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PHY • PHYSICS

09. Current Electricity

Official PMDC Solved Past Paper Topical Booklet • High-Yield Examination Series

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📅 2008 to 2024 Archive

🛡 Boards: BUMHS, DUHS, ETEA, KU, MDCAT, NUMS

📖 Weightage: 27% of MDCAT (54 MCQs)

Curated by Ibrahim for fellow bees. Every question in this chapter has been verified against official UHS, NUMS, SZABMU, DUHS, and KMU answer keys. Propolis cognitive autopsies are provided at the end of this booklet to explain core concepts and break down common distractor traps.

OFFICIAL SOLVED EDITION**Q1.**

SZABMU 2024

Kilowatt hour is the commercial unit of electrical energy. 1 kWh is equal to

- (A) 3.6 meV
- (B) 3.6 MeV
- (C) 3.6 J
- (D) 3.6 MJ

Q2.

SZABMU 2024

In any electric circuit, power output (P_{out}) will be maximum when _____. (Whereas R = external resistance, r = internal resistance)

- (A) $R = 0$ but $r \neq 0$
- (B) $r = 0$ but $R \neq 0$
- (C) $R = \infty$ and $r = 0$
- (D) $R = r$

Q3.

SZABMU 2024

The gradient/slope of I-V (Current-Potential) graph provides _____.

- (A) Conductance
- (B) Conductivity
- (C) Resistance
- (D) Resistivity

Q4.

SZABMU 2024

If 60 A current passes through a wire in 60 seconds. What will be the value of charge existing in the wire?

- (A) $4.6 \times 10^{-3} \text{ C}$
- (B) $3.6 \times 10^{-3} \text{ C}$
- (C) $2.6 \times 10^3 \text{ C}$
- (D) $3.6 \times 10^3 \text{ C}$

Q5.

SZABMU 2024

Which one of the following is the SI-unit of conventional current in a conductor?

- (A) Ampere
- (B) Coulomb
- (C) Ohm
- (D) Ohm meter

Q6.

SZABMU 2024

Which one of the following materials has negative temperature coefficient of resistance?

- (A) Copper
- (B) Germanium
- (C) Sulphur
- (D) Zinc

Q7.

KU 2024

The I-V Graph for a non-Ohmic material is always _____.

- (A) Curved
- (B) Horizontal
- (C) Linear
- (D) Perpendicular

Q8.

KU 2024

Temperature coefficient of resistance is defined as increase as increase in resistance per ohm original resistance per _____.

- (A) Degree rise in temperature
- (B) Unit increase in electric current
- (C) Unit decrease in capacitance
- (D) Degree drop in temperature

Q9.

KU 2024

For metals, the temperature coefficient of resistance is:

- (A) Infinity
- (B) Negative
- (C) Positive
- (D) Zero

Q10.

KU 2024

If R_1 and R_2 are respectively the filament resistance of a 100-Watt bulb and 200-Watt bulb designed to operate on the same voltage, then:

- (A) R_1 is two times R_2
- (B) R_2 is two times R_1
- (C) R_2 is four times R_1
- (D) R_1 is four times R_2

Q11.

KU 2024

The maximum power transfer theorem states that maximum power is delivered to the load when _____.

- (A) The load resistance is half of the source resistance
- (B) The load resistance is zero
- (C) The load resistance is double the source resistance
- (D) The load resistance is equal to the source resistance

Q12.

UHS 2024

Volt × Ampere is the measure of:

- (A) Current
- (B) Volt
- (C) Resistance
- (D) Power

Q13.

UHS 2024

The resistance of semi-conductor with rise in temperature:

- (A) Increases
- (B) Decreases
- (C) Remain same
- (D) Infinite

Q14.

UHS 2024

When length of copper wire is doubled then resistivity becomes:

- (A) Double
- (B) Half
- (C) Remains same
- (D) Four times

Q15.

UHS 2024

The magnitude of the current in metals is proportional to the potential difference across it as long as temperature of conductor is kept constant is known as:

- (A) Joule's law
- (B) Gauss law
- (C) Ohm's law
- (D) Ampere's law

Q16.

UHS 2024

A charge of 90 C passes through a wire for 30 seconds. Then the current in the wire will be:

- (A) 3 A
- (B) 0.3 A
- (C) 3 mA
- (D) 0.3 mA

Q17.

UHS 2024

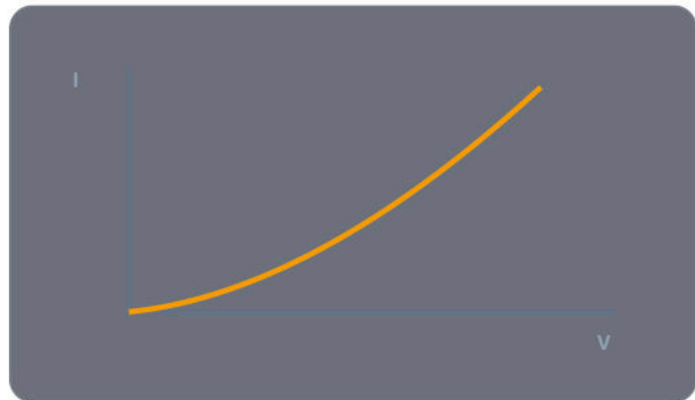
1 kWh = _____ J?

- (A) 3.6 J
- (B) 3.6 KJ
- (C) 3.6 MJ
- (D) 3.6 GJ

Q18.

NUMS 2024

Which graph explains non-ohmic material whose resistance decreases?



- (A) Graph showing a straight line curving horizontally towards the V-axis (Slope decreases)
- (B) Graph showing a straight line curving vertically towards the I-axis (Slope increases)
- (C) Graph showing a perfect linear straight line from the origin
- (D) Graph showing a horizontal flat line

Q19.

NUMS 2024

The substance having negative temperature coefficient are:

- (A) Insulators
- (B) Conductors
- (C) Semi-conductor
- (D) Alloys

Q20.

BUMHS 2024

Resistance is the measure of ____.

- (A) current
- (B) voltage
- (C) motion of charges
- (D) opposition to the motion of charges

Q21.

BUMHS 2024

No current flows between two charged bodies if they have same ____.

- (A) charge
- (B) potential
- (C) capacity
- (D) density

Q22.

BUMHS 2024

Ohm's law state that electric current through a conductor is proportional to the applied voltage provided:

- (A) electric current is constant
- (B) electric field is constant
- (C) resistance is constant
- (D) electric charge is constant

Q23.

BUMHS 2024

Let five resistors, each of 10 ohm, are connected in parallel and the combination is then connected with a battery of 50V. The current through each resistor will be:

- (A) 5A
- (B) 10A
- (C) 25A
- (D) 50A

Q24.

BUMHS 2024

A battery has an emf of 6.0V and an internal resistance of $0.4\ \Omega$. It is connected to a $2.60\ \Omega$ resistor through a switch. When switch is open, the potential difference across the switch is:

- (A) 0V
- (B) 6.0 V
- (C) 2.6 V
- (D) 5.2 V

Q25.

UHS 2023

The following formula can be used to determine the resistance of a length of conductor. $R = \rho l / A$. In the formula, the symbol ρ stands for the:

- (A) Cross-sectional area of the conductor in m^2
- (B) Product of the length of the conductor in metres
- (C) Resistivity of the material in units of ohm-meters
- (D) Resistance of the conductor in units of ohms per meter

Q26.

UHS 2023

The resistance of the wire varies inversely as:

- (A) Area of cross section
- (B) Length
- (C) Resistivity
- (D) Temperature

Q27.

UHS 2023

A wire of uniform area of cross-section 'A', length 'L', and resistance 'R' is cut into two equal parts. What will happen to the resistivity of each part?

- (A) It will be doubled
- (B) It will be one fourth
- (C) It will be halved
- (D) It will remain the same

Q28.

UHS 2023

According to maximum power transfer theorem, which of the following is the max power delivered by the battery to the output?

- (A) $E^2/4r$
- (B) $E^2/2r$
- (C) $E^2/5r$
- (D) $E^2/3r$

Q29.

SZABMU 2023

A charge of 90 C passes through a wire for 30 seconds. Then the current in the wire will be:

- (A) 3 A
- (B) 0.3 A
- (C) 3 mA
- (D) 0.3 mA

Q30.

SZABMU 2023

The magnitude of the current in metals is proportional to the applied voltage as long as temperature of conductor is kept constant. It is statement of:

- (A) Joule's Law
- (B) Gauss Law
- (C) Ohm's Law
- (D) Ampere's Law

Q31.

SZABMU 2023

When length of copper wire is double then resistivity becomes:

- (A) Double
- (B) Half
- (C) Remains same
- (D) Four times

Q32.

SZABMU 2023

The resistance of semi-conductor with rise in temperature:

- (A) Increases
- (B) Decreases
- (C) Remain same
- (D) Infinite

Q33.

SZABMU 2023

A heating coil has a resistance of 10 ohm. It is designed to operate on 20 V. What electric energy is supplied to heater in 10s?

- (A) 100J
- (B) 200J
- (C) 300J
- (D) 400J

Q34.

SZABMU 2023

The unit of resistivity is:

- (A) Ohm
- (B) Ohm meter
- (C) Ohm/meter
- (D) Meter/ohm

Q35.

ETEA 2023

For 0.5 siemens of conductance, resistance will be:

- (A) 1Ω
- (B) 2Ω
- (C) 20Ω
- (D) 10Ω

Q36.

ETEA 2023

1 volt $\times$ 1 ampere is equal to:

- (A) 1 coulomb
- (B) 1 newton
- (C) 1 watt
- (D) 1 hp

Q37.

ETEA 2023

A wire of length L has resistivity is ρ , If the wire is divided in two halves, then resistivity of each halve is:

- (A) $\rho/2$
- (B) ρ
- (C) 2ρ
- (D) $\rho/3$

Q38.

ETEA 2023

In how many hours a 1000-watt AC will consume one unit of electricity?

- (A) 0.5 hr
- (B) 1 hr
- (C) 1.5 hr
- (D) 2 hr

Q39.

ETEA 2023

Which of the following the copper conductor that has the least resistance must be?

- (A) Thick, short and cool
- (B) Thin, long and hot
- (C) Thick, long and hot
- (D) Thin, short and cool

Q40.

ETEA 2023

A certain x-ray tube requires a current of 5mA at a voltage of 60 kV. The rate of energy dissipation (in watts) is:

- (A) 560
- (B) 300
- (C) 200
- (D) 800

Q41.

ETEA 2023

Ampere second is the unit of:

- (A) Power
- (B) Charge
- (C) Potential difference
- (D) Current

Q42.

DUHS 2023

The Ohm's law is applicable if:

- (A) Temperature of the conductor becomes infinite
- (B) Temperature of the conductor increases
- (C) Temperature of the conductor decreases
- (D) Temperature of the conductor remains same

Q43.

DUHS 2023

Which of the following refers to the DC current that does not change its intensity?

- (A) Eddy's current
- (B) Surge current
- (C) Leakage current
- (D) Steady current

Q44.

DUHS 2023

The internal resistance of a battery is:

- (A) In parallel to the external load
- (B) In series to the external load
- (C) Not connected to the external load
- (D) Zero

Q45.

DUHS 2023

The electric potential sets across the terminals of a battery is called:

- (A) Potential difference
- (B) EMF
- (C) Internal potential drop
- (D) Terminal voltage

Q46.

DUHS 2023

One kilowatt-hour (1kWh) equals to:

- (A) 3.6 J
- (B) 3.6 KJ
- (C) 3.6 MJ
- (D) 3.6 GJ

Q47.

DUHS 2023

A soft cylindrical electrical conducting wire has resistance R. It is stretched so that its length is doubled, but its radius stays constant. What would be the new resistance?

- (A) $R/2$
- (B) R
- (C) 4R
- (D) 2R

Q48.

NUMS 2023

1 kWh =

- (A) 0.36×10^6 J
- (B) 36×10^6 J
- (C) 3.6×10^6 J
- (D) 0.036×10^6 J

Q49.

NUMS 2023

Volt $\times$ Ampere is the unit of:

- (A) Current
- (B) Volt
- (C) Resistance
- (D) Power

Q50.

NUMS 2023

If length of the wire becomes two times to its original value and area becomes one half to its original value, than resistance of the wire becomes:

- (A) Double
- (B) Four times
- (C) One half
- (D) One fourth

Q51.

UHS 2022

How much potential drop exist across closed switch?

- (A) 0 V
- (B) 1 V
- (C) 2 V
- (D) 3 V

Q52.

UHS 2022

A 3 V battery is connected in series with ammeter and 2 ohm resistance after short circuiting. What will be reading of ammeter?

- (A) 1 A
- (B) 1.5 A
- (C) 5 A
- (D) 6 A

Q53.

UHS 2022

The resistance of a conductor does not depend on which of the following?

- (A) Area
- (B) Resistivity
- (C) Length
- (D) Mass

Q54.

UHS 2022

Which of the following statement is NOT CORRECT Kirchhoff's rule?

- (A) Kirchhoff's current rule based upon the law of conservation of charge
- (B) Wheatstone bridge is an application of Kirchhoff's rule
- (C) Kirchhoff's rules are more suitable in AC circuits
- (D) Kirchhoff's voltage rule based upon the law of conservation of energy

Q55.

UHS 2022

What do the substances whose resistance decreases with increase in temperature have?

- (A) High temperature coefficient
- (B) Negative temperature coefficient
- (C) Positive temperature coefficient
- (D) Zero temperature coefficient

Q56.

UHS 2022

A low voltage supply with an e.m.f of 20 V and an internal resistance of 1.5 ohms is used to supply power to a heater of resistance 6.5 ohms in a fish tank. What is the power supplied to the water in the fish tank?

- (A) 41 W
- (B) 50 W
- (C) 53 W
- (D) 62 W

Q57.

SZABMU 2022

Ohm meter is the unit of:

- (A) Resistance
- (B) Resistivity
- (C) Conductance
- (D) Conductivity

Q58.

SZABMU 2022

The total resistance of wire is inversely proportional to:

- (A) Length
- (B) Area
- (C) Temperature
- (D) Time

Q59.

ETEA 2022

Potential divider circuit is made when:

- (A) Current is divided
- (B) Emf source is divided
- (C) Resistance is divided
- (D) Number of electrons are divided

Q60.

