# CBSE Class 12 Physics

## 30 Important Questions and Answers

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The 30 questions below cover the major concepts from all nine units of the CBSE Class 12 Physics syllabus. Try each question on your own first, and only then check the solution. That is where the real learning happens.

## Unit 1: Electrostatics

**Question 1. State Coulomb's law and calculate the electrostatic force between two point charges of 2 µC and 3 µC separated by a distance of 0.3 m in vacuum.**

**Answer:**

**Coulomb's Law:**

Coulomb's law states that the electrostatic force between two stationary point charges is directly proportional to the product of their magnitudes and inversely proportional to the square of the distance between them.

Mathematically,

$F = (1/4\pi\varepsilon_o) \times |q_1q_2|/r^2$

Where:

- $q_1$ and $q_2$ are the magnitudes of the charges.
- r is the distance between the charges.
- $\varepsilon_o$ is the permittivity of free space.
- $1/4\pi\varepsilon_o = 9 \times 10^9$ N m² $C^{-2}$.

**Given:**

$q_1 = 2\ \mu C = 2 \times 10^{-6}$ C

$q_2 = 3\ \mu C = 3 \times 10^{-6}$ C

r = 0.3 m

Substituting:

$F = (9 \times 10^9 \times 2 \times 10^{-6} \times 3 \times 10^{-6})/(0.3)^2$

$F = (54 \times 10^{-3})/0.09$

F = 0.6 N

**Final Answer: The magnitude of the electrostatic force is 0.6 N.**

Since both charges are positive, the force is repulsive.

**Question 2. State Gauss's theorem and write its mathematical expression. How is it used to calculate the electric field due to an infinitely long uniformly charged straight wire?**

**Answer:**

**Gauss's Theorem:**

Gauss's theorem states that the total electric flux through any closed surface is equal to $1/\varepsilon_o$ times the total electric charge enclosed within that surface.

Mathematically,

$\oint E \cdot dA = Q_{enc}/\varepsilon_o$

Where:

- E is the electric field.
- dA is the area vector.
- $Q_{enc}$ is the charge enclosed by the Gaussian surface.
- $\varepsilon_o$ is the permittivity of free space.

**Application to an infinitely long charged wire:**

Consider an infinitely long straight wire having uniform linear charge density λ.

Choose a cylindrical Gaussian surface of radius r and length l around the wire.

Due to cylindrical symmetry, the electric field has the same magnitude at every point on the curved surface and is directed radially outward.

The electric flux through the two flat ends is zero because the electric field is perpendicular to their area vectors.

Therefore, the total electric flux is:

$\Phi = E \times 2\pi rl$

The charge enclosed is:

$Q_{enc} = \lambda l$

Using Gauss's theorem:

$E \times 2\pi rl = \lambda l/\varepsilon_o$

Therefore,

$\mathbf{E = \lambda/(2\pi\varepsilon_o r)}$

This is the electric field due to an infinitely long uniformly charged straight wire.

**Question 3. Derive the expression for the capacitance of a parallel plate capacitor in vacuum. What happens when a dielectric medium is introduced between the plates?**

**Answer:**

Consider a parallel plate capacitor consisting of two conducting plates, each having area A and separated by a distance d.

Let the charges on the plates be +Q and −Q.

Surface charge density is:

$\sigma = Q/A$

The electric field between the plates, neglecting edge effects, is:

$E = \sigma/\varepsilon_o$

Therefore,

$E = Q/(A\varepsilon_o)$

The potential difference between the plates is:

$V = Ed$

Substituting:

$V = Qd/(A\varepsilon_o)$

Capacitance is defined as:

$C = Q/V$

Therefore,

$C = Q/[Qd/(A\varepsilon_o)]$

$$\mathbf{C = \varepsilon_o A/d}$$

This is the capacitance of a parallel plate capacitor in vacuum.

**When a dielectric is introduced:**

If a dielectric of relative permittivity K completely fills the space between the plates, the capacitance becomes:

$$\mathbf{C = K\varepsilon_o A/d}$$

Thus, the capacitance increases by a factor of K.

