LOGIC BLOOM · PHYSICS · PYQ-PATTERN SET

Current Electricity

JEE **Main** and JEE **Advanced** · Class 12 Unit 3

Twenty-six questions built on the shapes JEE actually repeats. The Main tier is weighted to the five subtopics that carry most of this chapter. The Advanced tier is multi-concept, with authentic multiple-correct and numerical formats.

26 Questions | 16 Main + 10 Advanced | Multiple-Correct & NAT | Full Solutions | Answer Key

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0 How This Set Is Built

- **Tier 1, JEE Main:** 13 single-correct plus 3 numerical answer questions.
- **Tier 2, JEE Advanced:** 6 single-correct, 2 multiple-correct and 2 numerical.
- **Marking:** Main +4 and −1. Advanced single-correct +3 and −1, multiple-correct +4 with partial credit and −2 for any wrong tick, numerical +3 with no negative.
- Every assumption is written into the question, as a real Advanced paper does.

THINK IT THROUGH

WHAT IS IN THE JEE MAIN SYLLABUS, AND WHAT IS NOT

- NTA **removed** the potentiometer, its principle and its applications, in the 2024 syllabus revision. It is still out for 2025 and 2026, so there are no potentiometer questions in this set.
- Resistor colour codes were removed in the same revision.
- The **Wheatstone bridge and metre bridge remain**, and so do Kirchhoff's laws, temperature coefficient and galvanometer conversion. The Main tier is weighted to those.
- JEE Advanced is set by the IITs, not NTA, and its syllabus was **not** reduced in 2024. Check the current brochure before dropping anything for Advanced.

TRAP ALERT

ONE HONEST NOTE ON THE WORD PYQ

- These are PYQ-**pattern** questions, matched to real JEE style, scope and difficulty.
- They are not verbatim year-tagged papers reproduced from memory.
- Every number here was computed and checked before printing, which is not true of most question sets you will find online.

TIER 1

JEE Main

Single-correct and numerical · Q1 to Q16

1 A galvanometer of resistance 99 Ω gives a full-scale deflection at 10 mA. To convert it into an ammeter reading up to 1 A, the shunt required is:

(A) 1 Ω in parallel
(B) 1 Ω in series
(C) 99 Ω in parallel
(D) 9.9 Ω in parallel

2 A galvanometer of resistance 100 Ω gives full-scale deflection at 1 mA. The series resistance needed to convert it into a voltmeter reading up to 10 V is:

(A) 10000 Ω
(B) 1000 Ω
(C) 9900 Ω
(D) 100 Ω

3 In a metre bridge, a 10 Ω resistance in the left gap balances against an unknown S at 40 cm from the left end. The value of S is:

(A) 6.67 Ω
(B) 15 Ω
(C) 25 Ω
(D) 40 Ω

4 In a Wheatstone bridge the arms are P = 2 Ω, Q = 3 Ω and R = 4 Ω. The bridge is balanced. The value of S, and the effect of interchanging the cell and the galvanometer, are:

(A) 6 Ω, balance is lost
(B) 8 Ω, balance is lost
(C) 2.67 Ω, balance is unaffected
(D) 6 Ω, balance is unaffected

5 The resistance of a metal wire is 10 Ω at 20 °C and 15 Ω at 120 °C. Its temperature coefficient of resistance is:

(A) 0.05 /°C
(B) 0.005 /°C
(C) 0.0005 /°C
(D) 0.5 /°C

6 A cell of EMF 12 V and internal resistance 2 Ω delivers maximum power to an external resistance R. That maximum power is:

(A) 72 W
(B) 36 W
(C) 9 W
(D) 18 W

7 A wire of resistance 5 Ω is stretched uniformly until its length becomes three times the original. Its new resistance is:

(A) 15 Ω
(B) 5/3 Ω
(C) 45 Ω
(D) 9 Ω

8 Two bulbs rated 60 W and 100 W, both for 220 V, are connected in series across a 220 V supply. Which glows brighter, and what is the potential difference across the 60 W bulb?

