Edexcel A2 Physics: Electric and Magnetic Fields – Calculation Practice

Praneel Physics

1. A charge of $5\,\mu C$ is placed in an electric field of strength $200\,N/C$. Calculate the force experienced by the charge. **(P)**

Working and Answer:

Force = Charge × Electric Field = $5 \times 10^{-6}\,C \times 200\,N/C = 1 \times 10^{-3}\,N$.

---

2. What is the potential difference across a capacitor that stores $2\,mC$ of charge and has a capacitance of $4\,\mu F$? **(P)**

Working and Answer:

Potential Difference $= \dfrac{\text{Charge}}{\text{Capacitance}} = \dfrac{2 \times 10^{-3}\,C}{4 \times 10^{-6}\,F} = 500\,V.$

---

3. Calculate the energy stored in a capacitor with a capacitance of $10\,\mu F$ charged to a potential difference of $12\,V$. **(P)**

Working and Answer:

Energy $= \dfrac{1}{2}CV^2 = \dfrac{1}{2} \times 10 \times 10^{-6}\,F \times (12\,V)^2 = 0.00072\,J.$

---

4. A wire carries a current of $3\,A$ and has a resistance of $4\,\Omega$. Calculate the voltage across the wire. **(P)**

> *Working and Answer:*
> Voltage = Current × Resistance = $3\,A \times 4\,\Omega = 12\,V$.

5. If a magnetic field strength is $0.5\,T$ and a wire carrying a current of $2\,A$ is placed perpendicular to the field, calculate the force on a $1\,m$ length of the wire. **(P)**

> *Working and Answer:*
> Force = $BIL = 0.5\,T \times 2\,A \times 1\,m = 1\,N$.

6. A capacitor has a capacitance of $6\,\mu F$ and is charged to $9\,V$. What is the charge on the capacitor? **(PP)**

Working and Answer:
Charge $= C \times V = 6 \times 10^{-6}\,F \times 9\,V = 54 \times 10^{-6}\,C = 54\,\mu C$.

---

7. Calculate the electric field strength at a distance of $0.1\,m$ from a point charge of $3\,\mu C$. **(PP)**

Working and Answer:
Electric Field $= \dfrac{k \cdot |Q|}{r^2} = \dfrac{8.99 \times 10^9\,Nm^2/C^2 \cdot 3 \times 10^{-6}\,C}{(0.1\,m)^2} = 269700\,N/C$.

---

8. A solenoid has a length of $0.5\,m$, a cross-sectional area of $0.01\,m^2$, and carries a current of $2\,A$. If it has 100 turns, calculate the magnetic field inside the solenoid. **(PP)**

Working and Answer:
$B = \mu_0 \dfrac{NI}{L} = (4\pi \times 10^{-7}\,Tm/A)\dfrac{100 \times 2}{0.5} = 5.03 \times 10^{-5}\,T.$

---

9. A parallel plate capacitor has a plate area of $0.02\,m^2$ and a separation of $0.01\,m$. If the dielectric constant is 2.5, calculate its capacitance. **(PP)**

Working and Answer:
$C = \dfrac{\varepsilon_0 \cdot A}{d} = \dfrac{(8.85 \times 10^{-12}\,F/m) \cdot 2.5 \cdot 0.02}{0.01} = 4.425 \times 10^{-12}\,F = 4.425\,pF.$

---

10. A charged particle with a charge of $1.6 \times 10^{-19}\,C$ moves through a magnetic field of strength $0.3\,T$ at a velocity of $2 \times 10^6\,m/s$. Calculate the magnetic force acting on the particle if the angle between the velocity and the magnetic field is $90°$. **(PP)**

Working and Answer:
$F = BQv\sin(\theta) = 0.3\,T \cdot 1.6 \times 10^{-19}\,C \cdot 2 \times 10^6\,m/s = 9.6 \times 10^{-14}\,N.$

11. A circuit has a total resistance of $12\,\Omega$ and a current of $1.5\,A$. Calculate the total voltage supplied by the battery. **(PPP)**

Working and Answer:
$V = I \times R = 1.5\,A \times 12\,\Omega = 18\,V.$

12. A magnetic field of $0.4\,T$ is applied perpendicular to a wire carrying a current of $5\,A$. If the length of the wire in the field is $0.3\,m$, calculate the force on the wire. **(PPP)**

> *Working and Answer:*
> $F = BIL = 0.4\,T \times 5\,A \times 0.3\,m = 0.6\,N.$

13. Calculate the capacitance of a capacitor that stores $0.01\,C$ of charge at a potential difference of $20\,V$. **(PPP)**