## Unit 2: Current Electricity

**Question 4. State Ohm's law. A conductor has a resistance of 10 Ω and carries a current of 2 A. Calculate the potential difference across it and the electrical power consumed.**

**Answer:**

**Ohm's Law:**

Ohm's law states that, at constant temperature and other physical conditions, the current flowing through a conductor is directly proportional to the potential difference across its ends.

$V \propto I$

Therefore,

$V = IR$

Where:

- V = Potential difference
- I = Current
- R = Resistance

**Given:**

R = 10 Ω

I = 2 A

Potential difference:

$V = IR$

$= 2 \times 10$

$= 20$ V

Electrical power:

$P = VI$

$= 20 \times 2$

$= 40$ W

**Final Answer:**

Potential difference = 20 V

Electrical power = 40 W

**Question 5. Derive the expression for the equivalent resistance of three resistors connected in parallel.**

**Answer:**

Consider three resistors $R_1$, $R_2$, and $R_3$ connected in parallel across a battery.

In a parallel combination, the potential difference across each resistor remains the same.

Let the common potential difference be V.

The currents through the resistors are:

$I_1 = V/R_1$

$I_2 = V/R_2$

$I_3 = V/R_3$

According to Kirchhoff's current law, the total current is:

$I = I_1 + I_2 + I_3$

Substituting:

$I = V/R_1 + V/R_2 + V/R_3$

If R is the equivalent resistance, then:

$I = V/R$

Therefore,

$V/R = V/R_1 + V/R_2 + V/R_3$

Dividing by V:

$$\mathbf{1/R = 1/R_1 + 1/R_2 + 1/R_3}$$

This is the expression for the equivalent resistance of three resistors connected in parallel.

**Question 6. A cell of emf 12 V and internal resistance 1 Ω is connected to an external resistance of 5 Ω. Calculate the current and terminal potential difference.**

**Answer:**

**Given:**

EMF (E) = 12 V

Internal resistance (r) = 1 Ω

External resistance (R) = 5 Ω

The current flowing through the circuit is:

$I = E/(R + r)$

Substituting:

$I = 12/(5 + 1)$

$I = 12/6$

$I = 2$ A

The terminal potential difference is:

$V = E - Ir$

$V = 12 - (2 \times 1)$

$V = 10$ V

Alternatively:

$V = IR = 2 \times 5 = 10$ V

**Final Answer:**

Current = 2 A

Terminal potential difference = 10 V

## Unit 3: Magnetic Effects of Current and Magnetism

**Question 7. State the Biot-Savart law and write the expression for the magnetic field at the centre of a circular current-carrying loop.**

**Answer:**

**Biot-Savart Law:**

The Biot-Savart law states that the magnetic field produced at a point by a small current element is directly proportional to the current, the length of the current element, and the sine of the angle between the current element and the position vector. It is inversely proportional to the square of the distance.

Mathematically,

$dB = (\mu_o/4\pi) \times (I\, dl \sin\theta/r^2)$

Where:

- dB = Small magnetic field contribution
- $\mu_o$ = Permeability of free space
- I = Current
- dl = Current element

- r = Distance from the element
- θ = Angle between dl and r

**Magnetic field at the centre of a circular loop:**

For a circular loop of radius R carrying current I, every current element produces a magnetic field in the same direction at the centre.

Integrating the contributions of all elements:

$B = (\mu_o I/4\pi R^2) \times 2\pi R$

Therefore,

**$B = \mu_o I/2R$**

For a circular coil having N turns:

**$B = \mu_o NI/2R$**

**Question 8. A charged particle enters a uniform magnetic field perpendicular to the field direction. Derive the expression for the radius of its circular path.**

**Answer:**

When a charged particle enters a uniform magnetic field perpendicular to its velocity, it experiences a magnetic Lorentz force.