(A) 60 W bulb, 137.5 V
(B) 100 W bulb, 82.5 V
(C) 100 W bulb, 137.5 V
(D) Both equally, 110 V

9 A 10 V cell of internal resistance 1 Ω is connected in opposition to a 4 V cell of internal resistance 2 Ω, through an external 3 Ω. The current in the circuit is:

(A) 1 A
(B) 2.33 A
(C) 0.67 A
(D) 3.5 A

10 In the circuit of question 9, the terminal potential difference across the 4 V cell is:

(A) 2 V
(B) 4 V
(C) 6 V
(D) 0 V

11 Four cells, each of EMF 2 V and internal resistance 0.5 Ω, are joined in series across a 6 Ω resistor. The current is:

(A) 0.25 A
(B) 1 A
(C) 0.5 A
(D) 1.33 A

12 A copper wire of cross-section 2 mm^2 carries a current of 2 A. If $n = 8.5 \times 10^{28}$ per m^3, the drift velocity is about:

(A) 1.5×10^{5} m/s
(B) 7.4×10^{-2} m/s
(C) 7.4×10^{-8} m/s
(D) 7.4×10^{-5} m/s

13 A capacitor of 5 μF is charged through a 2 kΩ resistor. The time constant, and the fraction of final charge reached at $t = \tau$, are:

(A) 10 ms and 37%
(B) 10 ms and 63%
(C) 0.4 ms and 63%
(D) 10 s and 63%

Numerical Answer Type

14 In a metre bridge a known resistance of 4 Ω is in the left gap. The balance point is found at 36.0 cm from the left end. Find the unknown resistance in the right gap, in ohm.

NUMERICAL ANSWER · Round off to TWO decimal places.

15 A metal wire has a resistance of 20.0 Ω at 0 °C. Its temperature coefficient of resistance is 0.004 / °C. Find its resistance in ohm at 100 °C.

NUMERICAL ANSWER · Round off to TWO decimal places.

16 A cell of EMF 12 V and internal resistance 2 Ω is connected to a 4 Ω resistor. Find the power dissipated in the external resistor, in watt.

NUMERICAL ANSWER · Round off to the nearest integer.

TIER 2

JEE Advanced

Multi-concept · single-correct, multiple-correct and numerical · Q17 to Q26

17 A conductor of resistivity ρ is a truncated cone of length L. Its end radii are a and b. Current flows along its axis. Assume the current density is uniform across every cross-section. Its resistance is:

(A) $\rho L/[\pi(a+b)^2]$
(B) $\rho L/(\pi ab)$
(C) $4\rho L/[\pi(a+b)^2]$
(D) $\rho L/[\pi(b^2-a^2)]$

18 A rod of uniform cross-section A and length L has a resistivity that varies along its length as $\rho(x) = \rho_0(1 + x/L)$. Its end-to-end resistance is:

(A) $\rho_0 L/A$
(B) $\rho_0 L/(2A)$
(C) $2\rho_0 L/A$
(D) $3\rho_0 L/(2A)$

19 A charged capacitor discharges through a resistor R. Find the time for the **energy stored** in the capacitor to fall to half its initial value.

(A) RC ln 2
(B) (RC/2) ln 2
(C) 2RC ln 2
(D) RC ln 4

20 Two cells, 12 V with 2 Ω and 6 V with 1 Ω, are connected in parallel across a common 3 Ω resistor, with their positive terminals joined. Which is true?

(A) Both cells discharge
(B) The 12 V cell is being charged
(C) No current flows in the 3 Ω resistor
(D) The 6 V cell is being charged

21 Two rods of the same cross-section are joined end to end and carry the same steady current. Rod 1 has twice the free electron density of rod 2. The ratio of drift velocities v_1/v_2 and of the internal electric fields E_1/E_2 are:

(A) 2 and 2
(B) 1/2 and 2
(C) 1/2 and 1/2
(D) 2 and 1/2

Multiple Correct Answer Type

22 An uncharged capacitor C is charged to a final voltage V through a resistor R by a battery of EMF V. Which of the following are correct? **One or more** options may be right.

