# Physics Competitive Exam Notes: Electrostatics & Mechanics

*Comprehensive 1-Hour Class Material with Extensive Numericals*

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## 📚 CLASS 12 ELECTROSTATICS (1 Hour Session)

### 🎯 PART A: FUNDAMENTAL CONCEPTS (15 minutes)

#### 1. Electric Charge and Coulomb's Law

**Core Theory:**

- Charge quantization: $Q = ne$ ($e = 1.6 \times 10^{-19}$ C)
- Conservation: Total charge in isolated system remains constant
- Two types: Positive and Negative

**Coulomb's Law:**

$$F = k(q_1q_2)/r^2 = (1/4\pi\varepsilon_0)(q_1q_2)/r^2$$

**Constants:** $k = 9 \times 10^9$ N·m²/C², $\varepsilon_0 = 8.85 \times 10^{-12}$ C²/N·m²

🔥 **Vector Form:** $F\square_{12} = k(q_1q_2)/r^2 \times \hat{r}_{12}$

### 🧮 NUMERICAL PROBLEMS SET 1: Basic Coulomb's Law

**Problem 1 (KCET Style):** Two point charges +3μC and +5μC are separated by 2m in air. Calculate the force between them.

**Solution:**

Given: $q_1 = 3 \times 10^{-6}$ C, $q_2 = 5 \times 10^{-6}$ C, r = 2m

$F = k(q_1q_2)/r^2$

$F = (9 \times 10^9)(3 \times 10^{-6})(5 \times 10^{-6})/(2)^2$

$F = (9 \times 15 \times 10^{-3})/4 = 0.03375 \text{ N} = 3.375 \times 10^{-2} \text{ N}$

**Problem 2 (NEET Style):** Three charges +2μC, -3μC, and +1μC are placed at corners of an equilateral triangle of side 10cm. Find net force on +1μC charge.

**Solution:**

Step 1: Force due to +2μC on +1μC

$F_1 = k(2\times10^{-6})(1\times10^{-6})/(0.1)^2 = 1.8 \text{ N (repulsive)}$

Step 2: Force due to -3μC on +1μC

$F_2 = k(3\times10^{-6})(1\times10^{-6})/(0.1)^2 = 2.7 \text{ N (attractive)}$

Step 3: Vector addition (60° between forces)

$F_{net} = \sqrt{(F_1^2 + F_2^2 + 2F_1F_2\cos60°)}$

$F_{net} = \sqrt{(1.8^2 + 2.7^2 + 2\times1.8\times2.7\times0.5)} = 3.89 \text{ N}$

**Problem 3 (JEE Style):** Four identical charges Q are placed at four corners of a square of side 'a'. Find the force on one charge due to the other three.

**Solution:**

Force due to adjacent charges: $F_{adj} = kQ^2/a^2$ each (2 charges)
Force due to opposite charge: $F_{opp} = kQ^2/(a\sqrt{2})^2 = kQ^2/(2a^2)$

Resultant of two adjacent forces: $F_{res} = \sqrt{2} \times kQ^2/a^2$
Net force = $F_{res} + F_{opp} = kQ^2/a^2(\sqrt{2} + 1/2)$
$F_{net} = kQ^2/a^2 \times (\sqrt{2} + 0.5) = 1.914\ kQ^2/a^2$

**2. Electric Field Concepts**

**Definition:** $E = F/q_0$ (force per unit positive charge)

**Point Charge:** $E = kQ/r^2$ (magnitude), Direction: radially outward (+ve), inward (-ve)

**Principle of Superposition:** $E_{net} = E_1 + E_2 + E_3 + ...$

## 🧮 NUMERICAL PROBLEMS SET 2: Electric Field

**Problem 4 (KCET Style):** Calculate electric field at a point 30cm away from a +5μC point charge.

**Solution:**

$E = kQ/r^2 = (9\times10^9)(5\times10^{-6})/(0.3)^2$
$E = 45\times10^3/0.09 = 5\times10^5$ N/C

**Problem 5 (NEET Style):** Two charges +8μC and -2μC are separated by 15cm. Find the point where electric field is zero.