ETEA 2022

A conductor has resistance R . If its length is stretched to twice the actual value and its radius is reduced to one third of its original values, the new resistance will be:

- (A) $3R$
- (B) $9R$
- (C) $18R$
- (D) $27R$

Q61.

ETEA 2022

Two electric bulbs "A" and "B" of powers 500W and 2000W respectively are connected to 240V supply. The ratio of current passing through bulb "A" to the current passing through bulb "B" is:

- (A) 1:2
- (B) 1:4
- (C) 1:8
- (D) 1:16

Q62.

ETEA 2022

A conductor has length equal to π meters and radius r meters. Its resistance will be equal to:

- (A) $R = \rho r^{-1}$
- (B) $R = \rho r^{-2}$
- (C) $R = \rho r^{-3}$
- (D) $R = \rho r^2$

Q63.

ETEA 2022

When two conductors each of resistance R are attached in series to external circuit, their net resistance is:

- (A) R
- (B) $2R$
- (C) $3R$
- (D) $4R$

Q64.

ETEA 2022

In a conducting electric wire, the electric current flows due to:

- (A) Protons
- (B) Ions
- (C) Holes
- (D) Electrons

Q65.

BUMHS 2022

Which of the following is Ohmic device?

- (A) Filament bulb
- (B) Transistor
- (C) Semi-conductor diode
- (D) Copper wire

Q66.

BUMHS 2022

The internal resistance of a battery is due to which of the following reasons?

- (A) Electrolytes
- (B) Ions moving charges
- (C) Moving charges
- (D) Static charges

Q67.

DUHS 2022

When different resistors are connected across the terminal of a battery:

- (A) Its emf remains same but terminal potential difference changes
- (B) Both emf and terminal potential difference changes
- (C) Its emf changes but terminal potential difference remains the same
- (D) Both emf and terminal potential difference remains the same

Q68.

DUHS 2022

A battery of emf 'E' has an internal resistance 'r'. If current 'I' is drawn then terminal potential V_t is given by:

- (A) $V_t = E + Ir$
- (B) $V_t = E - Ir$
- (C) $V_t = \frac{E}{1-r}$
- (D) $V_t = Er$

Q69.

DUHS 2022

The electrical energy dissipated as heat in a resistor is:

- (A) $V^2 R$
- (B) $V^2 R t$
- (C) $I^2 R$
- (D) $I^2 R t$

Q70.

DUHS 2022

Resistance of $5\ \Omega$ and $10\ \Omega$ are connected in parallel. If the P.D across $5\ \Omega$ resistor is 20V then current through $10\ \Omega$ resistor will be:

- (A) 0.5 A
- (B) 2 A
- (C) 4 A
- (D) 10 A

Q71.

DUHS 2022

A conducting wire of resistivity ' ρ ' is cut into two equal parts. The resistivity of each part will be:

- (A) The same
- (B) One fourth
- (C) $\sqrt{2}$ times
- (D) Halved

Q72.

DUHS 2022

Four cells of emf 3 volt are connected in series to form a battery. Net emf of the combination is:

- (A) 12 volt
- (B) 1.33 volt
- (C) 9 volt
- (D) 7 volt

Q73.

NUMS 2022

The magnitude of current in metals is proportional to the applied voltage as long as temperature of conductor is kept constant. It is statement of:

- (A) Joule's law
- (B) Gauss's law
- (C) Ohm's law
- (D) Ampere's law

Q74.

NUMS 2022

The resistance of pure metal increases with:

- (A) Increase in temperature
- (B) Increase in pressure
- (C) Decrease in temperature
- (D) Decrease in pressure

Q75.

PMDC 2021

Conductivity depends on

- (A) Temperature and nature of material
- (B) Length
- (C) Area
- (D) All

Q76.

PMDC 2021

A load of resistance $0.04\ \Omega$ is attached to the cell having E.M.F 1.5 V and 15 A is drawn in the circuit. The internal resistance of cell will be

- (A) $0.6\ \Omega$
- (B) $0.06\ \Omega$
- (C) $6\ \Omega$
- (D) $0.3\ \Omega$

Q77.

PMDC 2021

Bulb Having Current 200A, and Voltage 220 find Power

- (A) 22kw
- (B) 44kw
- (C) 44watt
- (D) 40 kw

Q78.

PMDC 2021

A heater of 400 Watt was on for 5 hours what is electrical Consumption

- (A) 20KwH
- (B) 12 KWH
- (C) 2KWH
- (D) None

Q79.

PMDC 2021

Which of the following bulb has least resistance?

- (A) 50 W
- (B) 100 W
- (C) 200 W
- (D) 300 W

Q80.

PMDC 2020

One kilowatt-hour is commonly termed as one commercial unit of electric energy which is equal to

- (A) $3.6 \times 10^5\ \text{J}$
- (B) $3.6 \times 10^6\ \text{J}$
- (C) $3.6 \times 10^4\ \text{J}$
- (D) $3.6 \times 10^3\ \text{J}$

Q81.

PMDC 2020

When a wire is compressed and its radius becomes 2R then its resistance will be:

- (A) 16R
- (B) 4R
- (C) $1/16\ R$
- (D) $1/4\ R$

Q82.

PMDC 2020

One of the following is an ohmic device

- (A) Filament bulb
- (B) Semiconductor diode
- (C) Transistor
- (D) Copper wire

Q83.

PMDC 2020

The change in a resistance of metallic conductor below 0°C ?

- (A) Nonlinear
- (B) Curve
- (C) Linear
- (D) Curvilinear

Q84.

NUMS 2020

The power of an electric bulb is 100W. It is connected to 110V power is supply. The resistance of electric bulb will be?

- (A) $11\ \Omega$
- (B) $121\ \Omega$
- (C) $20\ \Omega$
- (D) $200\ \Omega$

Q85.

NUMS 2020

If length of the wire becomes two time to the original value and area becomes one half to its original value, then resistance of the wire becomes:

- (A) Double
- (B) Four times
- (C) One half
- (D) One fourth

Q86.

MDCAT 2019

Calculate the rate at which energy is transferred by 220 V mains supply which provides a current of 0.1 A to a LED?

- (A) 22 kW
- (B) 22 W
- (C) 2.2 kW
- (D) 2.2 W

Q87.

MDCAT 2019

A copper wire has length L and cross-sectional area A . Its resistance is R . If we halved the length and halved the diameter of wire, then what will be the resistance of this wire?

- (A) R
- (B) $2R$
- (C) $3R$
- (D) $4R$

Q88.

ETEA 2019

A car battery has EMF of 12 Volts and internal resistance $5 \times 10^{-2}\ \text{ohm}$. If it draws 60 ampere current, then terminal voltage of the battery will be

- (A) 5 volts
- (B) 3 volts
- (C) 15 volts
- (D) 9 volts

Q89.

MDCAT 2018

When potential difference is applied across the ends of uniform wire of length l and radius r , a current I flow in the wire. If same potential difference is applied to the ends of another wire of the same material but of length $2l$ and radius $2r$, the current in the wire is

- (A) $I/4$
- (B) I
- (C) $2I$
- (D) $I/2$

Q90.

ETEA 2018

The reciprocal of the conductance is called

- (A) conductivity
- (B) Resistivity
- (C) Resistance
- (D) Inductance

Q91.

ETEA 2018

A typical mobile phone of 5.0 V and an internal resistance of $200\ \text{m}\Omega$. What is the terminal P.D of the battery when it supports a current of 500 mA?

- (A) 4.8V
- (B) 4.9V
- (C) 5.0 V
- (D) 5.1V

Q92.

ETEA 2018

A metal cube with sides of length "a" has electrical resistance R between opposite faces. What is the resistance between the opposite faces of a cube of the same metal with sides of length 3a?

- (A) 9R
- (B) 3R
- (C) R/3
- (D) R/9

Q93.

ETEA 2018

A filament lamp has a resistance of 180Ω when the current in it is 500mA. What is the power dissipated in the lamp?

- (A) 45 W
- (B) 90 W
- (C) 290 W
- (D) 360 W

Q94.

ETEA 2018

A cell of internal resistance 2.0Ω and electromotive force (e.m.f) 1.5V is connected to a resistor of resistance 3.0Ω what is the potential difference across 3Ω resistor.

- (A) 5V
- (B) 1.2V
- (C) 0.9 V
- (D) 0.6V

Q95.

MDCAT 2017

2×10^6 electrons passing through a conductor in 1 ms. Find electric current flowing through conductor:

- (A) 32×10^{-9} A
- (B) 3.2×10^{-10} A
- (C) 320×10^{-10} A
- (D) 0.32×10^{-10} A

Q96.

MDCAT 2017

A carbon resistor is connected to a battery of 50 volt and 2 ampere current is passing through it. If voltage is increased to 75 volt, current will become:

- (A) 3Amp
- (B) 4.5Amp
- (C) 1.5Amp
- (D) 6Amp

Q97.

MDCAT 2017

When the current is neither drawn from a source nor given to it then:

- (A) $E = V_t$
- (B) $E > V_t$
- (C) $V_t > E$
- (D) Both "B" & "C"

Q98.

MDCAT 2016

Resistance between two opposite faces of square thin film of area 1mm^2 having thickness of $1\mu\text{m}$ if resistivity of material is $10^{-6}\Omega\text{m}$ will be:

- (A) 1000Ω
- (B) 1Ω
- (C) 100Ω
- (D) 10Ω

Q99.

ETEA 2016

If the potential difference across a resistor is doubled:

- (A) Only the current is doubled
- (B) Only the current is halved
- (C) Only the resistance is doubled
- (D) Only the resistance is halved

Q100.

ETEA 2016

A total charge of 100 C flows through a 12W bulb in a time of 50 second. What is the potential difference across the bulb during this time?

- (A) 0.12V
- (B) 2.0V
- (C) 6.0V
- (D) 24V

Q101.

ETEA 2016

The temperature coefficient of resistance of a semiconductor is:

- (A) Positive
- (B) Negative
- (C) Imaginary
- (D) Zero

Q102.

MDCAT 2013

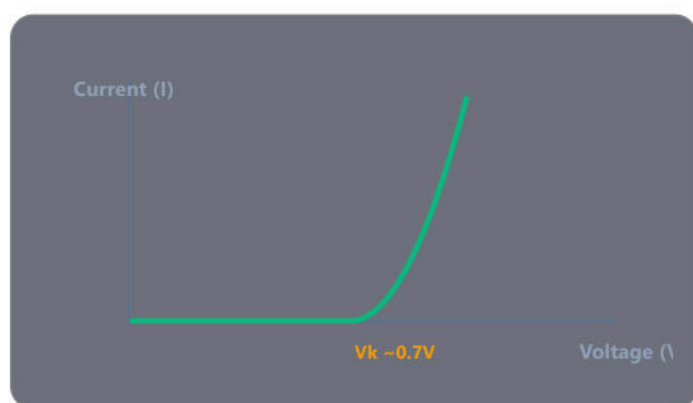
12-volt battery is applied across 6Ω resistance to have a steady flow of current. What must be the required potential difference across the same resistance to have a steady current of one ampere?

- (A) 12V
- (B) 1V
- (C) 3V
- (D) 6V

Q103.

MDCAT 2012

Which one of the following is I-V curve of a junction diode?



- (A) A straight vertical line
- (B) A straight horizontal line
- (C) A non-linear curve showing exponential rise in forward bias
- (D) None of these

Q104.

MDCAT 2012

Electric charge on an object is measured as 5 micro coulombs. How the value of this charge can be expressed in terms of base unit:

- (A) 5×10^{-3} ampere second
- (B) 5×10^{-6} ampere second
- (C) 5×10 ampere second
- (D) 5×10^{-2} ampere second

Q105.

MDCAT 2011

If 2 A current passes through a resistor when connected to a certain battery. If the resistance is replaced by the double resistance, then the current will become

- (A) 2A
- (B) 6A
- (C) 4A
- (D) 1A

Q106.

MDCAT 2010

The equivalent current which passes from a point at higher potential to a point at a lower potential as if it represented a movement of positive charges is

- (A) Electronic current
- (B) Magnetic lines
- (C) Electric current
- (D) Conventional current

Q107.

MDCAT 2010

The substances like germanium and silicon have

- (A) Negative temperature coefficient
- (B) Positive temperature coefficients
- (C) Both A and B
- (D) None of the above

Q108.

MDCAT 2009

The fractional change in resistance per Kelvin is known as:

- (A) Temperature coefficient of resistance
- (B) Linear coefficient of expansion
- (C) Thermal coefficient
- (D) Volumetric coefficient of expansion

Q109.

MDCAT 2009

The energy supplied by the cell to the charge carriers is derived from the conversion of:

- (A) Heat energy into Electrical energy
- (B) Solar energy into Electrical energy
- (C) Chemical energy into Electrical energy
- (D) Mechanical energy into Electrical energy

Q110.

MDCAT 2009

The deviation of I-V graph from the straight line is due to:

- (A) Decrease in temperature and decrease in resistance
- (B) Decrease in temperature and increase in resistance
- (C) Increase in temperature and increase in resistance
- (D) Increase in temperature and decrease in resistance

Q111.

MDCAT 2008

A wire has resistance 100 Ohm at 0°C and 200 Ohm at 100°C . What is its temperature coefficient in K^{-1} ?

- (A) -0.01
- (B) 0.01
- (C) $-1/273$
- (D) $1/273$

Q112.

MDCAT 2008

The heat produced by a current I in the wire of resistance R during time interval t is

- Ⓐ I^2/Rt
 - Ⓑ $I^2/R/t$
 - Ⓒ I^2Rt
 - Ⓓ IR^2t
-

RAPID 5–COLUMN ANSWER KEY

Official PMDC verified answer keys for 09. Current Electricity.