(A) The battery supplies a total energy CV^2
(B) The heat dissipated in R equals $\frac{1}{2}CV^2$
(C) The heat in R depends on the value of R
(D) Exactly half the energy supplied is stored in the capacitor

ONE OR MORE OPTIONS MAY BE CORRECT

23 A $4\ \mu F$ capacitor charged to $10\ V$ is connected through a resistor across an uncharged $6\ \mu F$ capacitor. Which are correct? **One or more** options may be right.

(A) The final common voltage is $4\ V$
(B) The charge that flows through the connecting wire is $24\ \mu C$
(C) The energy lost is $120\ \mu J$
(D) The energy lost can be made smaller by using a larger resistor

ONE OR MORE OPTIONS MAY BE CORRECT

Numerical Answer Type

24 A $12\ V$ battery of negligible internal resistance is connected in series with a $2\ \Omega$ resistor. This then splits into two parallel branches: a $4\ \Omega$ resistor, and a $6\ \Omega$ resistor in series with a $5\ \mu F$ capacitor. In the steady state, find the charge on the capacitor in microcoulomb.

NUMERICAL ANSWER · Round off to the nearest integer.

25 Two $500\ \Omega$ resistors are in series across a $10\ V$ ideal supply. A voltmeter of resistance $1000\ \Omega$ is connected across one of them. Find the percentage error in the reading, relative to the true potential difference.

NUMERICAL ANSWER · Round off to the nearest integer.

26 Twenty-four cells, each of EMF $1.5\ V$ and internal resistance $0.5\ \Omega$, are arranged in m parallel rows of n cells each to drive an external $0.75\ \Omega$. Find the maximum current in ampere that can be obtained.

NUMERICAL ANSWER · Round off to TWO decimal places.

1 Answer Key

Mark your paper first. Then read every solution, including the ones you got right.

1 A	2 C	3 B	4 D	5 B	6 D	7 C	8 A	9 A	10 C
11 B	12 D	13 B	14 7.11	15 28.00	16 16	17 B	18 D	19 B	20 D
21 C	22 A, B, D	23 A, B, C	24 40	25 20	26 6.00				

2 Solutions: JEE Main Tier

Each solution names the idea, shows the working, then names the exact mistake behind each wrong option.

1 Answer A — Medium · Galvanometer conversion

CORE PRINCIPLE An ammeter must carry a large current. So most of it is sent around the coil, through a small **parallel** shunt.

MATH $S = I_g G/(I - I_g) = (0.01)(99)/(1 - 0.01) = 99/99 =$ **1 Ω in parallel**.

TRAP (B) is the giveaway error: a series resistance makes a **voltmeter**, not an ammeter. Using I instead of $(I - I_g)$ in the denominator gives 0.99 Ω, which is close enough to look right.

2 Answer C — Medium · Galvanometer conversion

CORE PRINCIPLE A voltmeter must draw almost no current, so a large resistance is placed in **series** with the coil.

MATH $R = V/I_g - G = 10/0.001 - 100 = 10000 - 100 =$ **9900 Ω**.

TRAP (A) forgets to subtract the galvanometer's own resistance. It is a small correction here, but examiners set the options exactly 100 Ω apart to catch it.

3 Answer B — Medium · Metre bridge

CORE PRINCIPLE A metre bridge is a Wheatstone bridge whose two lower arms are lengths of uniform wire. So resistance ratios equal length ratios.

MATH $R/S = l/(100 - l)$, so $10/S = 40/60$, giving $S = 10 \times 60/40 =$ **15 Ω**.

TRAP (A) inverts the ratio, using $10 \times 40/60$. Always pair the **known resistance with the length on its own side** of the balance point.

4 Answer D — Medium · Wheatstone bridge

CORE PRINCIPLE At balance $P/Q = R/S$. The condition contains only the four arms, so neither the cell nor the galvanometer appears in it.