The magnitude of this force is:

$F = |q|vB$

Where:

- q = Charge of the particle
- v = Velocity
- B = Magnetic field

This magnetic force acts perpendicular to the velocity and provides the centripetal force required for circular motion.

Therefore,

$|q|vB = mv^2/r$

Where m is the mass of the particle and r is the radius of the circular path.

Rearranging:

$r = mv^2/(|q|vB)$

**$r = mv/(|q|B)$**

Thus, the radius of the circular path is directly proportional to the particle's mass and velocity and inversely proportional to the magnetic field and magnitude of charge.

### Question 9. Explain the principle and working of a moving coil galvanometer.

**Answer:**

**Principle:**

A current-carrying coil placed in a magnetic field experiences a torque.

The torque acting on the coil is:

$\tau = NIAB \sin \theta$

Where:

- N = Number of turns
- I = Current
- A = Area of the coil
- B = Magnetic field
- θ = Angle between the normal to the coil and the magnetic field.

In a radial magnetic field, the deflecting torque is:

$\tau = NIAB$

The restoring torque produced by the suspension is:

$\tau = k\varphi$

Where k is the torsional constant and φ is the angular deflection.

At equilibrium:

$NIAB = k\varphi$

Therefore,

$I = k\varphi/NAB$

**Working:**

A rectangular coil is suspended between the poles of a permanent magnet. When current flows through the coil, it experiences a torque and rotates.

The suspension produces an opposing restoring torque. The coil comes to rest when both torques become equal.

The deflection is directly proportional to the current.

**Hence, a moving coil galvanometer can be used to detect and measure small electric currents.**

## Unit 4: Electromagnetic Induction and Alternating Currents

**Question 10. State Faraday's laws of electromagnetic induction and explain Lenz's law.**

**Answer:**

**Faraday's First Law:**

Whenever the magnetic flux linked with a closed circuit changes, an electromotive force is induced in the circuit.

If the circuit is closed, an induced current flows through it.

**Faraday's Second Law:**

The magnitude of the induced electromotive force is directly proportional to the rate of change of magnetic flux linked with the circuit.

For a coil of N turns:

$E = -N(d\Phi B/dt)$

Where:

- E = Induced emf
- N = Number of turns
- ΦB = Magnetic flux

**Lenz's Law:**

Lenz's law states that the direction of induced current is such that the magnetic field produced by it opposes the change in magnetic flux responsible for its induction.

The negative sign in Faraday's law represents Lenz's law.

This law is consistent with the principle of conservation of energy.

**Question 11. A coil of 200 turns experiences a change in magnetic flux from $5 \times 10^{-3}$ Wb to $1 \times 10^{-3}$ Wb in 0.02 seconds. Calculate the magnitude of the induced emf.**

**Answer:**

Given:

Number of turns, N = 200

Initial flux = $5 \times 10^{-3}$ Wb

Final flux = $1 \times 10^{-3}$ Wb

Time interval = 0.02 s

Change in flux:

$\Delta\Phi = (1 \times 10^{-3}) - (5 \times 10^{-3})$

$\Delta\Phi = -4 \times 10^{-3}$ Wb

Magnitude of change:

$|\Delta\Phi| = 4 \times 10^{-3}$ Wb

Using Faraday's law:

$|E| = N \times |\Delta\Phi|/\Delta t$

$= 200 \times (4 \times 10^{-3})/0.02$

$= 0.8/0.02$

$= 40$ V

**Final Answer: The magnitude of the induced emf is 40 V.**

**Question 12. Derive the expression for the impedance of a series LCR circuit connected to an alternating voltage source.**

**Answer:**

Consider a resistor R, an inductor L, and a capacitor C connected in series to an alternating voltage source.

The voltage across the resistor is in phase with the current.

The voltage across the inductor leads the current by 90°.

The voltage across the capacitor lags the current by 90°.

The inductive reactance is:

$X_L = \omega L$

The capacitive reactance is:

$X_C = 1/\omega C$

The net reactive voltage is determined by the difference between the inductive and capacitive voltage drops.