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Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD
1	D	SZABMU 2024	24	B	BUMHS 2024	47	D	DUHS 2023	70	B	DUHS 2022	93	A	ETEA 2018
2	D	SZABMU 2024	25	C	UHS 2023	48	C	NUMS 2023	71	A	DUHS 2022	94	C	ETEA 2018
3	A	SZABMU 2024	26	A	UHS 2023	49	D	NUMS 2023	72	A	DUHS 2022	95	B	MDCAT 2017
4	D	SZABMU 2024	27	D	UHS 2023	50	B	NUMS 2023	73	C	NUMS 2022	96	A	MDCAT 2017
5	A	SZABMU 2024	28	A	UHS 2023	51	A	UHS 2022	74	A	NUMS 2022	97	A	MDCAT 2017
6	B	SZABMU 2024	29	A	SZABMU 2023	52	B	UHS 2022	75	A	PMDC 2021	98	B	MDCAT 2016
7	A	KU 2024	30	C	SZABMU 2023	53	D	UHS 2022	76	B	PMDC 2021	99	A	ETEA 2016
8	A	KU 2024	31	C	SZABMU 2023	54	C	UHS 2022	77	B	PMDC 2021	100	C	ETEA 2016
9	C	KU 2024	32	B	SZABMU 2023	55	B	UHS 2022	78	C	PMDC 2021	101	B	ETEA 2016
10	A	KU 2024	33	D	SZABMU 2023	56	A	UHS 2022	79	D	PMDC 2021	102	D	MDCAT 2013
11	D	KU 2024	34	B	SZABMU 2023	57	B	SZABMU 2022	80	B	PMDC 2020	103	C	MDCAT 2012
12	D	UHS 2024	35	B	ETEA 2023	58	B	SZABMU 2022	81	C	PMDC 2020	104	B	MDCAT 2012
13	B	UHS 2024	36	C	ETEA 2023	59	C	ETEA 2022	82	D	PMDC 2020	105	D	MDCAT 2011
14	C	UHS 2024	37	B	ETEA 2023	60	C	ETEA 2022	83	C	PMDC 2020	106	D	MDCAT 2010
15	C	UHS 2024	38	B	ETEA 2023	61	B	ETEA 2022	84	B	NUMS 2020	107	A	MDCAT 2010
16	A	UHS 2024	39	A	ETEA 2023	62	B	ETEA 2022	85	B	NUMS 2020	108	A	MDCAT 2009
17	C	UHS 2024	40	B	ETEA 2023	63	B	ETEA 2022	86	B	MDCAT 2019	109	C	MDCAT 2009
18	B	NUMS 2024	41	B	ETEA 2023	64	D	ETEA 2022	87	B	MDCAT 2019	110	C	MDCAT 2009
19	C	NUMS 2024	42	D	DUHS 2023	65	D	BUMHS 2022	88	D	ETEA 2019	111	B	MDCAT 2008
20	D	BUMHS 2024	43	D	DUHS 2023	66	A	BUMHS 2022	89	C	MDCAT 2018	112	C	MDCAT 2008
21	B	BUMHS 2024	44	B	DUHS 2023	67	A	DUHS 2022	90	C	ETEA 2018			
22	C	BUMHS 2024	45	D	DUHS 2023	68	B	DUHS 2022	91	B	ETEA 2018			
23	A	BUMHS 2024	46	C	DUHS 2023	69	D	DUHS 2022	92	C	ETEA 2018			

TOTAL
MCQS

112

CORRECT

INCORRECT

BLANK

ACCURACY

%

Scan the booklet QR code to enter answers in
BeambePrep Grind Mode for automated error
 autopsies.

PROPOLIS COGNITIVE ERROR AUTOPSIES

Step-by-step conceptual derivations, formula working, and distractor autopsies for every question.

Question #1 Key: (D)

SZABMU 2024

Kilowatt hour is the commercial unit of electrical energy. 1 kWh is equal to

CORE CONCEPT AND DERIVATION

Conversion of kWh to standard SI Joules with proper metric prefixing.

Solution:

- $1 \text{ kWh} = 1000 \text{ W} \times 3600 \text{ s} = 3,600,000 \text{ J}$.
- This is $3.6 \times 10^6 \text{ J}$.
- The metric prefix for 10^6 is Mega (M).
- Therefore, it equals **3.6 MJ**.

Why other options are incorrect:

- **Opt A & B:** Electron-volts (eV) are for atomic scale energy, incredibly tiny compared to a commercial kWh.
- **Opt C:** Missing the multiplier (10^6).

Question #2 Key: (D)

SZABMU 2024

In any electric circuit, power output ([Formula]) will be maximum when _____. (Whereas R = external resistance...)

CORE CONCEPT AND DERIVATION

The maximum power transfer theorem defines the absolute limit of power a source can deliver to a load.

Solution:

- The theorem states that to obtain maximum external power from a source with a fixed internal resistance (r), the external load resistance (R) must be exactly matched to it.
- Therefore, maximum power occurs strictly when $R = r$.

Why other options are incorrect:

- **Opt A:** If $R = 0$ (short circuit), voltage drops to zero across the load, yielding zero power output.
- **Opt B:** While an ideal theoretical battery ($r = 0$) delivers more total power unconditionally, the theorem asks for the condition on any given real circuit.
- **Opt C:** Infinite resistance means zero current flow, thus zero power.

Question #3 Key: (A)

SZABMU 2024

The gradient/slope of I-V (Current-Potential) graph provides _____.

CORE CONCEPT AND DERIVATION

The slope of any 2D graph is the change in the y-axis divided by the change in the x-axis.

Formula:

$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{\Delta I}{\Delta V}$$

Solution:

- By Ohm's Law, $R = \frac{V}{I}$.
- The slope of an **I-V graph** (where Current is Y and Voltage is X) is $\frac{I}{V}$.
- This is the exact mathematical reciprocal of resistance ($\frac{1}{R}$).
- The reciprocal of resistance is formally defined as **Conductance**.

Why other options are incorrect:

- **Opt C:** Resistance would be the slope of a V-I graph, not an I-V graph.
- **Opt B & D:** These are intrinsic material properties that require knowledge of physical dimensions, not just electrical readings.

Question #4 Key: (D)

SZABMU 2024

If 60 A current passes through a wire in 60 seconds. What will be the value of charge existing in the wire?

CORE CONCEPT AND DERIVATION

Electric current is the rate of charge flow.

Formula:

$$Q = I \times t$$

Solution:

- Current $I = 60 \text{ A}$.
- Time $t = 60 \text{ s}$.
- Charge $Q = 60 \times 60 = 3600 \text{ Coulombs}$.
- Converting to scientific notation yields $3.6 \times 10^3 \text{ C}$.

Why other options are incorrect:

- **Opt B:** Features a negative exponent, which implies micro-scale charge, not a massive 3600 Coulombs.
- **Opt A & C:** Incorrect mathematical multiplication.

Question #5 Key: (A)

SZABMU 2024

Which one of the following is the SI-unit of conventional current in a conductor?

CORE CONCEPT AND DERIVATION

The International System of Units (SI) defines exactly 7 base quantities.

Solution:

- Electric current is one of the fundamental SI base quantities.
- Its assigned standard SI unit is universally the **Ampere**.

Why other options are incorrect:

- **Opt B:** Coulomb is the SI derived unit of charge.
- **Opt C:** Ohm is the unit of resistance.
- **Opt D:** Ohm-meter is the unit of resistivity.

Question #6 Key: (B)

SZABMU 2024

Which one of the following materials has negative temperature coefficient of resistance?

CORE CONCEPT AND DERIVATION

A negative temperature coefficient means the material's resistance drops as temperature goes up.

Solution:

- Metals (like Copper and Zinc) have positive coefficients because heat increases atomic vibrations and scattering.
- Semiconductors, like **Germanium** (and Silicon), have negative coefficients. Heating them frees massive amounts of valence electrons across the band gap, vastly improving conductivity and plummeting resistance.

Why other options are incorrect:

- **Opt A & D:** Metals. Resistance increases with heat.
- **Opt C:** Sulphur is a strong insulator.

Question #7 Key: (A)

KU 2024

The I-V Graph for a non-Ohmic material is always _____.

CORE CONCEPT AND DERIVATION

Ohm's Law relies on a linear relationship between voltage and current.

Solution:

- If a material is non-Ohmic, its resistance ($R = V/I$) fluctuates dynamically depending on the current passing through it or the applied voltage (like in a diode or a hot filament bulb).
- Because the ratio changes constantly, the slope of the graph changes continuously, which visually manifests as a **Curved** line rather than a straight one.

Why other options are incorrect:

- **Opt C:** Defines a perfect Ohmic material.
- **Opt B & D:** Represent impossible/extreme scenarios of zero or infinite resistance continuously.

Question #8 Key: (A)

KU 2024

Temperature coefficient of resistance is defined as increase as increase in resistance per ohm original resist...

CORE CONCEPT AND DERIVATION

The mathematical definition of the temperature coefficient gives context to physical properties.

Formula:

$$\alpha = \frac{\Delta R}{R_0 \cdot \Delta T}$$

Solution:

- Reading the formula in words: It is the fractional change in resistance ($\Delta R/R_0$) per unit change in temperature (ΔT).
- Therefore, it is measured per **Degree rise in temperature**.

Why other options are incorrect:

- **Opt B & C:** Fundamentally unrelated to thermal properties.
- **Opt D:** Standard definition uses "degree rise" to align with standard positive definitions of α .

Question #9 **Key: (C)**

KU 2024

For metals, the temperature coefficient of resistance is:

CORE CONCEPT AND DERIVATION

Thermal kinetics affect free charge carriers in different lattices differently.

Solution:

- In standard metals, heating them causes lattice ions to vibrate violently.
- This vibration blocks the path of drifting electrons, increasing the resistance.
- Because Resistance increases as Temperature increases, the mathematical fraction ($\Delta R / \Delta T$) is heavily **Positive**.

Why other options are incorrect:

- **Opt B:** True for semiconductors, not metals.
- **Opt D:** True for highly specialized alloys like constantan, not general metals.

Question #10 **Key: (A)**

KU 2024

If [Formula] and [Formula] are respectively the filament resistance of a 100-Watt bulb and 200-Watt bulb desig...

CORE CONCEPT AND DERIVATION

When components are designed to operate at the same nominal voltage, their internal resistance heavily dictates their power draw.

Formula:

$$P = \frac{V^2}{R} \implies R = \frac{V^2}{P}$$

Solution:

- Resistance is inversely proportional to Power rating ($R \propto 1/P$).
- Let's take the ratio: $\frac{R_1}{R_2} = \frac{P_2}{P_1}$.
- $\frac{R_1}{R_2} = \frac{200}{100} = 2$.
- Therefore, $R_1 = 2R_2$. The 100W bulb has exactly **two times** the resistance of the 200W bulb.

Why other options are incorrect:

- **Opt B:** Assumes resistance is directly proportional to power.
- **Opt C & D:** Assumes a squared relationship which doesn't exist here.

Question #11 Key: (D)

KU 2024

The maximum power transfer theorem states that maximum power is delivered to the load when ____.

CORE CONCEPT AND DERIVATION

Optimization of electrical circuits specifically to get the highest wattage from a limiting source.

Solution:

- According to the mathematically proven Maximum Power Transfer Theorem, power is maximized exclusively when the external circuit's total resistance (load) perfectly mirrors the internal resistance of the supplying battery or generator.
- Therefore, **the load resistance is equal to the source resistance.**

Why other options are incorrect:

- Opt A, B, C:** Any value higher or lower than exact equality decreases the total fraction of $P = \frac{E^2 R}{(R+r)^2}$.

Question #12 Key: (D)

UHS 2024

Volt [Formula] Ampere is the measure of:

CORE CONCEPT AND DERIVATION

Electrical Power represents the rate at which electrical energy is utilized.

Formula:

$$P = V \times I$$

Solution:

- Voltage (Volts) is Work per unit Charge.
- Current (Amperes) is Charge per unit Time.
- Their product results in Work per unit Time, which is the definition of **Power** (measured in Watts).

Why other options are incorrect:

- Opt A & C:** Basic units in Ohm's Law but not defined by this specific product.

Question #13 Key: (B)

UHS 2024

The resistance of semi-conductor with rise in temperature:

CORE CONCEPT AND DERIVATION

Semiconductors have a negative temperature coefficient due to band-gap mechanics.

Solution:

- At absolute zero, a pure semiconductor acts as a perfect insulator.
- As temperature rises, thermal energy excites electrons from the valence band into the conduction band.
- This massive influx of available charge carriers (electrons and holes) vastly overpowers any increased scattering from atomic vibrations.
- Consequently, the overall resistance **decreases** significantly.

Why other options are incorrect:

- Opt A:** Metals increase resistance with temperature.
- Opt C & D:** Incorrect physical behavior.

Question #14 Key: (C)

UHS 2024

When length of copper wire is doubled then resistivity becomes:

CORE CONCEPT AND DERIVATION

Distinguish between extensive properties (Resistance) and intensive properties (Resistivity).

Solution:

- Resistivity (ρ) is purely a property of the material's atomic lattice and its current temperature.
- Stretching, cutting, or doubling a wire fundamentally alters its geometric resistance (R), but it does not magically change copper into a different element.
- Therefore, the resistivity **remains the same.**

Why other options are incorrect:

- Opt A, B, D:** These are incorrect assumptions that resistivity scales geometrically like resistance.

Question #15 Key: (C)

UHS 2024

The magnitude of the current in metals is proportional to the potential difference across it as long as temperature...

CORE CONCEPT AND DERIVATION

The foundational law of basic electrical circuits connects Voltage, Current, and Resistance.

Solution:

- The precise statement: "Current is directly proportional to voltage ($I \propto V$) provided physical state and temperature are constant" is the exact definition of **Ohm's law**.

Why other options are incorrect:

- **Opt A:** Joule's Law deals with power and heat ($P = I^2 R$).
- **Opt B & D:** Deals with electrostatics and magnetism, not circuit resistance.

Question #16 Key: (A)

UHS 2024

A charge of 90 C passes through a wire for 30 seconds. Then the current in the wire will be:

CORE CONCEPT AND DERIVATION

Electric current is the continuous rate of charge flow.

Formula:

$$I = \frac{Q}{t}$$

Solution:

- Given total Charge $Q = 90$ Coulombs.
- Given time interval $t = 30$ seconds.
- Current $I = \frac{90}{30} = 3$ Amperes.

Why other options are incorrect:

- **Opt B:** Mathematical decimal error.
- **Opt C & D:** Unnecessary and incorrect use of milli (10^{-3}) prefix.

Question #17 Key: (C)

UHS 2024

1 kWh = ____ J?

CORE CONCEPT AND DERIVATION

The Kilowatt-hour is a massive unit of commercial energy relative to the tiny Joule.