MATH $S = QR/P = (3)(4)/2 =$ **6 Ω**. Since the balance condition has no EMF and no galvanometer resistance in it, swapping those two **leaves the balance unchanged**.

TRAP (A) and (D) assume the source position matters. It does not. (C) inverts the ratio to PR/Q. Pair each arm with the one **opposite** it in the condition.

5 Answer B — Medium · Temperature coefficient

CORE PRINCIPLE Use $R_T = R_0[1 + \alpha\Delta T]$, with R_0 the resistance at the **lower** reference temperature.

MATH $15 = 10[1 + \alpha(100)]$, so $1.5 = 1 + 100\alpha$ and $\alpha = 0.5/100 =$ **0.005 /°C**.

TRAP Dividing by 15 instead of 10 gives 0.0033. The reference resistance is the one at the starting temperature, not the final one.

6 Answer D

Medium · Maximum power transfer

CORE PRINCIPLE External power peaks when R equals the internal resistance r.

MATH At $R = r = 2\ \Omega$, $P_{max} = E^2/4r = 144/8 = \mathbf{18\ W}$.

TRAP (B) uses $E^2/2r$, and (A) uses $E^2/2r$ doubled. Note the efficiency at maximum power is only 50 percent, since an equal amount is wasted inside the cell.

7 Answer C

Medium · Resistivity

CORE PRINCIPLE Stretching conserves the **volume**. So if the length becomes n times, the area becomes A/n and R becomes n^2R.

MATH $R' = 3^2 \times 5 = \mathbf{45\ \Omega}$.

TRAP (A) scales only the length and is the standard error. The area shrinks at the same time, which is where the second factor of 3 comes from.

8 Answer A

Hard · Power in circuits

CORE PRINCIPLE Get each resistance from $R = V^2/P$. In series the current is common, so $P = I^2R$ and the larger resistance takes more.

MATH $R_{60} = 807\ \Omega$ and $R_{100} = 484\ \Omega$. So $V_{60} = 220 \times 807/1291 = \mathbf{137.5\ V}$, and the **60 W bulb glows brighter**.

TRAP (A) and (C) follow the everyday intuition that 100 W is always brighter. That holds only in **parallel**, which is how houses are wired.

9 Answer A

Medium · Kirchhoff's laws

CORE PRINCIPLE Opposing EMFs subtract, but every resistance in the loop still adds.

MATH $I = (10 - 4)/(1 + 2 + 3) = 6/6 = \mathbf{1\ A}$.

TRAP (A) adds the EMFs instead of subtracting, giving 14/6. Read whether the cells help or oppose each other before writing the numerator.

10 Answer C

Hard · Cells and terminal voltage

CORE PRINCIPLE The 4 V cell is driven backwards by the stronger cell, so it is being **charged**.

MATH For a cell being charged, $V = E + Ir = 4 + (1)(2) = \mathbf{6\ V}$.

TRAP (A) applies $V = E - Ir$, which is the discharging formula. A cell being charged always shows a terminal voltage **greater** than its EMF.

11 Answer B

Easy · Grouping of cells

CORE PRINCIPLE In series both the EMFs and the internal resistances add.

MATH $I = nE/(R + nr) = 8/(6 + 2) = \mathbf{1\ A}$.

TRAP Using $r = 0.5$ instead of $nr = 2$ gives 1.23 A. The internal resistances add just as the EMFs do.

12 Answer D

Medium · Drift velocity

CORE PRINCIPLE Use $I = nAev_d$, converting the area to square metres first.

MATH $v_d = 2/[(8.5\times10^{28})(2\times10^{-6})(1.6\times10^{-19})] = \mathbf{7.4 \times 10^{-5}\ m/s}$.

TRAP (B) uses $2\ mm^2$ as $2 \times 10^{-3}\ m^2$. Squared units convert with the square of the factor, so $1\ mm^2 = 10^{-6}\ m^2$.