Using the phasor diagram:

$V^2 = V_R^2 + (V_L - V_C)^2$

Dividing by $I^2$:

$(V/I)^2 = R^2 + (X_L - X_C)^2$

Since impedance $Z = V/I$:

$$\mathbf{Z = \sqrt{[R^2 + (X_L - X_C)^2]}}$$

Therefore,

$$Z = \sqrt{[R^2 + (\omega L - 1/\omega C)^2]}$$

This is the impedance of a series LCR circuit.

At resonance:

$X_L = X_C$

Therefore, impedance becomes minimum and is equal to R.

The resonant angular frequency is:

$$\omega_o = 1/\sqrt{LC}$$

## Unit 5: Electromagnetic Waves

**Question 13. What are electromagnetic waves? Write any four important properties of electromagnetic waves.**

**Answer:**

Electromagnetic waves are waves consisting of mutually perpendicular, time-varying electric and magnetic fields that propagate through space.

They are produced by accelerated electric charges.

**Important properties (any four are sufficient for the answer):**

1. Electromagnetic waves are transverse waves.
2. The electric field and magnetic field are perpendicular to each other and to the direction of propagation.
3. They do not require a material medium and can travel through vacuum.
4. In vacuum, they travel with a speed of approximately $3 \times 10^8$ m/s.
5. The electric and magnetic fields are in the same phase.
6. They carry energy and momentum.

The speed of electromagnetic waves in vacuum is:

$c = 1/\sqrt{(\mu_o \varepsilon_o)}$

**Question 14. Arrange the following electromagnetic waves in increasing order of frequency: Radio waves, X-rays, Infrared rays, Ultraviolet rays, Microwaves and Gamma rays.**

**Answer:**

The electromagnetic spectrum in increasing order of frequency is:

1. Radio waves
2. Microwaves

3. Infrared rays
4. Visible light
5. Ultraviolet rays
6. X-rays
7. Gamma rays

**Final Answer:**

Radio waves < Microwaves < Infrared rays < Ultraviolet rays < X-rays < Gamma rays.

Visible light lies between infrared and ultraviolet radiation.

## Unit 6: Optics

**Question 15. State the laws of refraction. Write the lens formula and calculate the image distance for a convex lens of focal length 20 cm when an object is placed 30 cm in front of it.**

**Answer:**

**Laws of Refraction:**

1. The incident ray, refracted ray, and normal at the point of incidence lie in the same plane.
2. For a given pair of media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant.

According to Snell's law:

$n_1 \sin i = n_2 \sin r$

**Lens Formula:**

$1/f = 1/v - 1/u$

Where:

- f = Focal length
- v = Image distance
- u = Object distance

**Given:**

Focal length, f = +20 cm

Object distance, u = −30 cm

Using the lens formula:

$1/20 = 1/v - 1/(-30)$

$1/20 = 1/v + 1/30$

$1/v = 1/20 - 1/30$

$1/v = (3 - 2)/60$

$1/v = 1/60$

$v = 60$ cm

**Final Answer: The image is formed 60 cm on the other side of the lens.**

The image is real, inverted, and magnified.

**Question 16. What is total internal reflection? State the necessary conditions for total internal reflection.**

**Answer:**

**Total Internal Reflection:**

Total internal reflection is the phenomenon in which a light ray travelling from an optically denser medium to an optically rarer medium is completely reflected back into the denser medium when the angle of incidence exceeds the critical angle.

**Necessary conditions:**

1. Light must travel from an optically denser medium to an optically rarer medium.
2. The angle of incidence must be greater than the critical angle for the two media.