Solution:

- Convert kilowatts to watts: $1 \text{ kW} = 10^3 \text{ W}$.
- Convert hours to seconds: $1 \text{ hour} = 3600 \text{ seconds}$.
- Multiply: $10^3 \text{ J/s} \times 3600 \text{ s} = 3.6 \times 10^6 \text{ Joules}$.
- The prefix for 10^6 is Mega. Thus, the answer is **3.6 MJ**.

Why other options are incorrect:

- **Opt A:** Ignores all metric multipliers.
- **Opt B:** Too small by a factor of 1000.
- **Opt D:** Too large by a factor of 1000.

Question #18 Key: (B)

NUMS 2024

Which graph explains non-ohmic material whose resistance decreases? I V

CORE CONCEPT AND DERIVATION

In an I-V graph (Current on the y-axis, Voltage on the x-axis), the slope of the curve at any point dictates the conductance. Resistance is the inverse of that slope.

Formula:

$$\text{Slope} = \frac{\Delta I}{\Delta V} = \frac{1}{R}$$

Solution:

- Since Slope = $1/R$, if the resistance (R) is **decreasing**, the fraction $1/R$ must be **increasing**.
- An increasing slope means the curve must bend upwards, getting steeper towards the I-axis (current axis).
- Graph B correctly depicts an upward curving line (like a semiconductor/thermistor) where more current flows progressively easier as voltage increases.

Why other options are incorrect:

- **Opt A:** Bending towards the V-axis means slope decreases, meaning Resistance is *increasing* (like a filament bulb).
- **Opt C:** Constant slope means Ohmic (constant resistance).

Question #19 Key: (C)

NUMS 2024

The substance having negative temperature coefficient are:

CORE CONCEPT AND DERIVATION

Materials respond to heat differently based on their electron valence bands.

Solution:

- **Semi-conductors** naturally have very few free charge carriers at room temperature.
- When heated, the thermal energy breaks bonds, suddenly flooding the material with electrons and holes.
- This surge in charge carriers vastly decreases the overall resistance.
- Because resistance drops as temperature rises, this mathematical relationship is termed a **negative temperature coefficient**.

Why other options are incorrect:

- **Opt B & D:** Conductors and most alloys have positive coefficients (resistance increases with heat).
- **Opt A:** While insulators do technically decrease resistance slightly when heated, semiconductors are the defining textbook standard for this specific measurable coefficient property.

Question #20 **Key: (D)**

BUMHS 2024

Resistance is the measure of _____.

CORE CONCEPT AND DERIVATION

The fundamental definition of electrical resistance.

Solution:

- As electrons drift through a lattice, they violently collide with the atomic structure of the material.
- These collisions inherently restrict and slow down the steady flow of the electrons.
- Therefore, Resistance is formally defined as the **opposition to the motion of charges**.

Why other options are incorrect:

- **Opt A & C:** Define current.
- **Opt B:** Defines the potential pushing force.

Question #21 **Key: (B)**

BUMHS 2024

No current flows between two charged bodies if they have same _____.

CORE CONCEPT AND DERIVATION

Current strictly requires a gradient (a difference) to flow, much like water needs a height difference.

Solution:

- Electric current is driven exclusively by a **Potential Difference** (Voltage).
- If two bodies are connected and sit at the exact same electric potential, the voltage difference between them is zero ($\Delta V = 0$).
- By Ohm's Law ($I = \Delta V / R$), if $\Delta V = 0$, then current $I = 0$.

Why other options are incorrect:

- **Opt A:** Two bodies can have identical charge amounts but different potentials if their physical sizes (capacitance) differ. Current will still flow until potentials equalize.
- **Opt C & D:** These do not inherently stop current flow if a potential difference exists.

Question #22 **Key: (C)**

BUMHS 2024

Ohm's law state that electric current through a conductor is proportional to the applied voltage provided:

CORE CONCEPT AND DERIVATION

Ohm's Law holds true only under strict linear conditions.

Solution:

- The law states $V \propto I$ linearly.
- The mathematical constant of proportionality that makes this a firm equation ($V = IR$) is the Resistance (R).
- For the relationship to remain perfectly proportional (a straight line graph), the **resistance must remain absolutely constant**. (This usually implies keeping physical states like temperature constant).

Why other options are incorrect:

- **Opt A, B, D:** These are not the defined physical constraints required to maintain the proportionality of Ohm's Law.

Question #23 Key: (A)

BUMHS 2024

Let five resistors, each of 10 ohm, are connected in parallel and the combination is then connected with a bat...

CORE CONCEPT AND DERIVATION

In a purely parallel circuit, every single branch is exposed to the exact full voltage of the source.

Formula:

$$I = \frac{V}{R}$$

Solution:

- Because they are in parallel, the potential difference across each resistor is exactly 50V.
- We want the current through just ONE resistor, not the total circuit.
- Applying Ohm's law to a single branch: $I_{\text{branch}} = \frac{50 \text{ V}}{10 \Omega} = 5 \text{ A}$.

Why other options are incorrect:

- **Opt C:** 25A is the total current drawn from the battery by all five branches combined ($5 \text{ A} \times 5 = 25 \text{ A}$). The question asked for current through each resistor.
- **Opt B & D:** Mathematical errors.

Question #24 Key: (B)

BUMHS 2024

A battery has an emf of 6.0V and an internal resistance of 0.4 [Formula]. It is connected to a 2.6Ω resistor ...

CORE CONCEPT AND DERIVATION

An open switch effectively creates a circuit with infinite resistance, halting all current flow.

Solution:

- When the switch is Open, Current $I = 0 \text{ A}$.
- Because there is no current, there is zero voltage drop across the internal resistance of the battery ($Ir = 0 \times 0.4 = 0 \text{ V}$) and zero voltage drop across the external 2.6Ω resistor ($IR = 0 \times 2.6 = 0 \text{ V}$).
- Therefore, the entirety of the battery's EMF is "waiting" across the break in the circuit (the open switch).
- The potential difference across the switch is exactly the full EMF: **6.0 V**.

Why other options are incorrect:

- **Opt A:** A closed (on) switch has 0V across it, an open switch blocks the full voltage.
- **Opt D:** This would be the terminal voltage if the switch was closed ($I = 6 / (2.6 + 0.4) = 2 \text{ A}$, $V = 2 \times 2.6 = 5.2 \text{ V}$).

Question #25 Key: (C)

UHS 2023

The following formula can be used to determine the resistance of a length of conductor. [Formula] . In the for...

CORE CONCEPT AND DERIVATION

The formula connects bulk resistance to intrinsic material properties.

Solution:

- In the equation $R = \rho \frac{l}{A}$, R is resistance, l is length, and A is the cross-sectional area.
- The symbol ρ (rho) represents the constant of proportionality known as **Resistivity** (or specific resistance).
- Its SI unit is Ohm-meters ($\Omega \cdot \text{m}$).

Why other options are incorrect:

- **Opt A:** Area is represented by A .
- **Opt D:** Resistance per meter is R/l , not ρ .

Question #26 Key: (A)

UHS 2023

The resistance of the wire varies inversely as:

CORE CONCEPT AND DERIVATION

Resistance is dictated by the physical geometry of the conductor.

Formula:

$$R = \rho \frac{L}{A}$$

Solution:

- The formula places Cross-sectional Area (A) in the denominator.
- This implies that as Area increases, Resistance decreases. Thus, resistance varies **inversely** as the Area of cross section.

Why other options are incorrect:

- **Opt B & C:** Resistance varies *directly* with Length and Resistivity (they are in the numerator).
- **Opt D:** Resistance varies directly (linearly) with temperature for metals.

Question #27 Key: (D)

UHS 2023

A wire of uniform area of cross-section ' A ', length ' L ', and resistance ' R ' is cut into two equal parts. What ...

CORE CONCEPT AND DERIVATION

Resistivity is an intrinsic property characteristic of the specific material (e.g., copper, silver) and its temperature.

Solution:

- Unlike Resistance (R), which depends on macroscopic dimensions like length and area, Resistivity (ρ) is purely determined by atomic structure.
- Cutting the wire physically changes its length and halves its total resistance, but the material itself hasn't changed.
- Therefore, the resistivity **remains exactly the same**.

Why other options are incorrect:

- **Opt A, B, C:** These incorrectly assume resistivity is dimension-dependent like resistance.

Question #28 Key: (A)

UHS 2023

According to maximum power transfer theorem, which of the following is the max power delivered by the battery ...

CORE CONCEPT AND DERIVATION

Maximum power transfer occurs when the external load resistance (R) perfectly matches the internal resistance (r) of the source.

Formula:

$$P = I^2 R \quad \text{and} \quad I = \frac{E}{R + r}$$

Solution:

- For max power, set $R = r$.
- The current becomes $I = \frac{E}{r+r} = \frac{E}{2r}$.
- Substitute this current into the power formula: $P_{max} = \left(\frac{E}{2r}\right)^2 \times r$.
- $P_{max} = \frac{E^2}{4r^2} \times r = \frac{E^2}{4r}$.

Why other options are incorrect:

- **Opt B, C, D:** Mathematical errors from improper substitution or ignoring the squaring of the denominator $2r$.

Question #29 Key: (A)

SZABMU 2023

A charge of 90 C passes through a wire for 30 seconds. Then the current in the wire will be:

CORE CONCEPT AND DERIVATION

Electric current is defined as the rate of flow of electric charge over time.

Formula:

$$I = \frac{Q}{t}$$

Solution:

- Given Charge $Q = 90$ C.
- Time $t = 30$ s.
- $I = \frac{90}{30} = 3$ A.

Why other options are incorrect:

- **Opt B:** Decimal placement error.
- **Opt C & D:** Using milliAmperes incorrectly assumes the charge was given in milliCoulombs or time in hours.

Question #30 Key: (C)

SZABMU 2023

The magnitude of the current in metals is proportional to the applied voltage as long as temperature of conduc...

CORE CONCEPT AND DERIVATION

The linear relationship between current and voltage under constant physical conditions is a fundamental principle of basic circuits.

Solution:

- The statement " $V \propto I$ at constant temperature" is the exact textbook definition of **Ohm's Law**.

Why other options are incorrect:

- **Opt A:** Joule's Law deals with heat dissipation ($P = I^2 R$).
- **Opt B & D:** Gauss's and Ampere's laws deal with electromagnetics and flux, not basic circuit resistance.

Question #31 Key: (C)

SZABMU 2023

When length of copper wire is double then resistivity becomes:

CORE CONCEPT AND DERIVATION

Resistivity (ρ) is an intrinsic, material-specific property (like density) and does not scale with macroscopic dimensions.

Solution:

- While doubling the length will double the wire's **resistance** (R), the **resistivity** of copper is a constant value at a given temperature.
- Therefore, it **remains the same** regardless of how you cut or stretch the physical wire.

Why other options are incorrect:

- **Opt A, B, D:** Confuses resistivity with resistance.

Question #32 Key: (B)

SZABMU 2023

The resistance of semi-conductor with rise in temperature:

CORE CONCEPT AND DERIVATION

Semiconductors behave fundamentally differently from metals when exposed to heat.

Solution:

- As temperature rises, thermal energy breaks covalent bonds in the semiconductor lattice.
- This significantly increases the density of free charge carriers (electrons and holes).
- Because there are vastly more carriers available for conduction, the overall opposition to current drops. Hence, resistance **decreases**.

Why other options are incorrect:

- **Opt A:** This is true for metallic conductors, not semiconductors.
- **Opt C:** Resistance changes drastically with temp.

Question #33 Key: (D)

SZABMU 2023

A heating coil has a resistance of 10 ohm. It is designed to operate on 20 V. What electric energy is supplied...

CORE CONCEPT AND DERIVATION

Electrical energy over time is calculated by multiplying power by time.

Formula:

$$E = P \times t = \frac{V^2}{R} \times t$$

Solution:

- Voltage $V = 20 \text{ V}$.
- Resistance $R = 10 \Omega$.
- Time $t = 10 \text{ s}$.
- Energy $E = \frac{(20)^2}{10} \times 10 = \frac{400}{10} \times 10 = 40 \times 10 = 400 \text{ Joules}$.

Why other options are incorrect:

- **Opt A & B:** Arise from mathematical mistakes, such as forgetting to square the voltage ($20/10 \times 10 = 20$).

Question #34 Key: (B)

SZABMU 2023

The unit of resistivity is:

CORE CONCEPT AND DERIVATION

Resistivity is calculated by rearranging the resistance formula.

Formula:

$$\rho = \frac{R \cdot A}{L}$$

Solution:

- Unit of R is Ohms (Ω).
- Unit of Area A is square meters (m^2).
- Unit of length L is meters (m).
- Plugging in the units: $\frac{\Omega \cdot m^2}{m} = \Omega \cdot m$.
- Therefore, the unit is **Ohm meter**.

Why other options are incorrect:

- **Opt A:** Ohm is the unit for Resistance.
- **Opt C:** Ohm/meter describes resistance per unit length, not resistivity.

Question #35 Key: (B)

ETEA 2023

For 0.5 siemens of conductance, resistance will be:

CORE CONCEPT AND DERIVATION

Conductance is defined as the mathematical reciprocal of resistance.

Formula:

$$G = \frac{1}{R} \Rightarrow R = \frac{1}{G}$$

Solution:

- Given Conductance $G = 0.5$ Siemens.
- $R = \frac{1}{0.5} = 2 \Omega$.

Why other options are incorrect:

- **Opt A, C, D:** Mathematical errors when taking the reciprocal of 0.5.

Question #36 Key: (C)

ETEA 2023

1 volt [Formula] 1 ampere is equal to:

CORE CONCEPT AND DERIVATION

The product of voltage and current equates to electrical power.

Formula:

$$P = V \times I$$

Solution:

- The unit of Potential Difference V is Volts.
- The unit of Current I is Amperes.
- The resulting unit of Power P is Joules per second, universally known as the **Watt**.
- Thus, 1 Volt $\times$ 1 Ampere = 1 Watt.

Why other options are incorrect:

- **Opt A:** Coulomb is Ampere $\times$ Second.
- **Opt B:** Newton is a unit of mechanical force.
- **Opt D:** 1 hp (horsepower) equals exactly 746 Watts, not 1 Watt.

Question #37 Key: (B)

ETEA 2023

A wire of length L has resistivity is [Formula], If the wire is divided in two halves, then resistivity of ea...

CORE CONCEPT AND DERIVATION

Resistivity (ρ) is an intensive property; it depends entirely on the material's atomic composition and temperature, not on macroscopic size.

