Physics For Life Sciences 2: Exam 2 Solutions

Section A

1. D	5. D	9. B	13. D	17. B	21. B
2. B	6. B	10. C	14. A	18. A	22. D
3. C	7. B	11. A	15. C	19. B	23. A
4. B	8. D	12. B	16. A	20. A	

Section B

Question 1: A $+4 \times 10^{-9}\,\mathrm{C}$ point charge is at $x = 2\,\mathrm{m}$ and a $-1 \times 10^{-9}\,\mathrm{C}$ point charge is at $x = -3\,\mathrm{m}$. What is the electric field at $x = 0\,\mathrm{m}$ due to these two charges? (Include the correct sign in your answer; *i.e.*, "+" and "−" for the electric field pointing in the positive and negative x-directions, respectively.)

Answer:

The electric field at a point due to charge q_i is

$$\mathbf{E} = \frac{kq_i}{r_i^2}\hat{\mathbf{r}},$$

where r_i is the distance of the charge to the point and $\hat{\mathbf{r}}$ is the unit vector pointing from the charge to the point.

The electric fields due to each of the two charges at the origin are

$$+4 \times 10^{-9}\,\mathrm{C}\text{ charge}: \quad \frac{9 \times 10^9\,\mathrm{Nm^2/C^2} \cdot (4 \times 10^{-9}\,\mathrm{C})}{(2\,\mathrm{m})^2} \times \underbrace{(-1)}_{\substack{\text{unit vector in} \\ -x\text{-direction}}} = -9\,\mathrm{N/C};$$

$$-1 \times 10^{-9}\,\mathrm{C}\text{ charge}: \quad \frac{9 \times 10^9\,\mathrm{Nm^2/C^2} \cdot (-1 \times 10^{-9}\,\mathrm{C})}{(3\,\mathrm{m})^2} \times \underbrace{(+1)}_{\substack{\text{unit vector in} \\ +x\text{-direction}}} = -1\,\mathrm{N/C}.$$

The electric field at the origin is the sum of these electric fields:

$$\mathbf{E}_{\text{at origin}} = -9\,\mathrm{N/C} - 1\,\mathrm{N/C} = \boxed{-10\,\mathrm{N/C}}.$$

Questions 2: You have 3 resistors of resistances $1\,\Omega$, $\frac{1}{2}\,\Omega$ and $\frac{1}{4}\,\Omega$.

(a) What is the equivalent resistance when you connect all three resistors is **series**? [8 points]

(b) What is the equivalent resistance when you connect all three resistors in **parallel**? [12 points]

Answers:

(a)

$$R_{\text{equiv}} = \sum_i R_i = 1\,\Omega + \frac{1}{2}\,\Omega + \frac{1}{4}\,\Omega = \boxed{1\frac{3}{4}\,\Omega}.$$

(b)

$$\frac{1}{R_{\text{equiv}}} = \sum_i \frac{1}{R_i} = \frac{1}{1\,\Omega} + \frac{1}{\frac{1}{2}\,\Omega} + \frac{1}{\frac{1}{4}\,\Omega} = \frac{1+2+4}{\Omega} = \frac{7}{\Omega} \;\Rightarrow\; R_{\text{equiv}} = \boxed{\frac{1}{7}\,\Omega}.$$