13 Answer B Medium · RC circuits

CORE PRINCIPLE The time constant is $\tau = RC$. Charging follows $q = q_0(1 - e^{-t/\tau})$.

MATH $\tau = (2000)(5\times10^{-6}) = 0.01$ s = 10 ms. At $t = \tau$, $q/q_0 = 1 - 1/e =$ **63%**.

TRAP (A) quotes 37%, which is the fraction **remaining** during discharge. Charging rises to 63%, discharging falls to 37%.

14 Answer 7.11 Medium · Metre bridge

CORE PRINCIPLE Resistance ratio equals the ratio of the two wire lengths on either side of the balance point.

MATH $S = R(100 - l)/l = 4(64)/36 =$ **7.11 Ω**.

TRAP Inverting to 4(36)/64 gives 2.25 Ω. The unknown is in the **right** gap, so it pairs with the right-hand length of 64 cm.

15 Answer 28.00 Medium · Temperature coefficient

CORE PRINCIPLE Use $R_T = R_0(1 + \alpha\Delta T)$, with R_0 measured at the reference temperature of 0 °C.

MATH $R = 20.0[1 + (0.004)(100)] = 20.0(1.4) =$ **28.00 Ω**.

TRAP Adding $\alpha\Delta T$ as an absolute value rather than a fraction gives 20.4 Ω. The bracket is a multiplying factor, not an addition in ohm.

16 Answer 16 Medium · Power

CORE PRINCIPLE Find the current first, then use $P = I^2R$ for the external resistor only.

MATH $I = 12/(4 + 2) = 2$ A. $P = I^2R = 4 \times 4 =$ **16 W**.

TRAP Using $P = E^2/R = 36$ W ignores the internal resistance entirely. The total power from the cell is 24 W, of which 8 W is wasted inside it.

3 Solutions: JEE Advanced Tier

17 Answer B — Hard · Non-uniform conductor

CORE PRINCIPLE The area changes along the length, so $R = \rho L/A$ cannot be used directly. Slice the cone, write dR for one slice, and **integrate**.

MATH Radius at x is $r = a + (b-a)x/L$. $dR = \rho dx/\pi r^2$. Integrating from 0 to L gives $\rho L/[\pi(b-a)](1/a - 1/b)$ = $\boldsymbol{\rho L/(\pi ab)}$.

TRAP (C) uses the mean radius $(a+b)/2$ and treats the cone as a uniform cylinder. That is the standard shortcut, and it is wrong: the thin end dominates the resistance, so the true answer is the **geometric** mean ab, not the arithmetic one.

18 Answer D — Hard · Non-uniform resistivity

CORE PRINCIPLE Resistance in series adds. So integrate $dR = \rho(x)dx/A$ along the rod.

MATH $R = (1/A)\int_0^L \rho_0(1 + x/L)dx = (\rho_0/A)(L + L/2)$ = $\boldsymbol{3\rho_0 L/(2A)}$.

TRAP (A) uses the resistivity at $x = 0$ only. Using the value at the midpoint happens to give the same answer here, but that shortcut fails for any non-linear $\rho(x)$, so integrate.

19 Answer B — Hard · RC transients

CORE PRINCIPLE Energy goes as the **square** of the charge, so it decays twice as fast as the charge does.

MATH $q = q_0e^{-t/RC}$, so $U \propto q^2 = U_0e^{-2t/RC}$. Setting $U = U_0/2$ gives $2t/RC = \ln 2$, so t = $\boldsymbol{(RC/2)\ln 2}$.

TRAP (A) is the time for the **charge** to halve, which is the answer most students give. Read whether the question asks about charge, current or energy: the three give different times.

20 Answer D — Hard · Kirchhoff, multi-loop

CORE PRINCIPLE Let the common node be at potential V and write one node equation. A negative branch current means that cell is absorbing energy.

MATH $(12-V)/2 + (6-V)/1 = V/3$ gives $V = 6.55$ V. Then $I_1 = 2.73$ A but $I_2 = -0.55$ A. The node sits **above** 6 V, so current is pushed into the 6 V cell: it is **being charged**.

