Electric Fields Questions – OCR A Level Physics

Praneel Physics

1. Define the electric field strength. **(P)**

Working and Answer:

Electric field strength is the force per unit positive charge, $E = \frac{F}{q}$.

2. State the unit of electric field strength. **(P)**

Working and Answer:

The unit is volts per metre (V/m) or newtons per coulomb (N/C).

3. What is meant by a radial electric field? **(P)**

Working and Answer:

A field that radiates from a point charge, decreasing with distance.

4. Give an example of where a uniform electric field is used in technology. **(P)**

Working and Answer:

Cathode ray tubes (CRT) or inkjet printers.

5. Explain the difference between uniform and non-uniform electric fields. **(PP)**

Working and Answer:

Uniform fields have constant field strength and parallel field lines; non-uniform fields have varying strength and diverging/converging field lines.

6. Describe the electric field pattern between two oppositely charged parallel plates. **(PP)**

Working and Answer:

The field lines are straight, parallel, and equally spaced, indicating a uniform electric field.

7. State and explain the direction of the electric field. **(PP)**

Working and Answer:

The direction of the field is the direction of the force on a positive test charge.

8. Describe the work done when moving a charge in a uniform electric field. **(PP)**

Working and Answer:

Work done $W = qEd$, where d is the distance moved in the direction of the field.

9. Calculate the electric field strength between two parallel plates 5.0 mm apart with a potential difference of 100 V. **(PPP)**

Working and Answer:

$$E = \frac{V}{d} = \frac{100}{5.0 \times 10^{-3}} = 2.0 \times 10^4 \,\text{V/m}$$

10. A charge of 2.0×10^{-6} C is placed in an electric field of strength 3.0×10^{4} V/m. Calculate the force. **(PPP)**

Working and Answer:

$$F = Eq = 3.0 \times 10^{4} \times 2.0 \times 10^{-6} = 0.06\,\text{N}$$

11. A proton moves from a plate at 0 V to one at 500 V. Calculate the work done. **(PPP)**

Working and Answer:

$$W = qV = 1.6 \times 10^{-19} \times 500 = 8.0 \times 10^{-17}\,\text{J}$$

12. What is the potential at a point 0.20 m from a 5.0×10^{-6} C point charge? ($k = 8.99 \times 10^9\,\text{Nm}^2/\text{C}^2$) **(PPP)**

Working and Answer:

$$V = \frac{kQ}{r} = \frac{8.99 \times 10^9 \times 5.0 \times 10^{-6}}{0.2} = 2.25 \times 10^5\,\text{V}$$

13. Derive the expression for electric field due to a point charge. **(PPPP)**

Working and Answer:

From Coulomb's Law:

$$F = \frac{kQq}{r^2}, \quad E = \frac{F}{q} = \frac{kQ}{r^2}$$

14. Describe the motion of a charged particle entering a uniform electric field at right angles. **(PPPP)**

Working and Answer:

The particle undergoes uniform acceleration perpendicular to its initial velocity, resulting in a parabolic path.

15. Explain how electric potential varies with distance from a point charge. **(PPPP)**

Working and Answer:

Electric potential decreases with distance as:

$$V = \frac{kQ}{r}$$

16. Calculate the energy gained by a 3.0×10^{-6} C charge moving through a potential difference of 1200 V. **(PPPP)**

Working and Answer:

$$W = qV = 3.0 \times 10^{-6} \times 1200 = 3.6 \times 10^{-3} \text{ J}$$

17. Two charges of $+4.0 \times 10^{-6}\,\text{C}$ and $-4.0 \times 10^{-6}\,\text{C}$ are separated by 0.10 m. Calculate the electric field at the midpoint. **(PPPPP)**

Working and Answer:

The fields add since they are in the same direction:

$$E = 2 \times \frac{kQ}{(0.05)^2} = 2 \times \frac{8.99 \times 10^9 \times 4.0 \times 10^{-6}}{0.0025} = 2.88 \times 10^7\,\text{V/m}$$

18. Find the force between two charges of $6.0 \times 10^{-6}\,\text{C}$ and $3.0 \times 10^{-6}\,\text{C}$ separated by 0.15 m. **(PPPPP)**

Working and Answer:

$$F = \frac{kQ_1Q_2}{r^2} = \frac{8.99 \times 10^9 \times 6.0 \times 10^{-6} \times 3.0 \times 10^{-6}}{0.15^2} = 7.2\,\text{N}$$

19. Calculate the work done in bringing a $1.5 \times 10^{-6}\,\text{C}$ charge from infinity to a point $0.30\,\text{m}$ away from a $5.0 \times 10^{-6}\,\text{C}$ charge. **(PPPPP)**

Working and Answer:

$$V = \frac{kQ}{r} = \frac{8.99 \times 10^{9} \times 5.0 \times 10^{-6}}{0.3} = 1.5 \times 10^{5}\,\text{V}$$

$$W = qV = 1.5 \times 10^{-6} \times 1.5 \times 10^{5} = 0.225\,\text{J}$$

20. A charged particle with mass 1.0×10^{-3} kg and charge 2.0×10^{-6} C is accelerated through 3000 V. Find its final speed. **(PPPPP)**

Working and Answer:

$$W = qV = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{\frac{2qV}{m}} = \sqrt{\frac{2 \times 2.0 \times 10^{-6} \times 3000}{1.0 \times 10^{-3}}} = 3.46\,\text{m/s}$$