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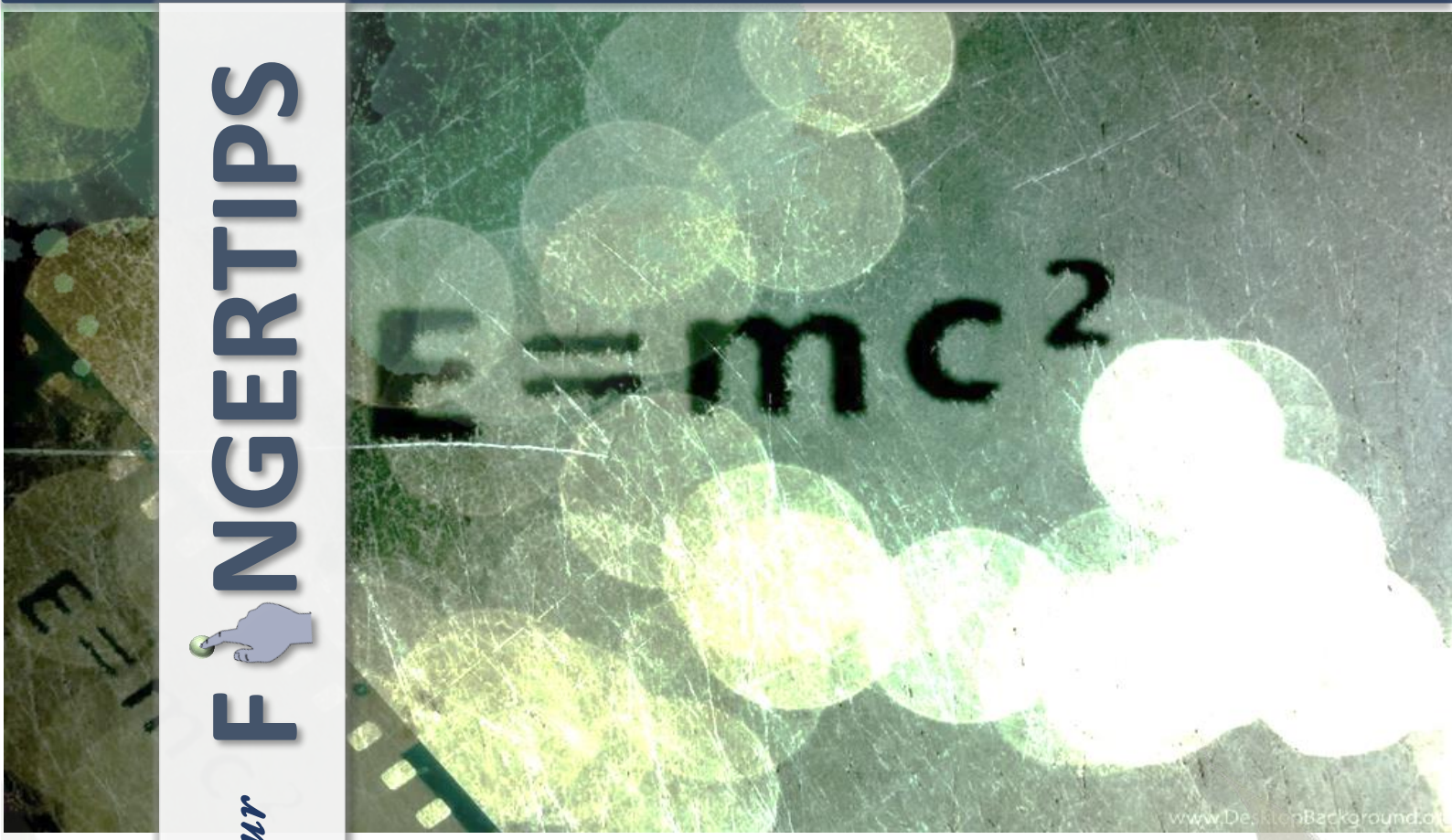


# PHYSICS at your FINGERTIPS

# 2024

## MADHYA PRADESH STATE FOREST SERVICE

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To all our successful candidates in