TRAP Most students assume every cell in a circuit must discharge. Whenever the node potential exceeds a cell's EMF, that cell absorbs current instead, and its terminal voltage then exceeds its EMF.

21 Answer C — Hard · Drift and current density

CORE PRINCIPLE The **current** is common, not the field. Use $I = nAev_d$ for the first ratio, then $E = \rho J$ with $\rho \propto 1/n$ for the second.

MATH Same I and A, so $v_d \propto 1/n$, giving v_1/v_2 = **1/2**. Resistivity falls as n rises, and J is common, so $E \propto \rho \propto 1/n$, giving E_1/E_2 = **1/2**.

TRAP (C) and (D) come from assuming the field is common across the junction. In a series circuit the **current** is what is shared. The field jumps at the junction, which is what builds up surface charge there.

22 Answer A, B, D

Hard · Energy in RC charging

CORE PRINCIPLE Do not integrate i^2R. Use an **energy balance** over the whole charging process instead.

MATH Charge delivered is Q = CV, so the battery does work QV = $\mathbf{CV^2}$. The capacitor stores $\frac{1}{2}CV^2$. The difference, $\mathbf{\frac{1}{2}CV^2}$, must appear as heat in R.

TRAP (C) is the trap and it is deeply counterintuitive. R sets how **fast** the charging happens, never how much heat is produced. A tiny R charges quickly with a huge current, and the total heat comes out identical.

23 Answer A, B, C

Hard · Capacitor redistribution

CORE PRINCIPLE Charge is conserved during the redistribution. Energy is not, and the loss does not depend on the resistor.

MATH Q_{total} = 40 µC over 10 µF gives V = **4 V**. The 6 µF ends with 6 × 4 = **24 µC**, which is what flowed. Energy falls from 200 µJ to 80 µJ, a loss of **120 µJ**, matching $\frac{1}{2}C_1C_2(V_1-V_2)^2/(C_1+C_2)$.

TRAP (D) is false for the same reason as in the previous question. The loss is fixed by the capacitances and the initial voltages alone. Even a superconducting wire loses the same energy, radiated away instead.

24 Answer 40

Hard · Steady state with a capacitor

CORE PRINCIPLE In the steady state no current flows into a capacitor. So the branch containing it carries zero current, and the resistor in that branch has **no potential drop** across it.

MATH All the current goes through the 2 Ω and 4 Ω: I = 12/6 = 2 A. The drop across the 4 Ω is 8 V. With no current in the 6 Ω, the full 8 V sits across the capacitor. Q = 5 × 8 = **40 µC**.

TRAP Including the 6 Ω in the parallel combination gives a different current and a wrong charge. In the steady state that branch is an open circuit, so the 6 Ω may as well not exist.

25 Answer 20

Hard · Non-ideal measurement

CORE PRINCIPLE The voltmeter is part of the circuit. It loads the resistor it measures, which lowers the very voltage being read.

MATH 500 ‖ 1000 = 333.3 Ω. I = 10/833.3 = 12 mA, so the reading is 12 × 333.3 = 4.00 V. The true value is 5.00 V, so the error is (5–4)/5 = **20 percent**.

TRAP Answering 0 assumes an ideal voltmeter. This loading error is exactly why a good voltmeter is built with a very high resistance: the less current it draws, the less it disturbs what it is measuring.

26 Answer 6.00

Hard · Mixed grouping of cells

CORE PRINCIPLE A row gives EMF nE and resistance nr, and m rows in parallel give nr/m. The current peaks when the external resistance **matches** the internal one.

MATH Set 0.5n/m = 0.75 with mn = 24. This gives n = 1.5m, so $1.5m^2$ = 24 and m = 4 rows of n = 6. Then I = nE/2R = 9/1.5 = **6.00 A**.

TRAP Stacking all 24 in one series row gives only 2.77 A. Adding cells in series raises the EMF and the internal resistance at the same rate, so beyond the matching point you gain nothing.

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