Solution:

- No matter how you cut, stretch, or bend the wire, the specific nature of the material does not change.
- Therefore, cutting the wire in half leaves the resistivity constant as ρ .

Why other options are incorrect:

- **Opt A:** Half the length halves the Resistance (R), not Resistivity.
- **Opt C & D:** Dimensionally scaling an intrinsic property is incorrect.

Question #38 Key: (B)

ETEA 2023

In how many hours a 1000-watt AC will consume one unit of electricity?

CORE CONCEPT AND DERIVATION

A "unit" of commercial electricity is officially 1 Kilowatt-hour (kWh).

Formula:

$$\text{Energy (kWh)} = \text{Power (kW)} \times \text{Time (hours)}$$

Solution:

- Target Energy = 1 kWh.
- Power of AC = 1000 Watts = 1 kW.
- Time = $\frac{\text{Energy}}{\text{Power}} = \frac{1 \text{ kWh}}{1 \text{ kW}} = 1 \text{ hour}$.

Why other options are incorrect:

- **Opt A, C, D:** Mathematical failures in simple division.

Question #39 **Key: (A)**

ETEA 2023

Which of the following the copper conductor that has the least resistance must be?

CORE CONCEPT AND DERIVATION

Resistance connects linearly with length, inversely with area, and linearly with temperature for metallic conductors.

Formula:

$$R = \rho_0(1 + \alpha\Delta T) \frac{L}{A}$$

Solution:

- To get the **least** resistance, we must minimize the numerator and maximize the denominator.
- **Thick** (large area A) minimizes resistance.
- **Short** (small length L) minimizes resistance.
- **Cool** (low temperature) minimizes resistivity ρ .
- Therefore, "Thick, short and cool" gives the absolute lowest possible resistance.

Why other options are incorrect:

- **Opt B:** This combination yields the absolute *highest* resistance.
- **Opt C & D:** Have conflicting features that don't yield the absolute minimum.

Question #40 **Key: (B)**

ETEA 2023

A certain x-ray tube requires a current of 5mA at a voltage of 60 kV. The rate of energy dissipation (in watts...

CORE CONCEPT AND DERIVATION

Rate of energy dissipation is power, calculated purely from operational voltage and current.

Formula:

$$P = VI$$

Solution:

- Voltage $V = 60 \text{ kV} = 60 \times 10^3 \text{ V}$.
- Current $I = 5 \text{ mA} = 5 \times 10^{-3} \text{ A}$.
- $P = (60 \times 10^3) \times (5 \times 10^{-3})$.
- The 10^3 and 10^{-3} cancel out nicely.
- $P = 60 \times 5 = 300 \text{ Watts}$.

Why other options are incorrect:

- **Opt A, C, D:** Mathematical errors in multiplying 60 and 5.

Question #41 Key: (B)

ETEA 2023

Ampere second is the unit of:

CORE CONCEPT AND DERIVATION

Charge is fundamentally defined as the product of current flow over time.

Formula:

$$Q = I \times t$$

Solution:

- Current I is measured in Amperes.
- Time t is measured in Seconds.
- Multiplying them yields Ampere $\times$ second, which is the definition of the Coulomb, the standard unit of **Charge**.

Why other options are incorrect:

- **Opt A:** Power is Joules/second (Watts).
- **Opt C:** Potential difference is Joules/Coulomb (Volts).
- **Opt D:** Current is purely Amperes.

Question #42 Key: (D)

DUHS 2023

The Ohm's law is applicable if:

CORE CONCEPT AND DERIVATION

Ohm's Law states that current is directly proportional to voltage, but only under strict physical constraints.

Solution:

- The proportionality constant is Resistance (R).
- For the relationship to be linear (ohmic), R must remain completely steady.
- Since temperature severely alters atomic vibrations and resistance, Ohm's law strictly applies only if **temperature remains exactly the same**.

Why other options are incorrect:

- **Opt A, B, C:** Any dynamic change in temperature breaks the linear $V \propto I$ relationship.

Question #43 Key: (D)

DUHS 2023

Which of the following refers to the DC current that does not change its intensity?

CORE CONCEPT AND DERIVATION

By definition, Ideal DC from a stable source provides a constant, unchanging flow over time.

Solution:

- A current that flows in a singular direction with a perfectly constant magnitude (intensity) is referred to as a **Steady current**.

Why other options are incorrect:

- **Opt A:** Eddy currents are localized circular loops induced by changing magnetic fields.
- **Opt B:** Surge current implies a massive, momentary spike.
- **Opt C:** Leakage implies a gradual, unwanted escape of charge across a dielectric over time.

Question #44 Key: (B)

DUHS 2023

The internal resistance of a battery is:

CORE CONCEPT AND DERIVATION

In circuit models, a real battery is modeled as an ideal voltage source (EMF) paired with a resistor.

Solution:

- Because 100% of the current leaving the battery **MUST** first fight through the battery's own internal electrolytes, this resistance physically lies in the exact path of the load.
- Therefore, it acts completely **in series** with the external load.

Why other options are incorrect:

- **Opt A:** If it were parallel, current could completely bypass it.
- **Opt D:** Only ideal theoretical batteries have zero internal resistance.

Question #45 **Key: (D)**

DUHS 2023

The electric potential sets across the terminals of a battery is called:

CORE CONCEPT AND DERIVATION

While EMF represents the battery's theoretical maximum capability, the actual measurable voltage across its output nodes under operation gets a distinct name.

Solution:

- The specific voltage physically measurable across the outside connecting points (terminals) of a functioning cell is explicitly called the **Terminal voltage** (V_t).

Why other options are incorrect:

- **Opt A:** This is a general physics term, not specific to battery nodes.
- **Opt B:** EMF is the voltage when the circuit is entirely open (no current).
- **Opt C:** This is the voltage lost inside the battery (Ir), not what is available at the terminals.

Question #46 **Key: (C)**

DUHS 2023

One kilowatt-hour (1kWh) equals to:

CORE CONCEPT AND DERIVATION

Convert the commercial unit of energy into standard SI metric prefixes.

Solution:

- 1 kilowatt = 10^3 Watts (Joules/sec).
- 1 hour = 3600 seconds.
- 1 kWh = $1000 \text{ W} \times 3600 \text{ s} = 3,600,000 \text{ Joules}$.
- In scientific notation with prefixes: $3.6 \times 10^6 \text{ J}$.
- The prefix for 10^6 is Mega (M). Thus, it equals **3.6 MJ**.

Why other options are incorrect:

- **Opt A:** Missing all multiplier zeros.
- **Opt B:** Kilo (K) is only 10^3 .
- **Opt D:** Giga (G) is 10^9 .

Question #47 Key: (D)

DUHS 2023

A soft cylindrical electrical conducting wire has resistance R . It is stretched so that its length is doubled,...

CORE CONCEPT AND DERIVATION

Resistance is proportionally linked to length and cross-sectional area. Usually stretching implies volume remains constant (decreasing area), but the prompt places a strict hypothetical constraint.

Formula:

$$R = \rho \frac{L}{A}$$

Solution:

- The prompt explicitly states "**but its radius stays constant**". This means Area ($A = \pi r^2$) does not change.
- If Area is constant, Resistance is *directly* and linearly proportional to Length ($R \propto L$).
- Since Length is doubled ($L' = 2L$), the resistance simply doubles.
- New resistance = $2R$.

Why other options are incorrect:

- **Opt C:** $4R$ would be correct ONLY IF the wire's volume was conserved (meaning the area naturally shrank by half as it stretched). The prompt's constraint explicitly overrides this.

Question #48 Key: (C)

NUMS 2023

1 kWh =

CORE CONCEPT AND DERIVATION

Derive Joules from basic power and time conversions.

Solution:

- $1 \text{ kW} = 1000 \text{ W} = 1000 \text{ J/s}$.
- $1 \text{ h} = 3600 \text{ s}$.
- Multiply them: $1000 \text{ J/s} \times 3600 \text{ s} = 3,600,000 \text{ Joules}$.
- Expressed in correct scientific notation: $3.6 \times 10^6 \text{ J}$.

Why other options are incorrect:

- **Opt A, B, D:** All represent the wrong decimal shift for the standard value of 3,600,000.

Question #49 **Key: (D)**

NUMS 2023

Volt [Formula] Ampere is the unit of:

CORE CONCEPT AND DERIVATION

Electrical Power represents the rate at which electrical energy is transferred.

Formula:

$$P = V \times I$$

Solution:

- Voltage (V) provides the energy per unit charge (Joules/Coulomb).
- Current (I) is the flow rate of charge (Coulombs/second).
- Multiplying them (Joules/Coulomb $\times$ Coulombs/second) leaves Joules/second, which defines the Watt, the unit of **Power**.

Why other options are incorrect:

- **Opt A:** Current is just Ampere.
- **Opt B:** Volt is just Joules/Coulomb.
- **Opt C:** Resistance is Volt / Ampere.

Question #50 **Key: (B)**

NUMS 2023

If length of the wire becomes two times to its original value and area becomes one half to its original value,...

CORE CONCEPT AND DERIVATION

Resistance is directly proportional to length and inversely proportional to cross-sectional area.

Formula:

$$R = \rho \frac{L}{A}$$

Solution:

- Original resistance: R .
- New Length $L' = 2L$.
- New Area $A' = \frac{A}{2}$.
- New Resistance $R' = \rho \frac{2L}{A/2} = 4 \left(\rho \frac{L}{A} \right) = 4R$.
- The resistance becomes **four times** greater.

Why other options are incorrect:

- **Opt A:** Occurs if you only double the length and ignore the area change.
- **Opt C & D:** Mathematical inversions.

Question #51 Key: (A)

UHS 2022

How much potential drop exist across closed switch?

CORE CONCEPT AND DERIVATION

An ideal closed switch acts as a perfect conductor with zero resistance.

Formula:

$$V = IR$$

Solution:

- For a closed switch, Resistance $R = 0$.
- Therefore, regardless of current I , the potential drop $V = I \times 0 = 0 \text{ V}$.

Why other options are incorrect:

- **Opt B, C, D:** A potential drop only occurs across components that present resistance to the flow of current.

Question #52 Key: (B)

UHS 2022

A 3 V battery is connected in series with ammeter and 2 ohm resistance after short circuiting. What will be re...

CORE CONCEPT AND DERIVATION

"After short circuiting" implies any other parallel load was bypassed, leaving only the 2 Ω resistor in series with the ideal ammeter across the battery.

Formula:

$$I = \frac{V}{R}$$

Solution:

- Voltage $V = 3 \text{ V}$.
- Total circuit resistance $R = 2 \Omega$ (assuming the ammeter is ideal and has 0 resistance).
- Current $I = \frac{3}{2} = 1.5 \text{ A}$.
- The ammeter reads the total current, which is 1.5 A.

Why other options are incorrect:

- **Opt A, C, D:** Simple math errors or applying incorrect formulas (like $I = V \times R$).

Question #53 **Key: (D)**

UHS 2022

The resistance of a conductor does not depend on which of the following?

CORE CONCEPT AND DERIVATION

Electrical resistance is determined by the physical geometry of the conductor and the intrinsic property of the material.

Formula:

$$R = \rho \frac{L}{A}$$

Solution:

- The formula explicitly shows resistance depends on: **Length (L)**, **Cross-sectional Area (A)**, and **Resistivity (ρ)**.
- Mass itself is not a direct variable in calculating resistance (though it indirectly relates to volume). You can have a heavy, bulky block of copper and a thin long wire of copper with the same mass but vastly different resistances.

Why other options are incorrect:

- **Opt A, B, C:** These are all direct factors that define resistance.

Question #54 **Key: (C)**

UHS 2022

Which of the following statement is NOT CORRECT Kirchhoff's rule?

CORE CONCEPT AND DERIVATION

Kirchhoff's circuit laws are foundational to analyzing complex circuits, mostly modeled around DC circuits.

Solution:

- **Opt A:** True. KCL states sum of currents entering a junction equals sum leaving (conservation of charge).
- **Opt B:** True. The bridge formula is derived using Kirchhoff's rules.
- **Opt D:** True. KVL states the sum of voltages around a closed loop is zero (conservation of energy).
- **Opt C: False.** Kirchhoff's rules are primarily designed and most suitable for DC circuits. In high-frequency AC circuits, parasitic capacitance and inductance make standard KVL/KCL assumptions (like instantaneous propagation) inaccurate without complex modifications.

Why other options are incorrect:

- The question asks for the statement that is NOT correct, making C the target answer.

Question #55 **Key: (B)**

UHS 2022

What do the substances whose resistance decreases with increase in temperature have?

CORE CONCEPT AND DERIVATION

The temperature coefficient (α) denotes the direction and magnitude of resistance change with temperature.

Formula:

$$\Delta R = R_0 \alpha \Delta T$$

Solution:

- If resistance decreases as temperature increases, ΔR is negative while ΔT is positive.
- This mathematically requires α to be negative.
- Substances like semiconductors and insulators possess this **Negative temperature coefficient**.

Why other options are incorrect:

- **Opt C:** Means resistance increases with temperature (like typical metals).
- **Opt D:** Means resistance is independent of temperature (like specific alloys e.g., Manganin).

Question #56 **Key: (A)**

UHS 2022

A low voltage supply with an e.m.f of 20 V and an internal resistance of 1.5 ohms is used to supply power to a...

CORE CONCEPT AND DERIVATION

Power supplied to the water is the power dissipated specifically by the external heater.

Formula:

$$I = \frac{E}{R + r} \quad \text{and} \quad P = I^2 R$$

Solution:

- Calculate total current: $I = \frac{20 \text{ V}}{6.5 \Omega + 1.5 \Omega} = \frac{20}{8} = 2.5 \text{ A}$.
- Calculate power dissipated by the heater (external resistance $R = 6.5 \Omega$):
- $P = (2.5)^2 \times 6.5 = 6.25 \times 6.5 = 40.625 \text{ W}$.
- Rounding to the nearest whole number gives approx **41 W**.

Why other options are incorrect:

- **Opt B:** 50W is the total power generated by the source ($P = E \times I = 20 \times 2.5 = 50 \text{ W}$), but this includes heat lost inside the battery.

Question #57 Key: (B)

SZABMU 2022

Ohm meter is the unit of:

CORE CONCEPT AND DERIVATION

Resistivity is the inherent property of a material to oppose current, standardized by area and length.