**Solution:**

Let the point be at distance x from +8μC charge

$E_1 = k(8\times10^{-6})/x^2$ and $E_2 = k(2\times10^{-6})/(0.15-x)^2$

For E_net = 0: $E_1 = E_2$

$8/x^2 = 2/(0.15-x)^2$

$\sqrt{(8/2)} = x/(0.15-x)$

$2x = 0.15-x$

$3x = 0.15$

$x = 0.05m = 5cm$ from +8μC charge

**Problem 6 (JEE Style):** An electric dipole consists of charges +q and -q separated by distance 2a. Find electric field at a point on the axis at distance r from center (r >> a).

**Solution:**

$E_+ = kq/(r-a)^2$ (away from center)

$E_- = kq/(r+a)^2$ (towards center)

$E_{net} = kq[(1/(r-a)^2) - (1/(r+a)^2)]$

For r >> a: Use binomial approximation

$E_{net} \approx kq[(1/r^2)(1+2a/r) - (1/r^2)(1-2a/r)]$

$E_{net} = kq(4a/r^3) = k(2p)/r^3$ where $p = q\times2a$

### 3. Electric Potential and Potential Energy

**Electric Potential:** V = kQ/r (scalar quantity) **Potential Energy:** U = qV = kQq/r **Relationship:** E□ = -□V (E = -dV/dr for radial field)

## 🧮 NUMERICAL PROBLEMS SET 3: Electric Potential

**Problem 7 (KCET Style):** Find the potential at a point 25cm away from a +4μC charge.

**Solution:**

$$V = kQ/r = (9\times10^{9})(4\times10^{-6})/(0.25)$$
$$V = 36\times10^{3}/0.25 = 1.44\times10^{5}\ V = 144\ kV$$

**Problem 8 (NEET Style):** Two charges +6μC and -4μC are separated by 50cm. Find potential at the midpoint.

**Solution:**

$$V_1 = k(6\times10^{-6})/(0.25) = 2.16\times10^{5}\ V$$
$$V_2 = k(-4\times10^{-6})/(0.25) = -1.44\times10^{5}\ V$$
$$V_{net} = V_1 + V_2 = 2.16\times10^{5} - 1.44\times10^{5} = 0.72\times10^{5}\ V = 72\ kV$$

**Problem 9 (JEE Style):** A charge q is moved from infinity to a point in an electric field. If work done is W, find the potential at that point.

**Solution:**

Work done = Change in potential energy
$W = U_{final} - U_{initial} = qV - 0 = qV$
Therefore: $V = W/q$

### 4. Gauss's Law and Applications

**Gauss's Law:** $\oint E \cdot dA = Q_{enclosed}/\varepsilon_0$

**Key Results:**

- **Infinite line charge:** $E = \lambda/(2\pi\varepsilon_0 r)$
- **Infinite plane sheet:** $E = \sigma/(2\varepsilon_0)$
- **Spherical conductor:** $E = 0$ (inside), $E = kQ/r^2$ (outside)
- **Solid sphere:** $E = kQr/R^3$ (inside), $E = kQ/r^2$ (outside)

## 🧮 NUMERICAL PROBLEMS SET 4: Gauss's Law

**Problem 10 (NEET Style):** An infinite line charge has linear charge density $10^{-6}$ C/m. Find electric field at 5cm distance.

**Solution:**

$E = \lambda/(2\pi\varepsilon_0 r) = \lambda k'/(r)$ where $k' = 1/(2\pi\varepsilon_0) = 18\times10^9$
$E = (18\times10^9)(10^{-6})/(0.05) = 3.6\times10^5$ N/C

**Problem 11 (JEE Style):** A uniformly charged sphere of radius R has total charge Q. Find electric field at distance r from center when: (a) $r < R$ (b) $r > R$

**Solution:**

(a) For $r < R$ (inside sphere):
Charge enclosed $= Q(r^3/R^3)$
$E \times 4\pi r^2 = Q(r^3/R^3)/\varepsilon_0$
$E = Qr/(4\pi\varepsilon_0 R^3) = kQr/R^3$

(b) For $r > R$ (outside sphere):
$E = Q/(4\pi\varepsilon_0 r^2) = kQ/r^2$

### 5. Capacitors and Capacitance

**Definition:** $C = Q/V$

**Parallel Plate Capacitor:** $C = \varepsilon_0 A/d$

**Combinations:**

- **Series:** $1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3$
- **Parallel:** $C_{eq} = C_1 + C_2 + C_3$

**Energy:** $U = \frac{1}{2}CV^2 = \frac{1}{2}QV = Q^2/(2C)$

**With Dielectric:** $C' = KC$ (K = dielectric constant)

## 🧮 NUMERICAL PROBLEMS SET 5: Capacitors

**Problem 12 (KCET Style):** A parallel plate capacitor has plates of area 200 $cm^2$ separated by 2mm. Find its capacitance in air.