**Applications:**

- Optical fibres
- Endoscopy
- Reflecting prisms
- Brilliance of diamonds

**Question 17. In Young's double-slit experiment, the distance between two slits is 0.5 mm and the screen is placed 2 m away. If the wavelength of light is 500 nm, calculate the fringe width.**

**Answer:**

The fringe width in Young's double-slit experiment is:

$\beta = \lambda D/d$

Where:

- λ = Wavelength of light
- D = Distance between the slits and screen
- d = Separation between the slits

**Given:**

$\lambda = 500 \text{ nm} = 500 \times 10^{-9} \text{ m}$

$D = 2 \text{ m}$

$d = 0.5 \text{ mm} = 0.5 \times 10^{-3} \text{ m}$

Substituting:

$\beta = (500 \times 10^{-9} \times 2)/(0.5 \times 10^{-3})$

$\beta = (1000 \times 10^{-9})/(0.5 \times 10^{-3})$

$\beta = 2 \times 10^{-3} \text{ m}$

Converting into millimetres:

$\beta = 2 \text{ mm}$

**Final Answer: The fringe width is 2 mm.**

**Question 18. Explain the phenomenon of diffraction of light. How does it differ from interference?**

**Answer:**

**Diffraction:**

Diffraction is the phenomenon in which light waves bend and spread around the edges of an obstacle or through a narrow opening when the dimensions are comparable to the wavelength of light.

It demonstrates the wave nature of light.

**Difference between Diffraction and Interference:**

| Interference | Diffraction |
|---|---|
| It results from the superposition of waves originating from coherent sources. | It results from the superposition of wavelets from different parts of the same wavefront. |
| Fringes may have nearly equal widths in Young's double-slit experiment. | The central maximum in single-slit diffraction is wider than the secondary maxima. |
| Bright fringes can have approximately equal intensity in an ideal arrangement of | Secondary maxima have decreasing intensity. |

equal sources.

Both phenomena demonstrate the wave nature of light.

## Unit 7: Dual Nature of Radiation and Matter

**Question 19. Explain the photoelectric effect and state Einstein's photoelectric equation.**

**Answer:**

**Photoelectric Effect:**

The photoelectric effect is the phenomenon in which electrons are emitted from the surface of a metal when electromagnetic radiation of sufficiently high frequency falls on it.

The emitted electrons are called photoelectrons.

**Einstein's Photoelectric Equation:**

According to Einstein, the energy of an incident photon is used partly to overcome the work function of the metal and the remaining energy appears as the maximum kinetic energy of the emitted electron.

Therefore,

$h\nu = \varphi + K_{max}$

Where:

- h = Planck's constant
- ν = Frequency of incident radiation
- φ = Work function of the metal
- $K_{max}$ = Maximum kinetic energy of the photoelectron

Since $K_{max} = eV_o$:

**$h\nu = \varphi + eV_o$**

Where $V_o$ is the stopping potential.

The threshold frequency is:

$\nu_o = \varphi/h$

The maximum kinetic energy depends on the frequency of incident radiation, not on its intensity.

**Question 20. Light of frequency $8 \times 10^{14}$ Hz falls on a metal having a work function of 2 eV. Calculate the maximum kinetic energy of the emitted photoelectrons.**

**Answer:**

Given:

Frequency, $\nu = 8 \times 10^{14}$ Hz

Work function, $\varphi = 2$ eV

Planck's constant, $h = 6.63 \times 10^{-34}$ Js

Energy of the incident photon:

$E = h\nu$

$= 6.63 \times 10^{-34} \times 8 \times 10^{14}$

$= 5.304 \times 10^{-19}$ J

Converting into electron volts:

$E = (5.304 \times 10^{-19})/(1.602 \times 10^{-19})$

$\approx 3.31$ eV

Using Einstein's equation:

$K_{max} = h\nu - \varphi$

$= 3.31 - 2$

$= 1.31$ eV

**Final Answer: The maximum kinetic energy is approximately 1.31 eV.**

## Unit 8: Atoms and Nuclei

**Question 21. State the main postulates of Bohr's atomic model.**

**Answer:**

Niels Bohr proposed an atomic model to explain the stability of atoms and the discrete spectral lines of hydrogen.

The main postulates are:

1. Electrons revolve around the nucleus in certain permitted circular orbits called stationary orbits.
2. Electrons do not radiate energy while moving in these permitted stationary orbits.
3. The angular momentum of an electron in an allowed orbit is quantised.