> *Working and Answer:*
> $C = \dfrac{Q}{V} = \dfrac{0.01\,C}{20\,V} = 5 \times 10^{-4}\,F = 500\,\mu F.$

14. A particle with a mass of $0.01\,kg$ is moving in a magnetic field with a velocity of $3\times10^5\,m/s$ and experiences a magnetic force of $6 \times 10^{-3}\,N$. Calculate the magnetic field strength. **(PPP)**

Working and Answer:
$$B = \frac{F}{Qv} \Rightarrow Q = \frac{F}{Bv} \Rightarrow B = \frac{F}{mv} = \frac{6 \times 10^{-3}\,N}{0.01\,kg \cdot 3 \times 10^5\,m/s} = 2 \times 10^{-8}\,T.$$

15. A charged particle enters a uniform electric field of strength $1500\,N/C$ and experiences a force of $0.003\,N$. Calculate the charge of the particle. **(PPPP)**

Working and Answer:
$$F = EQ \Rightarrow Q = \frac{F}{E} = \frac{0.003\,N}{1500\,N/C} = 2 \times 10^{-6}\,C.$$

16. A solenoid with 200 turns, a length of $0.4\,m$, and a current of $3\,A$ produces a magnetic field. Calculate the magnetic field strength inside the solenoid. **(PPPP)**

Working and Answer:
$B = \mu_0 \dfrac{NI}{L} = (4\pi \times 10^{-7}\,Tm/A)\dfrac{200 \times 3}{0.4} = 6 \times 10^{-4}\,T.$

17. A capacitor is charged to $50\,V$ and has a capacitance of $20\,\mu F$. Calculate the energy stored in the capacitor. **(PPPP)**

Working and Answer:
$E = \dfrac{1}{2}CV^2 = \dfrac{1}{2} \times 20 \times 10^{-6}\,F \times (50\,V)^2 = 0.025\,J.$

9

18. A wire of length $0.5\,m$ carrying a current of $4\,A$ is placed in a magnetic field of $0.2\,T$. Calculate the angle at which the maximum force occurs if the force is measured to be $0.4\,N$. **(PPPP)**

Working and Answer:

$F = BIL\sin(\theta) \Rightarrow \sin(\theta) = \dfrac{F}{BIL} = \dfrac{0.4\,N}{0.2\,T \cdot 4\,A \cdot 0.5\,m} = 1 \Rightarrow \theta = 90°.$

19. A charged particle with a charge of $1.6 \times 10^{-19}\,C$ moves through a magnetic field of strength $0.5\,T$ at a velocity of $1 \times 10^6\,m/s$. Calculate the radius of the circular path it follows. **(PPPPP)**

> *Working and Answer:*
> $r = \dfrac{mv}{BQ} \Rightarrow m = 9.11 \times 10^{-31}\,kg \Rightarrow r = \dfrac{(9.11 \times 10^{-31}\,kg)(1 \times 10^6\,m/s)}{(0.5\,T)(1.6 \times 10^{-19}\,C)} =$
> $0.0114\,m.$

20. A capacitor is charged to $100\,V$ and has a capacitance of $50\,\mu F$. Calculate the total charge stored in the capacitor. **(PPPPP)**

> *Working and Answer:*
> $Q = C \times V = 50 \times 10^{-6}\,F \times 100\,V = 5 \times 10^{-3}\,C = 5\,mC.$

21. A magnetic field of $0.1\,T$ is applied to a wire carrying a current of $10\,A$. If the length of the wire in the field is $0.2\,m$, calculate the force on the wire. **(PPPPP)**

Working and Answer:
$F = BIL = 0.1\,T \times 10\,A \times 0.2\,m = 0.2\,N.$

---

22. A parallel plate capacitor has a plate area of $0.01\,m^2$ and a separation of $0.005\,m$. Calculate the capacitance if the dielectric constant is 3. **(PPPPP)**

Working and Answer:
$C = \dfrac{\varepsilon_0 \cdot A}{d} = \dfrac{(8.85 \times 10^{-12}\,F/m) \cdot 3 \cdot 0.01}{0.005} = 5.31 \times 10^{-12}\,F = 5.31\,pF.$

---

23. A charged particle with a mass of $9.11 \times 10^{-31}\, kg$ and a charge of $1.6 \times 10^{-19}\, C$ moves in a magnetic field of $0.2\, T$ with a velocity of $2 \times 10^6\, m/s$. Calculate the radius of the circular path. **(PPPPP)**

Working and Answer:
$$r = \frac{mv}{BQ} = \frac{(9.11 \times 10^{-31}\, kg)(2 \times 10^6\, m/s)}{(0.2\, T)(1.6 \times 10^{-19}\, C)} = 0.057\, m.$$