**Solution:**

$$C = \varepsilon_0 A/d = (8.85\times10^{-12})(200\times10^{-4})/(2\times10^{-3})$$
$$C = (8.85\times10^{-12})(0.02)/(0.002) = 8.85\times10^{-11}\ F = 88.5\ pF$$

**Problem 13 (NEET Style):** Three capacitors 2μF, 4μF, and 6μF are connected in series. Find equivalent capacitance.

**Solution:**

$$1/C_{eq} = 1/2 + 1/4 + 1/6 = (6+3+2)/12 = 11/12$$
$$C_{eq} = 12/11\ \mu F = 1.09\ \mu F$$

**Problem 14 (JEE Style):** A 5μF capacitor is charged to 100V. Calculate: (a) Charge stored (b) Energy stored (c) If connected to an identical uncharged capacitor, find final energy.

**Solution:**

(a) $Q = CV = 5\times10^{-6} \times 100 = 5\times10^{-4}$ C = 500 μC

(b) $U = \frac{1}{2}CV^2 = \frac{1}{2} \times 5\times10^{-6} \times (100)^2 = 2.5\times10^{-2}$ J = 25 mJ

(c) When connected in parallel:
Total charge = 500 μC (conserved)
Total capacitance = 5 + 5 = 10 μF
Final voltage = $Q/C = 500\times10^{-6}/10\times10^{-6}$ = 50V
Final energy = $\frac{1}{2} \times 10\times10^{-6} \times (50)^2 = 1.25\times10^{-2}$ J = 12.5 mJ
Energy lost = 25 - 12.5 = 12.5 mJ

### 6. Electric Dipole in Detail

**Dipole Moment:** $\vec{p} = q \times 2\vec{a}$ (from -q to +q)

**Potential:** $V = (1/4\pi\varepsilon_0) \times (\vec{p}\cdot\hat{r})/r^2 = kp \cos\theta/r^2$

**Electric Field:**

- **On axis:** $E = 2kp/r^3$
- **On equatorial line:** $E = kp/r^3$
- **General:** $E_r = 2kp \cos\theta/r^3$, $E_\theta = kp \sin\theta/r^3$

**Torque:** $\vec{\tau} = \vec{p} \times \vec{E}$

**Potential Energy:** $U = -\vec{p}\cdot\vec{E} = -pE \cos\theta$

## 🧮 NUMERICAL PROBLEMS SET 6: Electric Dipole

**Problem 15 (NEET Style):** An electric dipole has charges $\pm 4\times10^{-6}$ C separated by 6cm. Calculate dipole moment and potential at 30cm on the axis.

**Solution:**

$$p = q \times 2a = 4\times10^{-6} \times 0.06 = 2.4\times10^{-7}\ \text{C·m}$$

$$V = 2kp/r^2 = 2 \times 9\times10^{9} \times 2.4\times10^{-7}/(0.3)^2$$
$$V = 4.32\times10^{3}/0.09 = 4.8\times10^{4}\ \text{V} = 48\ \text{kV}$$

**Problem 16 (JEE Style):** A dipole with moment $2\times10^{-6}$ C·m is placed in uniform field $5\times10^{5}$ N/C. Find: (a) Maximum torque (b) Work done to rotate from $\theta=0°$ to $\theta=90°$.

**Solution:**

(a) $\tau_{max} = pE$ (when $\theta = 90°$)
$\tau_{max} = 2\times10^{-6} \times 5\times10^{5} = 1$ N·m

(b) $W = U_{final} - U_{initial} = -pE\cos(90°) - (-pE\cos(0°))$
$W = 0 - (-pE) = pE = 2\times10^{-6} \times 5\times10^{5} = 1$ J

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# 🚀 CLASS 11 MECHANICS (1 Hour Session)

## 🎯 PART B: KINEMATICS (20 minutes)

### 1. Motion in Straight Line

**Equations of Motion:**

1. $v = u + at$
2. $s = ut + \frac{1}{2}at^2$
3. $v^2 = u^2 + 2as$
4. $s = (u + v)t/2$

🔥 **Advanced Relations:**

- $s_{nth} = u + a/2(2n-1)$ (displacement in nth second)
- Average velocity = Total displacement/Total time

## 🧮 NUMERICAL PROBLEMS SET 7: Linear Motion

**Problem 17 (KCET Style):** A car accelerates from rest at 2 $m/s^2$ for 10 seconds. Find: (a) Final velocity (b) Distance covered.