Formula:

$$\rho = \frac{R \cdot A}{L}$$

Solution:

- Let's determine the units of ρ :
- R is measured in Ohms (Ω).
- A is measured in square meters (m^2).
- L is measured in meters (m).
- Unit = $\frac{\Omega \cdot m^2}{m} = \Omega \cdot m$ (Ohm-meter).

Why other options are incorrect:

- **Opt A:** Unit is Ohm (Ω).
- **Opt C:** Unit is Mho or Siemens.
- **Opt D:** Unit is $(\Omega \cdot m)^{-1}$.

Question #58 Key: (B)

SZABMU 2022

The total resistance of wire is inversely proportional to:

CORE CONCEPT AND DERIVATION

Resistance is dictated by the physical dimensions of the conductor.

Formula:

$$R = \rho \frac{L}{A}$$

Solution:

- From the formula, R is in the numerator opposite to Area A in the denominator.
- This mathematically proves that Resistance is **inversely proportional** to the Cross-sectional **Area**. (A thicker wire provides more path for electrons, reducing resistance).

Why other options are incorrect:

- **Opt A & C:** Resistance is directly proportional to length and (typically) temperature.
- **Opt D:** Resistance is independent of time.

Question #59 **Key: (C)**

ETEA 2022

Potential divider circuit is made when:

CORE CONCEPT AND DERIVATION

A potential divider (voltage divider) reduces an input voltage to a smaller output voltage using resistors in series.

Solution:

- By placing resistors in series, the total resistance is divided into segments.
- The total voltage drops across each segment proportionally according to $V = IR$.
- Hence, a potential divider is fundamentally created by **dividing the resistance** across the circuit path.

Why other options are incorrect:

- **Opt A:** Current divides in parallel circuits, not series voltage dividers.
- **Opt B:** The EMF source itself is not physically divided.

Question #60 **Key: (C)**

ETEA 2022

A conductor has resistance R . If its length is stretched to twice the actual value and its radius is reduced to...

CORE CONCEPT AND DERIVATION

Resistance changes drastically when both length and radius are altered.

Formula:

$$R = \rho \frac{L}{\pi r^2}$$

Solution:

- Original Resistance: $R = \rho \frac{L}{\pi r^2}$.
- New Length $L' = 2L$.
- New radius $r' = \frac{r}{3}$.
- New Area $A' = \pi(r')^2 = \pi\left(\frac{r}{3}\right)^2 = \frac{\pi r^2}{9} = \frac{A}{9}$.
- New Resistance $R' = \rho \frac{2L}{A/9} = 18\left(\rho \frac{L}{A}\right) = 18R$.

Why other options are incorrect:

- **Opt A & B:** Arise from failing to square the radius reduction factor or failing to multiply by the new doubled length.

Question #61 Key: (B)

ETEA 2022

Two electric bulbs "A" and "B" of powers 500W and 2000W respectively are connected to 240V supply. The ratio o...

CORE CONCEPT AND DERIVATION

When components are connected across the same voltage supply (parallel by default for rated household appliances unless stated otherwise), current is directly proportional to power.

Formula:

$$P = VI \implies I = \frac{P}{V}$$

Solution:

- Because both are connected to the same 240V supply, V is constant.
- Current $I \propto P$.
- Ratio $\frac{I_A}{I_B} = \frac{P_A}{P_B} = \frac{500}{2000} = \frac{1}{4}$.
- The ratio is 1:4.

Why other options are incorrect:

- **Opt D:** Would be the ratio if the relationship depended on the square of the power.

Question #62 Key: (B)

ETEA 2022

A conductor has length equal to [Formula] meters and radius r meters. Its resistance will be equal to:

CORE CONCEPT AND DERIVATION

Calculate resistance by substituting physical values into the standard resistivity formula.

Formula:

$$R = \rho \frac{L}{A}$$

Solution:

- Length $L = \pi$.
- Cross-sectional Area $A = \pi r^2$.
- Substitute values: $R = \rho \frac{\pi}{\pi r^2}$.
- The π cancels out: $R = \frac{\rho}{r^2}$.
- Written with a negative exponent: $R = \rho r^{-2}$.

Why other options are incorrect:

- **Opt A, C, D:** Feature incorrect algebraic simplifications of the denominator r^2 .

Question #63 Key: (B)

ETEA 2022

When two conductors each of resistance R are attached in series to external circuit, their net resistance is:

CORE CONCEPT AND DERIVATION

For resistors connected in series, the total equivalent resistance is simply the algebraic sum of the individual resistances.

Formula:

$$R_{eq} = R_1 + R_2 + \dots$$

Solution:

- We have two identical conductors, so $R_1 = R$ and $R_2 = R$.
- $R_{eq} = R + R = 2R$.

Why other options are incorrect:

- **Opt A:** This would be the resistance of just one conductor.
- **Opt C & D:** These would apply if 3 or 4 resistors were in series, respectively.

Question #64 Key: (D)

ETEA 2022

In a conducting electric wire, the electric current flows due to:

CORE CONCEPT AND DERIVATION

Current flow depends on the nature of the medium. In solid metallic conductors, the atoms are locked in a lattice, leaving only specific particles free to move.

Solution:

- In metallic electric wires (like copper), only the outer valence **electrons** are loosely bound and free to drift.
- Therefore, electric current in typical metallic conductors is exclusively due to the flow of free electrons.

Why other options are incorrect:

- **Opt A:** Protons are tightly bound in the atomic nucleus and cannot move.
- **Opt B:** Ions are the primary charge carriers in liquid electrolytes, not solid wires.
- **Opt C:** Holes act as charge carriers in semiconductors, not typical metallic wires.

Question #65 Key: (D)

BUMHS 2022

Which of the following is Ohmic device?

CORE CONCEPT AND DERIVATION

An Ohmic device strictly obeys Ohm's Law ($V \propto I$), meaning its resistance remains constant over a wide range of voltages and currents, provided physical conditions (like temperature) are stable.

Solution:

- **Copper wire** is a classic metallic conductor that behaves linearly (ohmic) under normal operating conditions.

Why other options are incorrect:

- **Opt A:** A filament bulb heats up drastically as current flows, causing its resistance to increase (non-ohmic).
- **Opt B & C:** Semiconductors, diodes, and transistors inherently possess non-linear I-V characteristics.

Question #66 Key: (A)

BUMHS 2022

The internal resistance of a battery is due to which of the following reasons?

CORE CONCEPT AND DERIVATION

A battery provides electromotive force but also resists the internal flow of its own current.

Solution:

- Inside a chemical battery, current is carried by ions moving through an **electrolyte**.
- The electrolyte material inherently offers opposition to the movement of these ions. This opposition is defined as the battery's internal resistance.

Why other options are incorrect:

- **Opt B & C:** Moving charges define the current itself, not the resistance acting upon them.
- **Opt D:** Static charges do not flow, so they do not participate in internal dynamic resistance.

Question #67 Key: (A)

DUHS 2022

When different resistors are connected across the terminal of a battery:

CORE CONCEPT AND DERIVATION

Electromotive force (EMF) is an intrinsic property of the battery chemistry, whereas terminal potential difference (V_t) depends on the current flowing through the circuit.

Formula:

$$V_t = E - Ir$$

Solution:

- Because **EMF (E)** is fixed by the chemical reaction of the cell, it **remains the same** regardless of the external circuit.
- When you connect different external resistors, the total equivalent resistance changes, causing the total current (I) to change.
- Since I changes, the internal voltage drop (Ir) changes, meaning the **terminal potential difference changes**. This makes Option A correct.

Why other options are incorrect:

- **Opt B, C, D:** All incorrectly assert that EMF changes or that terminal voltage remains immune to current variations.

Question #68 Key: (B)

DUHS 2022

A battery of emf 'E' has an internal resistance 'r'. If current 'I' is drawn then terminal potential [Formula]...

CORE CONCEPT AND DERIVATION

When a battery is discharging (supplying current to an external circuit), its terminal voltage is lower than its EMF due to internal losses.

Formula:

$$V_t = E - Ir$$

Solution:

- The total EMF (E) must overcome the internal resistance of the battery itself.
- The voltage dropped inside the battery is Ir .
- Therefore, the usable voltage at the terminals is E minus the internal drop: $V_t = E - Ir$.

Why other options are incorrect:

- **Opt A:** This is the formula for a battery that is being charged by an external source.
- **Opt C, D, E:** These are mathematically invalid formulas for battery potential.

Question #69 **Key: (D)**

DUHS 2022

The electrical energy dissipated as heat in a resistor is:

CORE CONCEPT AND DERIVATION

Joule's Law of heating quantifies the electrical energy converted into thermal energy over time.

Formula:

$$H = P \times t = I^2 R t$$

Solution:

- Electrical power P dissipated by a resistor is $I^2 R$.
- Energy (heat) is power multiplied by time (t).
- Therefore, the total heat energy dissipated is $I^2 R t$.

Why other options are incorrect:

- **Opt A & C:** These represent Power (Watts), not Energy (Joules). Wait, Opt A is dimensionally wrong anyway.
- **Opt B:** The correct voltage formula for energy is $\frac{V^2}{R} t$, not $V^2 R t$.
- **Opt E:** This represents Voltage (Ohm's Law).

Question #70 **Key: (B)**

DUHS 2022

Resistance of 5 [Formula] and 10 [Formula] are connected in parallel. If the P.D across 5 [Formula] resistor i...

CORE CONCEPT AND DERIVATION

In a parallel circuit, the potential difference (voltage) across all branches is identical.

Formula:

$$I = \frac{V}{R}$$

Solution:

- Because the resistors are in parallel, the voltage across the 10 Ω resistor is the exact same as the 5 Ω resistor, which is 20V.
- Apply Ohm's law to the 10 Ω resistor: $I = \frac{20 \text{ V}}{10 \Omega}$.
- $I = 2 \text{ A}$ (Option B).

Why other options are incorrect:

- **Opt A:** Inverting the calculation 10/20.
- **Opt C:** This is the current flowing through the 5 Ω resistor ($20/5 = 4 \text{ A}$).
- **Opt D:** Mathematical branch error.

Question #71 Key: (A)

DUHS 2022

A conducting wire of resistivity '[Formula]' is cut into two equal parts. The resistivity of each part will...

CORE CONCEPT AND DERIVATION

Resistivity (ρ) is an intrinsic property of the material and its temperature. It is strictly independent of physical dimensions like length or area.

Solution:

- Cutting the wire halves its **Resistance** (R), because resistance depends on length.
- However, since both pieces are made of the exact same material and are at the same temperature, their **Resistivity** remains exactly **the same**.

Why other options are incorrect:

- **Opt B, C, D, E:** All incorrectly assume resistivity scales with physical dimensions.

Question #72 Key: (A)

DUHS 2022

Four cells of emf 3 volt are connected in series to form a battery. Net emf of the combination is:

CORE CONCEPT AND DERIVATION

When ideal cells are connected in series (positive to negative terminal), their individual electromotive forces add algebraically.

Formula:

$$E_{total} = E_1 + E_2 + E_3 + \dots$$

Solution:

- There are 4 cells, each with an EMF of 3V.
- Total EMF = 3V + 3V + 3V + 3V = 12 V.

Why other options are incorrect:

- **Opt B:** Represents a parallel calculation logic.
- **Opt E:** This would be the total EMF if they were connected in perfectly parallel configurations instead of series.

Question #73 Key: (C)

NUMS 2022

The magnitude of current in metals is proportional to the applied voltage as long as temperature of conductor ...

CORE CONCEPT AND DERIVATION

The linear relationship between current and voltage under constant physical conditions is a fundamental principle of basic circuits.

Solution:

- The statement " $V \propto I$ at constant temperature" is the exact textbook definition of **Ohm's Law**.

Why other options are incorrect:

- **Opt A:** Relates heat generated to current ($H = I^2 R t$).
- **Opt B:** Relates electric flux to enclosed charge.
- **Opt D:** Relates magnetic field in a loop to the current passing through it.

Question #74 Key: (A)

NUMS 2022

The resistance of pure metal increases with:

CORE CONCEPT AND DERIVATION

Pure metals have a positive temperature coefficient of resistance.

Solution:

- As temperature increases, the kinetic energy of the metal lattice ions increases.
- This causes larger thermal vibrations, which increases the frequency of collisions between the free electrons and the ions.
- More collisions mean a shorter mean free path, thereby **increasing resistance**.

Why other options are incorrect:

- **Opt C:** Decreasing temperature lowers resistance.
- **Opt B & D:** Everyday atmospheric pressure changes have negligible effects on standard metallic resistance.

Question #75 Key: (A)

PMDC 2021

Conductivity depends on

CORE CONCEPT AND DERIVATION

Conductivity (σ) and resistivity (ρ) are intrinsic material properties. They do not depend on physical dimensions like length or area.

Solution:

- Unlike "Resistance" or "Conductance", **Conductivity** is an inherent property.
- It depends solely on the internal atomic structure (**nature of the material**) and the thermal kinetic energy of the atoms (**temperature**).

Why other options are incorrect:

- **Opt B & C:** Length and Area dictate the total Resistance, not the intrinsic Conductivity.
- **Opt D:** Because B and C are wrong, "All" is incorrect.

Question #76 Key: (B)

PMDC 2021

A load of resistance 0.04 [Formula] is attached to the cell having E.M.F 1.5 V and 15 A is drawn in the circui...

CORE CONCEPT AND DERIVATION

The total resistance of a circuit includes both external load resistance and the internal resistance of the battery.

Formula:

$$I = \frac{E}{R + r}$$

Solution:

- Given $I = 15$ A, $E = 1.5$ V, $R = 0.04 \Omega$.
- Rearrange for total resistance: $R + r = \frac{E}{I}$.
- $0.04 + r = \frac{1.5}{15} = 0.1 \Omega$.
- $r = 0.1 - 0.04 = 0.06 \Omega$.

Why other options are incorrect:

- **Opt A:** Decimal error ($0.1 - 0.04$ is not 0.6).
- **Opt C:** Drastic decimal misplacement.

Question #77 **Key: (B)**

PMDC 2021

Bulb Having Current 200A, and Voltage 220 find Power

CORE CONCEPT AND DERIVATION

Electrical power is the product of voltage and current.

Formula:

$$P = VI$$

Solution:

- Current $I = 200$ A (Note: unusually high for a real bulb, but treat mathematically).
- Voltage $V = 220$ V.
- Power $P = 220 \times 200 = 44,000$ W.
- Convert to kilowatts: $\frac{44,000}{1000} = 44$ kW.