# MADHYA PRADESH FOREST SERVICE 2020

## Assistant Conservator of Forest (ACF)


1 Ashish Vijaywar


2 Ankit Kumar Jain


3 Sachindra Singh Tomar


4 Shubham Soni


6 Rahul Chouhan

**5 Out of 6 Selections in MPPSC Forest (ACF) 2020**

## RANGE FOREST OFFICER (RFO)


1 Gourav Dubey


2 Saurabh Dubey


3 Pawan Sharma


4 Manish Sharma


5 Kuldeep Baghel


6 Sushil Parmar


7 Lantav Jain


9 Shubham Raghuvanshi


10 Manisha Mukati


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25 Shubham Tiwari


26 Yogesh Dhote


27 Piyush Shukla


28 Yogendra Singh Baghel


30 Abhilash Pathak


31 Manav Patidar


33 Omkar Nath Mishra


34 Amit Singh Chandel

MPPSC ACF/RFO EXAMINATION 2023/24

# PHYSICS

**MODULE – 8**

**EDITION : 2024**

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Gole ka mandir, Morar, Gwalior (MP) 474005

## SYLLABUS

| Unit | Syllabus |
|---|---|
| 1 | **LIGHT :** Nature of light reflection of light, laws of reflection, reflection from plane and curved surface, image formation by plane convex and concave mirror, relation between focal length and radius of curvature, determination of focal length of concave mirror by single pin method. Relation between u-v-f [numerical examples]. Refraction of light laws of refraction, refraction by glass slab, critical angle, total internal reflection, use of total internal reflection in daily life. lens [converging and diverging lens]. Definition focal length optical centre image formation by lens Human eye. its defects and remedies. Comparison between photographic camera and human eye. Simple telescope and astronomical telescope- Construction, working, uses, ray diagram [no formula derivation]. |
| 2 | **ELECTROSTATIC :** Electricity and its effects -electric intensity, potential, potential difference, |
| 3 | **ELECTRIC CURRENT :** electric current Ohm's law. Resistance specific resistance, influencing factors, combination of resistance and related numerical examples thermal effect of current it's use, calculation of power and electrical energy spent,(numerical) precautions observed in electric experiments. Chemical effects of electric current. Primary and secondary cells their properties and drawback. Leclanche cell, dry cell, lead accumulator cell, construction. Magnetic effect of current - Oersted experiment, electromagnetic induction, electric motor, working principle and use of generator, general studies of alternating current and direct current, |
| 4 | **MAGNETIC EFFECT OF CURRENT AND MAGNATE :** Magnetism - Magnet and it's types artificial magnet, methods of preparing magnets, molecular theory of magnetism, demagnetization, magnetic keepers, magnetic lines of force and their properties. Plotting the lines of force Terrestrial magnetism, magnetic storm, magnetic meridian geographical meridian, relation between VH1 and $\phi$ |
| 5 | **MAGNETIC FLUX :** Magnetism - Magnet and it's types artificial magnet, methods of preparing magnets, molecular theory of magnetism, demagnetization, magnetic keepers, magnetic lines of force and their properties. Plotting the lines of force Terrestrial magnetism, magnetic storm, magnetic meridian geographical meridian, relation between VH1 and $\phi$ |
| 6 | **NUCLEUS AND NUCLEAR ENERGY :** Nuclear energy, nuclear Fission, Fusion, chain reaction, nuclear reactor, uses and harms of nuclear energy. |
| 7 | **ENERGY :** Source of Energy - Conventional and new sources of Energy, source of solar energy, causes of origin of energy in the Sun, solar heating devices, solar cooker, solar cell, wind energy, biogas, fossil fuels, ideal fuel, properties of ideal fuel. |



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# INDEX

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CHAPTER

0

# PREVIOUS YEAR QUEXTIONS

## MPPSC FOREST SERVICE (MAIN) EXAMINATION 2018

1. Which has highest calorific value:
   (a) Charcoal
   (b) Cow dung
   (c) Wood
   (d) Biogas
2. Which is not the property of an ideal fuel:
   (a) It is a pollution free fuel.
   (b) It is a clean fuel
   (c) Its calorific value is lower
   (d) Its accidental hazards are lower.
3. which of the fallowing variety of coal contains highest percentage of carbon:
   (a) Bituminous
   (b) Anthracite
   (c) peat
   (d) Lignite
4. Which one is non renewable source of energy:
   (a) Hydrogen
   (b) Natural gas
   (c) Biogas
   (d) Ocean
5. Which particle is missing in the following nuclear reaction:

   $_{7}N^{14} + {}_{2}He^{4} \rightarrow {}_{8}O^{17} + \ldots\ldots\ldots\ldots\ldots?$