**Solution:**

Given: $u = 0$, $a = 2\ m/s^2$, $t = 10s$

(a) $v = u + at = 0 + 2 \times 10 = 20\ m/s$

(b) $s = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 2 \times (10)^2 = 100\ m$

**Problem 18 (NEET Style):** A stone is dropped from height h. Another stone is thrown downward with velocity u from same height after time $t_1$. When do they meet?

**Solution:**

For dropped stone: $y_1 = \frac{1}{2}gt^2$ (distance fallen)
For thrown stone: $y_2 = u(t-t_1) + \frac{1}{2}g(t-t_1)^2$ (distance fallen)

When they meet: $y_1 = y_2$
$\frac{1}{2}gt^2 = u(t-t_1) + \frac{1}{2}g(t-t_1)^2$
$\frac{1}{2}gt^2 = u(t-t_1) + \frac{1}{2}g(t^2 - 2tt_1 + t_1^2)$
$\frac{1}{2}gt^2 = u(t-t_1) + \frac{1}{2}gt^2 - gt\,t_1 + \frac{1}{2}gt_1^2$
$0 = u(t-t_1) - gt\,t_1 + \frac{1}{2}gt_1^2$
$gt\,t_1 = u(t-t_1) + \frac{1}{2}gt_1^2$
$t = (ut_1 + \frac{1}{2}gt_1^2)/(u + gt_1)$

### 2. Projectile Motion

**Key Equations:**

- **Time of flight:** $T = 2u \sin \theta/g$
- **Maximum height:** $H = u^2 \sin^2 \theta/(2g)$
- **Range:** $R = u^2 \sin 2\theta/g$
- **Trajectory:** $y = x \tan \theta - gx^2/(2u^2 \cos^2 \theta)$

## 🧮 NUMERICAL PROBLEMS SET 8: Projectile Motion

**Problem 19 (NEET Style):** A projectile is fired at 45° with velocity 50 m/s. Find: (a) Time of flight (b) Maximum height (c) Range.

**Solution:**

Given: $u = 50$ m/s, $\theta = 45°$, $g = 10$ m/s²

(a) $T = 2u \sin\theta/g = 2\times50\times\sin45°/10 = 2\times50\times(1/\sqrt{2})/10 = 5\sqrt{2} \approx 7.07$ s

(b) $H = u^2 \sin^2\theta/(2g) = (50)^2\times(\sin45°)^2/(2\times10) = 2500\times(1/2)/(20) = 62.5$ m

(c) $R = u^2 \sin 2\theta/g = (50)^2\times\sin90°/10 = 2500\times1/10 = 250$ m

**Problem 20 (JEE Style):** A ball is thrown horizontally from height 80m with velocity 20 m/s. Find: (a) Time to reach ground (b) Horizontal distance (c) Velocity when it hits ground.

**Solution:**

(a) Vertical motion: $h = \frac{1}{2}gt^2$
$80 = \frac{1}{2}\times10\times t^2 \implies t = 4$ s

(b) Horizontal distance = $u_x \times t = 20\times4 = 80$ m

(c) $v_x = 20$ m/s (remains constant)
$v_y = gt = 10\times4 = 40$ m/s
$|v| = \sqrt{(v_x^2 + v_y^2)} = \sqrt{(20^2 + 40^2)} = \sqrt{(400 + 1600)} = \sqrt{2000} = 20\sqrt{5} \approx 44.7$ m/s

## 🎯 PART C: LAWS OF MOTION (15 minutes)

**Newton's Laws and Applications**

**Newton's Second Law:** $\vec{F} = m\vec{a}$ (vector form)

**Friction:**

- Static: $f_s \leq \mu_s N$
- Kinetic: $f_k = \mu_k N$

**Constraint Relations:** For connected bodies, accelerations are related

## 🧮 NUMERICAL PROBLEMS SET 9: Force and Motion

**Problem 21 (KCET Style):** A 5kg block is pulled by 30N force at 37° to horizontal. If $\mu = 0.3$, find acceleration. ($\cos 37° = 0.8$, $\sin 37° = 0.6$)