Why other options are incorrect:

- **Opt A:** Matches 110×200 .
- **Opt C:** Incorrect units (Watt instead of kiloWatt).

Question #78 **Key: (C)**

PMDC 2021

A heater of 400 Watt was on for 5 hours what is electrical Consumption

CORE CONCEPT AND DERIVATION

Electrical consumption for billing is measured in Kilowatt-hours (kWh).

Formula:

$$\text{Energy (kWh)} = P(\text{kW}) \times t(\text{hours})$$

Solution:

- Power $P = 400$ W = 0.4 kW.
- Time $t = 5$ hours.
- Energy = 0.4 kW $\times$ 5 h = 2 kWh.

Why other options are incorrect:

- **Opt A:** Occurs if one multiplied $4 \times 5 = 20$, missing the decimal conversion from W to kW.

Question #79 **Key: (D)**

PMDC 2021

Which of the following bulb has least resistance?

CORE CONCEPT AND DERIVATION

For bulbs designed to operate on the same mains voltage, resistance and power are inversely proportional.

Formula:

$$P = \frac{V^2}{R} \implies R = \frac{V^2}{P}$$

Solution:

- Since $R \propto \frac{1}{P}$, the bulb with the **highest power rating** will have the **lowest (least) resistance**.
- Comparing the options, 300 W is the highest power. Therefore, it has the least resistance.

Why other options are incorrect:

- **Opt A:** The lowest power bulb (50 W) will have the highest resistance.

Question #80 **Key: (B)**

PMDC 2020

One kilowatt-hour is commonly termed as one commercial unit of electric energy which is equal to

CORE CONCEPT AND DERIVATION

The Kilowatt-hour (kWh) is a unit of energy, calculated by multiplying power in kilowatts by time in hours.

Solution:

- 1 kilowatt = 1000 Watts (Joules/second).
- 1 hour = 3600 seconds.
- Energy $E = P \times t = 1000 \text{ W} \times 3600 \text{ s} = 3,600,000 \text{ Joules}$.
- In scientific notation, this is $3.6 \times 10^6 \text{ J}$ (or 3.6 MegaJoules).

Why other options are incorrect:

- **Opt A, C, D:** Feature incorrect magnitudes (powers of 10), failing to account for both the kilo multiplier and the 3600 seconds.

Question #81 **Key: (C)**

PMDC 2020

When a wire is compressed and its radius becomes $2R$ then its resistance will be:

CORE CONCEPT AND DERIVATION

When a wire is mechanically compressed or stretched, its volume remains constant. Therefore, a change in radius forces a corresponding change in length.

Formula:

$$\text{Volume} = A \cdot L = \text{constant}$$

$$R = \rho \frac{L}{A}$$

Solution:

- Original Area $A = \pi r^2$.
- New radius $r' = 2r$. New Area $A' = \pi(2r)^2 = 4\pi r^2 = 4A$.
- Since Volume is constant: $A \cdot L = A' \cdot L' \implies L' = \frac{A \cdot L}{4A} = \frac{L}{4}$. The wire is 4 times thicker and 4 times shorter.
- New Resistance $R' = \rho \frac{L'}{A'} = \rho \frac{L/4}{4A} = \frac{1}{16} \rho \frac{L}{A} = \frac{1}{16} R$.

Why other options are incorrect:

- **Opt A:** Occurs if you stretch the wire (making it thinner) rather than compress it.
- **Opt D:** Occurs if you forget that length also shrinks by a factor of 4.

Question #82 Key: (D)

PMDC 2020

One of the following is an ohmic device

CORE CONCEPT AND DERIVATION

An Ohmic device strictly obeys Ohm's Law ($V \propto I$), meaning its resistance stays constant over a wide range of voltages and currents, provided temperature is stable.

Solution:

- **Copper wire** is a classic metallic conductor that behaves linearly (ohmic) under normal conditions.

Why other options are incorrect:

- **Opt A:** A filament bulb heats up drastically as current flows, causing its resistance to increase (non-ohmic).
- **Opt B & C:** Semiconductors, diodes, and transistors inherently possess non-linear I-V characteristics.

Question #83 Key: (C)

PMDC 2020

The change in a resistance of metallic conductor below 0 [Formula] ?

CORE CONCEPT AND DERIVATION

The resistance of typical metallic conductors (like copper or platinum) follows a specific empirical relationship with temperature.

Solution:

- For typical metallic conductors, the change in resistance with respect to temperature is approximately **linear** over a wide range of temperatures, including somewhat below 0 °C (until very near absolute zero where it curves or drops to zero in superconductors).
- The standard formula $R_t = R_0(1 + \alpha t)$ is the equation of a straight (linear) line.

Why other options are incorrect:

- **Opt A, B, D:** While strictly non-linear at cryogenic temperatures, standard syllabus models this behavior as linear for standard metallic conductors.

Question #84 Key: (B)

NUMS 2020

The power of an electric bulb is 100W. It is connected to 110V power supply. The resistance of electric bulb...

CORE CONCEPT AND DERIVATION

The power rating of a device is related to its internal resistance and the operating voltage.

Formula:

$$P = \frac{V^2}{R} \implies R = \frac{V^2}{P}$$

Solution:

- Given Voltage $V = 110$ V.
- Power $P = 100$ W.
- $R = \frac{(110)^2}{100} = \frac{12100}{100} = 121 \Omega$.

Why other options are incorrect:

- **Opt A:** This is V/P , which is meaningless dimensionally.
- **Opt C, D:** Mathematical errors.

Question #85 **Key: (B)**

NUMS 2020

If length of the wire becomes two time to the original value and area becomes one half to its original value, ...

CORE CONCEPT AND DERIVATION

Resistance is directly proportional to length and inversely proportional to cross-sectional area.

Formula:

$$R = \rho \frac{L}{A}$$

Solution:

- Original resistance: R .
- New Length $L' = 2L$.
- New Area $A' = \frac{A}{2}$.
- New Resistance $R' = \rho \frac{2L}{A/2} = 4 \left(\rho \frac{L}{A} \right) = 4R$.
- The resistance becomes four times greater.

Why other options are incorrect:

- **Opt A:** Occurs if you only double the length and ignore the area change.
- **Opt C & D:** Occurs if relations are applied inversely.

Question #86 **Key: (B)**

MDCAT 2019

Calculate the rate at which energy is transferred by 220 V mains supply which provides a current of 0.1 A to a...

CORE CONCEPT AND DERIVATION

The rate at which energy is transferred is the definition of electrical power.

Formula:

$$P = VI$$

Solution:

- Given Voltage $V = 220 \text{ V}$.
- Current $I = 0.1 \text{ A}$.
- $P = 220 \times 0.1 = 22 \text{ Joules/second} = 22 \text{ W}$.

Why other options are incorrect:

- **Opt A & C:** Use kW (kiloWatts) incorrectly. 22W is 0.022 kW.
- **Opt D:** Decimal placement error.

Question #87 **Key: (B)**

MDCAT 2019

A copper wire has length L and cross-sectional area A . Its resistance is R . If we halved the length and halved...

CORE CONCEPT AND DERIVATION

Resistance depends on length and the square of the diameter (since $\text{Area} \propto d^2$).

Formula:

$$R = \rho \frac{L}{A} \propto \frac{L}{d^2}$$

Solution:

- Original Resistance $R \propto \frac{L}{d^2}$.
- New length $L' = \frac{L}{2}$.
- New diameter $d' = \frac{d}{2}$, so new Area $A' \propto \left(\frac{d}{2}\right)^2 = \frac{d^2}{4}$. This means area is 1/4th of the original.
- New Resistance $R' \propto \frac{L/2}{d^2/4} = \frac{1/2}{1/4} \left(\frac{L}{d^2}\right) = 2 \left(\frac{L}{d^2}\right) = 2R$.

Why other options are incorrect:

- **Opt A:** Assumes linear relation with diameter rather than area.
- **Opt D:** Happens if one forgets to half the length, only scaling the area.

Question #88 **Key: (D)**

ETEA 2019

A car battery has EMF of 12 Volts and internal resistance [Formula] . If it draws 60 ampere current, then term...

CORE CONCEPT AND DERIVATION

When a battery outputs heavy current (like starting a car), there is a significant voltage drop across its internal resistance.

Formula:

$$V_t = E - Ir$$

Solution:

- EMF $E = 12 \text{ V}$.
- Internal resistance $r = 0.05 \Omega$.
- Current $I = 60 \text{ A}$.
- Voltage drop $Ir = 60 \times 0.05 = 3 \text{ V}$.
- Terminal voltage $V_t = 12 - 3 = 9 \text{ V}$.

Why other options are incorrect:

- **Opt B:** This is the internal voltage drop (Ir), not the terminal voltage.
- **Opt C:** This would be the voltage if the battery were being charged ($12 + 3 = 15 \text{ V}$).

Question #89 **Key: (C)**

MDCAT 2018

When potential difference is applied across the ends of uniform wire of length [Formula] and radius [Formula]...

CORE CONCEPT AND DERIVATION

Changing the physical dimensions of a wire alters its resistance, which inversely affects current for a constant voltage.

Formula:

$$R = \rho \frac{l}{\pi r^2} \quad \text{and} \quad I = \frac{V}{R}$$

Solution:

- Original Resistance: $R = \rho \frac{l}{\pi r^2}$.
- New length $l' = 2l$. New radius $r' = 2r$, meaning new area $A' = \pi(2r)^2 = 4\pi r^2$.
- New Resistance: $R' = \rho \frac{2l}{4\pi r^2} = \frac{1}{2} \left(\rho \frac{l}{\pi r^2} \right) = \frac{R}{2}$.
- Since voltage is constant, $I' = \frac{V}{R'} = \frac{V}{R/2} = 2 \left(\frac{V}{R} \right) = 2I$.

Why other options are incorrect:

- **Opt A, B, D:** Arise from failing to square the radius when calculating the new area, or directly applying the resistance ratio to current without taking the inverse.

Question #90 **Key: (C)**

ETEA 2018

The reciprocal of the conductance is called

CORE CONCEPT AND DERIVATION

Conductance represents how easily electricity flows, while its reciprocal represents opposition to the flow.

Formula:

$$G = \frac{1}{R} \implies R = \frac{1}{G}$$

Solution:

- By definition, **Resistance** (R , measured in Ohms) is the exact mathematical reciprocal of Conductance (G , measured in Siemens or mho).

Why other options are incorrect:

- **Opt A:** Conductivity is the reciprocal of Resistivity, not conductance.
- **Opt B:** Resistivity is a material property (ρ), reciprocal of conductivity (σ).
- **Opt D:** Inductance relates to magnetic flux and changing currents, not resistance.

Question #91 Key: (B)

ETEA 2018

A typical mobile phone of 5.0 V and an internal resistance of 200 m [Formula]. What is the terminal P.D of th...

CORE CONCEPT AND DERIVATION

When a battery supplies current, the terminal potential difference drops below the EMF due to internal resistance.

Formula:

$$V_t = E - Ir$$

Solution:

- EMF $E = 5.0$ V.
- Internal resistance $r = 200 \text{ m}\Omega = 0.2 \Omega$.
- Current $I = 500 \text{ mA} = 0.5$ A.
- Voltage drop inside battery $= Ir = 0.5 \text{ A} \times 0.2 \Omega = 0.1$ V.
- Terminal voltage $V_t = 5.0 - 0.1 = 4.9$ V.

Why other options are incorrect:

- **Opt A:** Results from a math error or using wrong decimal places.
- **Opt C:** Assumes an ideal battery with zero internal resistance.
- **Opt D:** Would represent a battery being charged, not discharging.

Question #92 Key: (C)

ETEA 2018

A metal cube with sides of length "a" has electrical resistance R between opposite faces. What is the resistan...

CORE CONCEPT AND DERIVATION

The resistance of a regular solid changes dynamically with its length and cross-sectional area.

Formula:

$$R = \rho \frac{L}{A}$$

Solution:

- For the first cube, distance $L = a$ and area $A = a \times a = a^2$. Resistance $R_1 = \rho \frac{a}{a^2} = \frac{\rho}{a} = R$.
- For the new larger cube, distance $L = 3a$ and area $A = (3a) \times (3a) = 9a^2$.
- New Resistance $R_2 = \rho \frac{3a}{9a^2} = \rho \frac{1}{3a} = \frac{1}{3} \left(\frac{\rho}{a} \right) = \frac{R}{3}$.

Why other options are incorrect:

- **Opt A & B:** Occurs if you only scale length and forget to scale the cross-sectional area.
- **Opt D:** Occurs if you divide area by length erroneously.

Question #93 **Key: (A)**

ETEA 2018

A filament lamp has a resistance of $180\ \Omega$ when the current in it is 500mA . What is the power dissipated...

CORE CONCEPT AND DERIVATION

Power dissipated by a resistive element can be calculated directly from current and resistance.

Formula:

$$P = I^2 R$$

Solution:

- Given Resistance $R = 180\ \Omega$.
- Current $I = 500\text{ mA} = 0.5\text{ A}$.
- $P = (0.5)^2 \times 180 = 0.25 \times 180 = 45\text{ W}$.

Why other options are incorrect:

- **Opt B:** Results from computing $P = I \times R$ without squaring the current ($0.5 \times 180 = 90$).
- **Opt D:** Results from computing using $P = 2 \times 180$ (bad math or confusion).

Question #94 **Key: (C)**

ETEA 2018

A cell of internal resistance $2.0\ \Omega$ and electromotive force (e.m.f) 1.5V is connected to a resistor of...

CORE CONCEPT AND DERIVATION

The potential difference across the external resistor is the same as the terminal voltage of the cell.

Formula:

$$I = \frac{E}{R + r} \quad \text{and} \quad V = IR$$

Solution:

- First, calculate total current: $I = \frac{1.5\text{ V}}{3.0\ \Omega + 2.0\ \Omega} = \frac{1.5}{5} = 0.3\text{ A}$.
- Now, find voltage across the external resistor R : $V = I \times R$.
- $V = 0.3\text{ A} \times 3.0\ \Omega = 0.9\text{ V}$.

Why other options are incorrect:

- **Opt B:** Might occur from incorrect resistance ratios.
- **Opt D:** 0.6V is the voltage drop *inside* the cell ($Ir = 0.3 \times 2.0 = 0.6\text{V}$), not across the external resistor.