$mvr = nh/2\pi$

Where n = 1, 2, 3, ...

4. Radiation is emitted or absorbed when an electron jumps from one permitted energy level to another.

The frequency of the emitted or absorbed radiation is determined by:

$h\nu = |E_2 - E_1|$

These postulates explain the discrete energy levels of the hydrogen atom.

**Question 22. Calculate the energy of a photon emitted when an electron in a hydrogen atom jumps from the n = 3 energy level to the n = 2 energy level.**

**Answer:**

The energy of an electron in the nth orbit of a hydrogen atom is:

$E_n = -13.6/n^2$ eV

For n = 3:

$E_3 = -13.6/9$

$= -1.51$ eV (approximately)

For n = 2:

$E_2 = -13.6/4$

$= -3.4$ eV

The energy of the emitted photon is:

$\Delta E = E_3 - E_2$ in magnitude

$= |-1.51 - (-3.4)|$

= 1.89 eV

**Final Answer: The energy of the emitted photon is approximately 1.89 eV.**

**Question 23. Define mass defect and binding energy. Calculate the binding energy of a nucleus if its mass defect is 0.02 u.**

**Answer:**

**Mass Defect:**

Mass defect is the difference between the sum of the masses of the individual nucleons and the actual mass of the nucleus.

$\Delta m = Zm_p + (A - Z)m_n - M$

Where:

- Z = Number of protons
- A − Z = Number of neutrons
- $m_p$ = Mass of a proton
- $m_n$ = Mass of a neutron
- M = Actual nuclear mass

**Binding Energy:**

Binding energy is the energy required to separate a nucleus completely into its constituent protons and neutrons.

According to Einstein's mass-energy relation:

$E = \Delta mc^2$

Given:

$\Delta m = 0.02$ u

We know:

$1 \text{ u} = 931.5 \text{ MeV}/c^2$

Therefore:

Binding energy = 0.02 × 931.5 MeV

= 18.63 MeV

**Final Answer: The binding energy of the nucleus is 18.63 MeV.**

**Question 24. Differentiate between nuclear fission and nuclear fusion.**

**Answer:**

| Nuclear Fission | Nuclear Fusion |
|---|---|
| A heavy nucleus splits into two or more lighter nuclei. | Two light nuclei combine to form a heavier nucleus. |
| It generally produces neutrons and releases energy. | It releases a large amount of energy. |
| It can be initiated by neutron bombardment in suitable fissile materials. | It requires extremely high temperatures and suitable conditions. |
| It is used in nuclear reactors. | It is the main source of energy in the Sun and other stars. |

Both processes release energy due to changes in nuclear binding energy.

## Unit 9: Electronic Devices

**Question 25. What is a semiconductor? Explain the difference between intrinsic and extrinsic semiconductors.**

**Answer:**

A semiconductor is a material whose electrical conductivity lies between that of a conductor and an insulator.

Its conductivity can be controlled by temperature, impurities, and other external conditions.

**Intrinsic Semiconductor:**

An intrinsic semiconductor is a pure semiconductor without intentionally added impurities.

Examples include pure silicon and germanium.

In an intrinsic semiconductor:

- The number of free electrons equals the number of holes.
- Its electrical conductivity is relatively low at room temperature.

**Extrinsic Semiconductor:**

An extrinsic semiconductor is formed by adding a small amount of suitable impurity to a pure semiconductor. This process is called doping.

There are two types:

**1. n-type Semiconductor:**

It is formed by doping silicon or germanium with a pentavalent impurity such as phosphorus.

Electrons are the majority charge carriers, while holes are the minority carriers.

**2. p-type Semiconductor:**

It is formed by doping silicon or germanium with a trivalent impurity such as boron.

Holes are the majority charge carriers, while electrons are the minority carriers.

**Question 26. Explain the formation of a p-n junction diode and describe its working under forward and reverse bias.**

**Answer:**

A p-n junction diode is formed by joining p-type and n-type semiconductor materials.