**Solution:**

Forces analysis:
Horizontal component: $F_x = 30 \times 0.8 = 24$ N
Vertical component: $F_y = 30 \times 0.6 = 18$ N

Normal force: $N = mg - F_y = 5 \times 10 - 18 = 32$ N
Friction force: $f = \mu N = 0.3 \times 32 = 9.6$ N

Net horizontal force = $F_x - f = 24 - 9.6 = 14.4$ N
Acceleration = $F_{net}/m = 14.4/5 = 2.88$ m/s²

**Problem 22 (JEE Style):** Two blocks of masses 2kg and 3kg are connected by a string passing over a pulley. Find acceleration of the system and tension in string.

**Solution:**

Let a = acceleration, T = tension
For 3kg block (downward): 3g - T = 3a
For 2kg block (upward): T - 2g = 2a

Adding equations: 3g - 2g = 3a + 2a
g = 5a ⟹ a = g/5 = 2 m/s²

From second equation: T = 2g + 2a = 2×10 + 2×2 = 24 N

## 🎯 PART D: WORK, ENERGY AND POWER (15 minutes)

**Energy Conservation and Work-Energy Theorem**

**Work:** $W = \vec{F} \cdot \vec{s} = Fs\cos\theta$

**Kinetic Energy:** $KE = \frac{1}{2}mv^2$

**Potential Energy:**

- Gravitational: $PE = mgh$
- Elastic: $PE = \frac{1}{2}kx^2$

**Work-Energy Theorem:** $W_{net} = \Delta KE$

**Power:** $P = W/t = \vec{F} \cdot \vec{v}$

## 🧮 NUMERICAL PROBLEMS SET 10: Work and Energy

**Problem 23 (NEET Style):** A 2kg object moves from rest under constant force 10N for 5m. Find: (a) Work done (b) Final velocity (c) Power at end.

**Solution:**

(a) Work done = F×s = 10×5 = 50 J

(b) Using work-energy theorem: W = ΔKE = ½mv² - 0
50 = ½×2×v² ⟹ v = 5√2 ≈ 7.07 m/s

Alternative: a = F/m = 10/2 = 5 m/s²
v² = u² + 2as = 0 + 2×5×5 = 50 ⟹ v = 5√2 m/s

(c) Power = F·v = 10×5√2 = 50√2 ≈ 70.7 W

**Problem 24 (JEE Style):** A spring with k = 200 N/m is compressed by 10cm. Find: (a) Potential energy stored (b) Velocity of 0.5kg mass when released from compression.

**Solution:**

(a) PE = ½kx² = ½×200×(0.1)² = ½×200×0.01 = 1 J

(b) Using energy conservation: PE = KE
½kx² = ½mv²
kx² = mv²
v = x√(k/m) = 0.1×√(200/0.5) = 0.1×√400 = 0.1×20 = 2 m/s

## 🎯 PART E: ROTATIONAL MECHANICS (10 minutes)

### Moment of Inertia and Rotational Motion

**Key Moments of Inertia:**

- Rod (center): I = ML²/12
- Rod (end): I = ML²/3

- Ring: $I = MR^2$
- Disc: $I = MR^2/2$
- Sphere: $I = 2MR^2/5$

**Rotational KE:** $KE_{rot} = \frac{1}{2}I\omega^2$

**Rolling Motion:** $KE_{total} = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}mv^2(1 + I/mR^2)$

## 🧮 NUMERICAL PROBLEMS SET 11: Rotation

**Problem 25 (NEET Style):** A solid disc of mass 2kg and radius 0.5m rolls down an incline of height 5m. Find velocity at bottom.

**Solution:**

Energy conservation: $mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$
For rolling: $v = \omega R$, so $\omega = v/R$
For disc: $I = \frac{1}{2}mR^2$

$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\times(\frac{1}{2}mR^2)\times(v/R)^2$
$mgh = \frac{1}{2}mv^2 + \frac{1}{4}mv^2$
$mgh = \frac{3}{4}mv^2$

$v^2 = 4gh/3 = 4\times10\times5/3 = 200/3$
$v = \sqrt{(200/3)} = 10\sqrt{(2/3)} \approx 8.16$ m/s

**Problem 26 (JEE Style):** A rod of length 2m and mass 3kg rotates about an axis through its center. If angular velocity is 10 rad/s, find rotational kinetic energy.