Question #95 **Key: (B)**

MDCAT 2017

[Formula] electrons passing through a conductor in 1 ms. Find electric current flowing through conductor:

CORE CONCEPT AND DERIVATION

Current is the rate of flow of quantized electric charge.

Formula:

$$I = \frac{Q}{t} = \frac{ne}{t}$$

Solution:

- Number of electrons $n = 2 \times 10^6$.
- Elementary charge $e = 1.6 \times 10^{-19}$ C.
- Time $t = 1 \text{ ms} = 1 \times 10^{-3}$ s.
- Total charge $Q = (2 \times 10^6) \times (1.6 \times 10^{-19}) = 3.2 \times 10^{-13}$ C.
- Current $I = \frac{3.2 \times 10^{-13}}{10^{-3}} = 3.2 \times 10^{-10}$ A.

Why other options are incorrect:

- **Opt A, C, D:** These are incorrect powers of 10 resulting from failing to convert milliseconds to seconds, or misplacing the decimal.

Question #96 **Key: (A)**

MDCAT 2017

A carbon resistor is connected to a battery of 50 volt and 2 ampere current is passing through it. If voltage ...

CORE CONCEPT AND DERIVATION

A carbon resistor obeys Ohm's Law, maintaining a constant resistance.

Formula:

$$R = \frac{V_1}{I_1} = \frac{V_2}{I_2}$$

Solution:

- First, find the resistance: $R = \frac{50 \text{ V}}{2 \text{ A}} = 25 \Omega$.
- Now, apply the new voltage to find the new current: $I_2 = \frac{V_2}{R}$.
- $I_2 = \frac{75 \text{ V}}{25 \Omega} = 3 \text{ A}$.

Why other options are incorrect:

- **Opt B, C, D:** Purely incorrect mathematical division, or incorrectly assuming an inverse relationship.

Question #97 Key: (A)

MDCAT 2017

When the current is neither drawn from a source nor given to it then:

CORE CONCEPT AND DERIVATION

The relationship between electromotive force (E) and terminal voltage (V_t) depends on whether the circuit is open or closed.

Formula:

$$V_t = E - Ir$$

Solution:

- When no current is drawn or given, the circuit is open, meaning $I = 0$.
- Substitute $I = 0$ into the terminal voltage equation: $V_t = E - (0)r$.
- Therefore, $V_t = E$. The terminal voltage exactly equals the EMF.

Why other options are incorrect:

- **Opt B:** This occurs when the cell is discharging (supplying current).
- **Opt C:** This occurs when the cell is being charged by an external source.

Question #98 Key: (B)

MDCAT 2016

Resistance between two opposite faces of square thin film of area 1 mm^2 [Formula] having thickness of 1 mm [Formula]...

CORE CONCEPT AND DERIVATION

Resistance is determined by the length of the path the current travels through and the cross-sectional area perpendicular to that flow.

Formula:

$$R = \rho \frac{L}{A_{\text{cross}}}$$

Solution:

- The film is a square of area 1 mm^2 , so each side length $L = 1\text{ mm} = 10^{-3}\text{ m}$.
- Current flows between opposite faces (edges) of this square, meaning it travels a distance $L = 10^{-3}\text{ m}$.
- The cross-sectional area A_{cross} the current sees is the width $\times$ thickness.
- $A_{\text{cross}} = (1\text{ mm}) \times (1\text{ }\mu\text{m}) = (10^{-3}\text{ m}) \times (10^{-6}\text{ m}) = 10^{-9}\text{ m}^2$.
- Given resistivity $\rho = 10^{-6}\text{ }\Omega\text{m}$.
- $R = \frac{10^{-6} \times 10^{-3}}{10^{-9}} = \frac{10^{-9}}{10^{-9}} = 1\text{ }\Omega$.

Why other options are incorrect:

- **Opt A, C, D:** Result from substituting incorrect length or cross-sectional area (e.g., using the face area 10^{-6} as the cross-section).

Question #99 Key: (A)

ETEA 2016

If the potential difference across a resistor is doubled:

CORE CONCEPT AND DERIVATION

For an ohmic resistor, Ohm's Law states that current is directly proportional to voltage, provided physical conditions (like temperature) remain constant.

Formula:

$$I = \frac{V}{R}$$

Solution:

- The resistance R is an intrinsic property of the resistor's dimensions and material; it does not change when voltage changes.
- If V becomes $2V$, then the new current $I' = \frac{2V}{R} = 2I$.
- Thus, only the current doubles.

Why other options are incorrect:

- **Opt B:** Current is directly, not inversely, proportional to voltage.
- **Opt C & D:** Resistance is independent of applied voltage for ohmic devices.

Question #100 Key: (C)

ETEA 2016

A total charge of 100 C flows through a 12W bulb in a time of 50 second. What is the potential difference across...

CORE CONCEPT AND DERIVATION

To find voltage, we link power, current, and charge.

Formula:

$$I = \frac{Q}{t} \quad \text{and} \quad P = VI$$

Solution:

- First, find the current flowing: $I = \frac{100\text{ C}}{50\text{ s}} = 2\text{ A}$.
- Next, use the power formula: $P = VI$.
- Substitute the values: $V = \frac{12\text{ W}}{2\text{ A}} = 6.0\text{ V}$.

Why other options are incorrect:

- **Opt B:** This is the value of the current (2A), not the voltage.
- **Opt D:** This results from multiplying Power and Current (12×2), which mathematically gives P^2/V , not V .

Question #101 Key: (B)

ETEA 2016

The temperature coefficient of resistance of a semiconductor is:

CORE CONCEPT AND DERIVATION

The behavior of resistance with respect to temperature distinguishes conductors from semiconductors.

Solution:

- In semiconductors, increasing temperature provides enough thermal energy to break covalent bonds, creating more free electrons and holes.
- This massive increase in charge carriers causes overall resistance to **drop**.
- Since resistance decreases as temperature increases, the temperature coefficient (α) is mathematically **negative**.

Why other options are incorrect:

- **Opt A:** Metals (conductors) have positive coefficients.
- **Opt C & D:** A coefficient cannot be imaginary in this context, and it is strictly non-zero because temperature significantly affects semiconductors.

Question #102 Key: (D)

MDCAT 2013

12-volt battery is applied across 6 [Formula] resistance to have a steady flow of current. What must be the re...

CORE CONCEPT AND DERIVATION

Ohm's Law relates voltage, current, and resistance.

Formula:

$$V = IR$$

Solution:

- We want a steady current $I_{new} = 1 \text{ A}$.
- The resistance remains unchanged, so $R = 6 \Omega$.
- The required potential difference $V_{new} = I_{new} \times R = 1 \text{ A} \times 6 \Omega = 6 \text{ V}$.

Why other options are incorrect:

- **Opt A:** 12V yields a current of 2A (12/6).
- **Opt B:** 1V yields a current of 1/6 A.
- **Opt C:** 3V yields a current of 0.5A.

Question #103 Key: (C)

MDCAT 2012

Which one of the following is I-V curve of a junction diode? Current (I) Voltage (V) $V_k \sim 0.7V$

CORE CONCEPT AND DERIVATION

A p-n junction diode is a non-ohmic device. It does not obey Ohm's Law (where $V \propto I$).

Solution:

- For a diode, current only begins to flow significantly after the forward voltage exceeds the depletion barrier (e.g., 0.7V for Silicon).
- After this knee voltage, the current rises exponentially.
- Therefore, the I-V graph is a **non-linear curve**, typically rising sharply in the first quadrant.

Why other options are incorrect:

- **Opt A & B:** These represent zero resistance and infinite resistance respectively, which do not apply to a standard diode.
- **Straight line through origin:** Would represent a perfectly ohmic resistor, not a diode.

Question #104 Key: (B)

MDCAT 2012

Electric charge on an object is measured as 5 micro coulombs. How the value of this charge can be expressed in...

CORE CONCEPT AND DERIVATION

The SI base units for charge are derived from current and time.

Formula:

$$Q = I \times t$$

Solution:

- Given charge $Q = 5 \mu C$.
- The prefix "micro" (μ) means 10^{-6} . So, $Q = 5 \times 10^{-6}$ Coulombs.
- Since 1 Coulomb = 1 Ampere $\times$ 1 Second.
- Therefore, $Q = 5 \times 10^{-6}$ ampere second.

Why other options are incorrect:

- **Opt A:** 10^{-3} corresponds to milli (m), not micro.
- **Opt C & D:** Completely incorrect scale magnitudes for the prefix micro.

Question #105 Key: (D)

MDCAT 2011

If 2 A current passes through a resistor when connected to a certain battery. If the resistance is replaced by...

CORE CONCEPT AND DERIVATION

According to Ohm's Law, current is inversely proportional to resistance when voltage is constant.

Formula:

$$I = \frac{V}{R}$$

Solution:

- Initial current $I_1 = 2\text{A}$.
- The battery remains the same, so V is constant. $I \propto \frac{1}{R}$.
- If new resistance $R' = 2R$, then new current $I' = \frac{V}{2R} = \frac{I}{2}$.
- $I' = \frac{2}{2} = 1\text{A}$.

Why other options are incorrect:

- Opt A:** Current would only stay 2A if resistance didn't change.
- Opt B & C:** Current would increase only if resistance was decreased (e.g., to half). Doubling resistance restricts the flow more.

Question #106 Key: (D)

MDCAT 2010

The equivalent current which passes from a point at higher potential to a point at a lower potential as if it ...

CORE CONCEPT AND DERIVATION

Historically, electric current was defined before the discovery of the electron.

Solution:

- The flow of current from a higher potential (positive terminal) to a lower potential (negative terminal) mimics the theoretical flow of positive charges.
- This standardized model is universally known as **Conventional current**.

Why other options are incorrect:

- Opt A:** Electronic current flows from lower potential (negative) to higher potential (positive).
- Opt B & C:** Magnetic lines aren't currents; "Electric current" is a general term that doesn't specify directionality based on positive charge flow.

Question #107 Key: (A)

MDCAT 2010

The substances like germanium and silicon have

CORE CONCEPT AND DERIVATION

Germanium and silicon are intrinsic semiconductors. Their resistance behavior differs fundamental from metals.

Solution:

- In semiconductors, increasing temperature breaks covalent bonds, freeing more electron-hole pairs for conduction.
- Because charge carrier density increases drastically, the overall resistance **decreases** as temperature rises.
- A decrease in resistance with an increase in temperature means they possess a **negative temperature coefficient** ($\alpha < 0$).

Why other options are incorrect:

- Opt B:** Metals (conductors) have a positive temperature coefficient.
- Opt C & D:** A material cannot be both uniformly intrinsic at the same time.

Question #108 Key: (A)

MDCAT 2009

The fractional change in resistance per Kelvin is known as:

CORE CONCEPT AND DERIVATION

The fractional change in resistance $\left(\frac{\Delta R}{R_0}\right)$ per unit change in temperature (ΔT) is the formal definition of a specific electrical property.

Formula:

$$\alpha = \frac{\Delta R}{R_0 \Delta T}$$

Solution:

- By definition, this quantity α is called the **Temperature coefficient of resistance**.

Why other options are incorrect:

- **Opt B & D:** These refer to physical dimensional changes (length and volume) due to heat, not electrical resistance.
- **Opt C:** A vague term that does not specifically denote resistance change.

Question #109 Key: (C)

MDCAT 2009

The energy supplied by the cell to the charge carriers is derived from the conversion of:

CORE CONCEPT AND DERIVATION

An electrochemical cell generates electromotive force (EMF) through internal reactions.

Solution:

- Inside a standard battery or cell, redox chemical reactions occur.
- The energy released by these chemical reactions is converted directly into electrical energy, giving potential to the charge carriers.

Why other options are incorrect:

- **Opt A:** Thermocouples do this, not cells.
- **Opt B:** Solar panels/photovoltaic cells do this, not standard electrochemical cells.
- **Opt D:** Generators/dynamos convert mechanical energy, not cells.

Question #110 Key: (C)

MDCAT 2009

The deviation of I-V graph from the straight line is due to:

CORE CONCEPT AND DERIVATION

Ohm's Law holds (a straight I-V line) only if physical conditions like temperature remain constant.

Solution:

- As current increases, power dissipation ($I^2 R$) increases, which raises the temperature of the conductor.
- For metallic conductors, an increase in temperature causes an **increase in resistance** ($\Delta R \propto \Delta T$).
- This increasing resistance causes the I-V curve to bend away from a straight line (the slope changes).

Why other options are incorrect:

- **Opt A & B:** Heating (not cooling) occurs when current passes through a typical resistor.
- **Opt D:** Resistance of metals increases, not decreases, with an increase in temperature.

Question #111 **Key: (B)**

MDCAT 2008

A wire has resistance 100 Ohm at 0 [Formula] and 200 Ohm at 100 [Formula]. What is its temperature coefficient...

CORE CONCEPT AND DERIVATION

The temperature coefficient of resistance (α) represents the fractional change in resistance per degree change in temperature.

Formula:

$$\alpha = \frac{R_t - R_0}{R_0 t}$$

Solution:

- Initial Resistance $R_0 = 100 \Omega$
- Final Resistance $R_t = 200 \Omega$
- Change in Temp $t = 100^\circ \text{C}$
- Substituting the values: $\alpha = \frac{200-100}{100 \times 100} = \frac{100}{10000} = 0.01 \text{ K}^{-1}$

Why other options are incorrect:

- **Opt A:** Incorrect negative sign; resistance increased, so α is positive.
- **Opt C/D:** These correspond to the volume expansion coefficient of ideal gases (Charles's Law), not the specific wire's resistance.

Question #112 **Key: (C)**

MDCAT 2008

The heat produced by a current [Formula] in the wire of resistance [Formula] during time interval [Formula] is

CORE CONCEPT AND DERIVATION

The electrical energy dissipated as heat in a resistor is governed by Joule's Law of heating.

Formula:

$$H = I^2 R t$$

Solution:

- According to Joule's law, heat produced is directly proportional to the square of the current, the resistance, and the time the current flows.
- Therefore, $H = I^2 R t$.

Why other options are incorrect:

- **Opt A & B:** Dimensionally incorrect; these represent expressions that do not yield energy (Joules).
- **Opt D:** Places the square on resistance instead of current, which contradicts $P = I^2 R$.