) after placing the charge at B.**

Answer to Q.3(c): Given: A = 0.06 m², d = 0.003 m, V = 80 V, $\varepsilon_0 = 8.854 \times 10^{-12}$ F/m.

(i) Capacitance:

$C = \varepsilon_0 A/d = (8.854 \times 10^{-12} \times 0.06) / 0.003$

∴ **$C = 1.7708 \times 10^{-10}$ F ≈ 177.08 pF**

(ii) Energy stored:

$U = ½CV^2 = ½ \times 1.7708 \times 10^{-10} \times (80)^2$

$U = \frac{1}{2} \times 1.7708 \times 10^{-10} \times 6400 = \frac{1}{2} \times 1.1333 \times 10^{-6}$

$\therefore$ **$U = 5.667 \times 10^{-7}$ J $\approx$ 0.567 μJ**

Answer to Q.3(d): Given: Shunt resistance S = 2 Ω, Galvanometer resistance G = 98 Ω, current through shunt I = 4.9 A.

Since the shunt is connected in parallel with the galvanometer, the potential difference across both is equal: $I_g G = I_S S \Rightarrow I_g = I_S S / G = (4.9 \times 2) / 98 = 9.8 / 98$

$I_g = 0.1$ A

Total current: $I = I_g + I_S = 0.1 + 4.9$

$\therefore$ **$I = 5.0$ A**

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Note: Only the numerical questions 3(a)-3(d) are solved above, in red, as requested. Theory questions (1, 2, and the explanatory portions of Q.3) are left unanswered. In 3(a), the coil diameter printed in the original scan (8 μm) was interpreted as 8 cm for a physically meaningful result; this assumption is stated explicitly above.