**Solution:**

$I = ML^2/12 = 3\times(2)^2/12 = 3\times4/12 = 1\ kg\cdot m^2$

$KE_{rot} = \frac{1}{2}I\omega^2 = \frac{1}{2}\times1\times(10)^2 = 50\ J$

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# 🎯 ADVANCED PROBLEM SETS

## 🔥 CHALLENGING NUMERICALS

**Problem 27 (JEE Advanced Style):** A charge +Q is distributed uniformly on a ring of radius R. Find electric field at distance x on the axis.

**Solution:**

Consider element dq on ring at angle θ

$dE = k(dq)/r^2$ where $r = \sqrt{(x^2 + R^2)}$

Component along axis: $dE_x = dE \times \cos\alpha = dE \times x/\sqrt{(x^2 + R^2)}$

$E_x = \int(k(dq)x)/(x^2 + R^2)^{(3/2)} = (kQx)/(x^2 + R^2)^{(3/2)}$

Special cases:

- At center (x = 0): E = 0
- At $x >> R$: $E \approx kQ/x^2$ (point charge)

**Problem 28 (NEET Advanced):** A satellite orbits Earth at height h above surface. If Earth's radius is R, find orbital velocity.

**Solution:**

For circular orbit: Gravitational force = Centripetal force

$GMm/(R+h)^2 = mv^2/(R+h)$

$v^2 = GM/(R+h)$

At surface: $g = GM/R^2 \implies GM = gR^2$

$v = \sqrt{(gR^2/(R+h))} = R\sqrt{(g/(R+h))}$

For $h << R$: $v \approx \sqrt{(gR)} = \sqrt{(10 \times 6.4 \times 10^6)} = 8 \times 10^3$ m/s = 8 km/s

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# 📋 COMPETITIVE EXAM PATTERNS

## 🎯 TOPIC-WISE WEIGHTAGE

**NEET Physics:**

- **Electrostatics:** 3-4 questions (12-16 marks)
- **Mechanics:** 8-10 questions (32-40 marks)

**JEE Main:**

- **Electrostatics:** 2-3 questions
- **Mechanics:** 7-8 questions

**KCET:**

- **Electrostatics:** 4-5 questions
- **Mechanics:** 15-18 questions

## 🔥 RAPID FIRE QUESTIONS

**Quick Solve (30 seconds each):**

1. **Q:** If charge is doubled and distance is halved, force becomes?
   **A:** 16 times ($\propto q^2/r^2$)
2. **Q:** Equipotential surfaces are always _____ to electric field lines.
   **A:** Perpendicular
3. **Q:** Inside a conductor in electrostatic equilibrium, E = ? **A:** Zero
4. **Q:** Capacitance of parallel plate capacitor is doubled when? **A:** Area doubled OR distance halved OR dielectric inserted
5. **Q:** For projectile motion, range is maximum at angle? **A:** 45°
6. **Q:** Rolling sphere KE = translational KE × ? **A:** 1.4 (since total = $1.4 \times \frac{1}{2}mv^2$)

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# ⚡ LAST MINUTE REVISION

## 🎯 FORMULA FLASH CARDS

**Electrostatics:**

- $F = kq_1q_2/r^2$
- $E = kQ/r^2$
- $V = kQ/r$
- $C = \varepsilon_0 A/d$
- $U = \frac{1}{2}CV^2$
- $\tau = p \times E$ (dipole)

**Mechanics:**

- $v^2 = u^2 + 2as$
- $R = u^2\sin2\theta/g$
- $F = ma$
- $W = F \cdot s$
- $KE = \frac{1}{2}mv^2$
- $I = \frac{1}{2}MR^2$ (disc)

## 🏆 SUCCESS MANTRAS

1. **Always draw diagrams** for electrostatics problems
2. **Check dimensions** of your final answer
3. **Use energy conservation** when possible - it's faster
4. **For multiple choice** - eliminate wrong options first
5. **Approximate** when exact calculation is time-consuming

**Time Allocation for 1-hour exam:**

- Easy (40%): 24 minutes
- Medium (40%): 24 minutes
- Difficult (20%): 12 minutes

**Remember: Accuracy > Speed. Master these numericals and you'll dominate competitive exams!** 🚀