

## Physics 262: Physics for Life Sciences 2

### Test 2 Solutions

#### Section A

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

#### Section B

**Question 1** Two point charges, one that is  $+1 \times 10^{-4} \text{ C}$  and the other  $-1 \times 10^{-3} \text{ C}$ , are initially 3 m apart.

- (a) Do these point charges repel or attract each other? [2 points]
- (b) What is the magnitude of the force of the positive charge on the negative charge? [8 points]
- (c) What is the work required to completely separate the two charges? [10 points]

#### Answers

- (a) Unlike charges **attract**.
- (b) The magnitude of the force between two charges  $q_1$  and  $q_2$  separated by a distance  $r$  is

$$F = \frac{k |q_1| |q_2|}{r^2}.$$

In this problem,

$$F = \frac{(9 \times 10^9 \text{ Nm}^2/\text{C}^2) \cdot (1 \times 10^{-4} \text{ C}) \cdot (1 \times 10^{-3} \text{ C})}{(3 \text{ m})^2} = \frac{9 \times 10^{9-4-3}}{9} \text{ N} = \boxed{100 \text{ N}}.$$

- (c) The electric potential energy for the two point charges is

$$U = \frac{k q_1 q_2}{r}.$$

Initially,  $r = 3 \text{ m}$ , so

$$U_{\text{initial}} = \frac{(9 \times 10^9 \text{ Nm}^2/\text{C}^2) \cdot (1 \times 10^{-4} \text{ C}) \cdot (-1 \times 10^{-3} \text{ C})}{(3 \text{ m})} = -300 \text{ J}.$$

When the charges are completely separated,  $r = \infty$  and therefore  $U_{\text{final}} = 0 \text{ J}$ . By conservation of energy, the work done to completely separate the charges must be equal to the change in the energy (which in this case is just the electric potential energy), hence

$$W = U_{\text{final}} - U_{\text{initial}} = 0 \text{ J} - (-300 \text{ J}) = \boxed{300 \text{ J}}.$$

## Question 2

- (a) What is the equivalent resistance of two  $2\Omega$  resistors and one  $1\Omega$  resistor wired in **series**? [10 points]
- (b) What is the equivalent resistance of two  $2\Omega$  resistors and one  $1\Omega$  resistor wired in **parallel**? [10 points]

## Answers

- (a) Resistances in series add. Therefore

$$R_{\text{equiv}} = R_1 + R_2 + R_3 = 2\Omega + 2\Omega + 1\Omega = \boxed{5\Omega}.$$

- (b) For the three resistors in parallel,

$$\frac{1}{R_{\text{equiv}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{2\Omega} + \frac{1}{2\Omega} + \frac{1}{1\Omega} = \left(\frac{1}{2} + \frac{1}{2} + 1\right) \frac{1}{\Omega} = 2\frac{1}{\Omega}.$$

Hence,

$$R_{\text{equiv}} = \boxed{\frac{1}{2}\Omega = 0.5\Omega}.$$