When the two regions are joined, electrons from the n-region diffuse towards the p-region, while holes from the p-region diffuse towards the n-region.

This creates a depletion region near the junction and an internal potential barrier.

**Forward Bias:**

In forward bias:

- The p-side is connected to the positive terminal of the battery.
- The n-side is connected to the negative terminal.
- The depletion layer becomes thinner.
- The potential barrier decreases.
- A substantial current flows after the applied voltage becomes sufficient.

**Reverse Bias:**

In reverse bias:

- The p-side is connected to the negative terminal.
- The n-side is connected to the positive terminal.
- The depletion layer becomes wider.
- The potential barrier increases.
- Only a very small reverse saturation current flows under normal operating conditions.

**Conclusion:**

A p-n junction diode allows current to flow much more easily in the forward direction than in the reverse direction. Therefore, it is used as a rectifier.

## Additional Important Numerical and Conceptual Questions

The questions below give you some extra practice with numerical problem-solving and with applying Physics concepts.

**Question 27. Two resistors of 4 Ω and 6 Ω are connected in series to a 20 V battery. Calculate the current flowing through the circuit and the potential difference across each resistor.**

**Answer:**

Given:

$R_1 = 4\ \Omega$

$R_2 = 6\ \Omega$

V = 20 V

For resistors in series:

$R = R_1 + R_2$

R = 4 + 6

R = 10 Ω

Using Ohm's law:

I = V/R

= 20/10

= 2 A

Potential difference across the first resistor:

$V_1 = IR_1$

= 2 × 4

= 8 V

Potential difference across the second resistor:

$V_2 = IR_2$

= 2 × 6

= 12 V

**Final Answer:**

Current = 2 A

Potential difference across 4 Ω resistor = 8 V

Potential difference across 6 Ω resistor = 12 V

**Question 28. A transformer has 500 turns in its primary coil and 100 turns in its secondary coil. If the primary voltage is 220 V, calculate the secondary voltage. Also identify the type of transformer.**

**Answer:**

Given:

Primary turns, $N_p$ = 500

Secondary turns, $N_s$ = 100

Primary voltage, $V_p$ = 220 V

The transformer equation is:

$V_s/V_p = N_s/N_p$

Therefore:

$V_s = V_p \times N_s/N_p$

$= 220 \times 100/500$

$= 220 \times 0.2$

$= 44$ V

Since the secondary voltage is less than the primary voltage, it is a step-down transformer.

**Final Answer: Secondary voltage = 44 V. It is a step-down transformer.**

**Question 29. A convex mirror has a focal length of 20 cm. An object is placed 30 cm in front of it. Calculate the image distance.**

**Answer:**

Given:

Focal length, f = +20 cm

Object distance, u = −30 cm

Using the mirror formula:

$1/f = 1/v + 1/u$

Substituting:

$1/20 = 1/v - 1/30$

$1/v = 1/20 + 1/30$

$1/v = (3 + 2)/60$

$1/v = 5/60$

$1/v = 1/12$

$v = 12$ cm

**Final Answer: The image is formed 12 cm behind the mirror.**

The image is virtual, erect, and diminished.

**Question 30. Case Study: Photoelectric Effect**

A student performs an experiment to study the photoelectric effect using a metal surface. Light of different frequencies is allowed to fall on the metal, and the stopping potential is measured.

Answer the following questions:

**(a) What is the minimum frequency of incident light required to produce photoelectric emission called?**

**Answer:**

It is called the threshold frequency ($v_o$).

**(b) What happens to the maximum kinetic energy of photoelectrons when the frequency of incident light increases above the threshold frequency?**

**Answer:**

The maximum kinetic energy increases linearly with the frequency of incident light, according to Einstein's photoelectric equation.

$K_{max} = hv - \varphi$

**(c) What happens to the photoelectric current when the intensity of incident light increases, keeping its frequency above the threshold frequency?**

**Answer:**

The photoelectric current increases because a greater number of photons fall on the metal surface per unit time, resulting in the emission of more photoelectrons.