   (a) $_{0}n^{1}$
   (b) $_{-1}e^{o}$
   (c) $_{0}Y^{O}$
   (d) $_{1}H^{1}$
6. A nuclear reactor delivers a power of 109 W . What is the amount of fuel consumed by the reactor in one hour :
   (a) .04g
   (b) .08g
   (c) .048g
   (d) .96g
7. A radioactive material has a half-life of 8 years. The activity of the material decreases to 1/8 of its original value in:
   (a) 12 years
   (b) 24 years
   (c) 48 years
   (d) 64years
8. The image of an object is formed by a convex lens on a screen. If lower half of the lens is painted black , the intensity of image becomes:
   (a) Half
   (b) One fourth
   (c) Same
   (d) Twice
9. Maximum lateral displacement of the ray of light incident on a slab of thickness t is:
   (a) $\frac{t}{4}$
   (b) $\frac{t}{3}$
   (c) $\frac{t}{2}$
   (d) t
10. The number of images of an object placed between two mirrors inclined at an angle of 45o are:
    (a) 5
    (b) 6
    (c) 7
    (d) 8

11. Total internal reflection takes place if light goes from:
    (a) Water to glass
    (b) Glass to water
    (c) Air to glass
    (d) Air to water
12. A wire of resistance R is stretched to reduce its diameter to half of its original value, The new resistance is
    (a) 2R
    (b) 4R
    (c) 8R
    (d) 16R
13. The resistivity of the material depends on:
    (a) Length of the wire
    (b) Diameter of the wire
    (c) Temperature of the wire
    (d) Material of the wire
14. The surface of a spherical shell is uniformly charged. Then what is the electric field inside the spherical shell:
    (a) Zero
    (b) Constant
    (c) Infinite
    (d) Proportional to the distance from the center
15. Five equal resistances each of resistance 3 are connected as shown in the fallowing figure .The equivalent resistance between the points A and E
    (a) 5
    (b) 8
    (c) 10
    (d) 15
16. A battery of emf E and internal resistance r is connected across the load R. When the current flows through the resistance R, power is dissipated in the form of heat energy. The output power will be maximum when
    (a) R = r
    (b) R = 2r
    (c) R = 3r
    (d) R = 4r
17. An ac generator consist of a coil of 50 turns and area 2.5m2 rotating at an angular speed of 60 rad s-1 in a uniform magnetic field B=0.3 T between two fixed pole pieces the resistance of the circuit including that of the coil is 500 . What is the maximum current drawn from the generator:
    (a) 2.3 A
    (b) 4.5 A
    (c) 5.2 A
    (d) 6.5 A
18. A steel wire has a magnetic movement M. If the wire is bend into semicircular arc, The new magnetic movement becomes:
    (a) M
    (b) 2M
    (c) 2πM
    (d) $\frac{2}{\pi}$ M
19. An X-ray machine is operated at an accelerating voltage V volts, then the minimum wavelength of X-rays emitted from X-ray machine is:
    (a) $\frac{eh}{Vc}$
    (b) $\frac{vc}{eh}$
    (c) $\frac{ev}{hc}$
    (d) $\frac{hc}{ev}$
20. Calculate the energy equivalent of 1g of substance
    (a) $3x10^{13}$ J
    (b) $6x10^{13}$ J
    (c) $9x10^{13}$ J
    (d) $2x10^{13}$ J



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# MPPSC FOREST SERVICE (MAIN) EXAMINATION 2019

1. Control rods used in nuclear reactor are made of
   (a) Zinc
   (b) Platinum
   (c) Cadmium
   (d) Lead
2. Name of the particle emitted in the following reaction.
   $_{93}Np^{239} \rightarrow {}_{94}Np^{239} + ?$
   (a) alfa -particle
   (b) Beeta -particle
   (c) gamma-rays
   (d) neutron
3. What should be the minimum length of a plane mirror to get a full image of a person of height 4 feet?
   (a) 4 feet
   (b) 6 feet.
   (c) 2 feet
   (d) 1 feet
4. The focal length of a plane mirror is
   (a) O
   (b) 10 cm
   (c) 20 cm
   (d) ∞
5. the power of covex lens of focal length 25cm is
   (a) 1D
   (b) 2D
   (c) 3D
   (d) 4D
6. Wind energy is a source of energy which is
   (a) renewable
   (b) non-renewable
   (c) thermal
   (d) none of the above
7. A man approaches a vertical plane mirror at speed of 2m/sec. At what rate does he approach his image?
   (a) 2 m/sec
   (b) 4 m/sec
   (c) 6 m/sec
   (d) 8 m/sec
8. When a thin convex lens is put in contact with a thin concave lens of same focal length. The resultant combination has focal length equal to
   (a) f/2
   (b) 2f
   (c) 0
   (d) ∞
9. According to Faraday's law, the total charge induced in a conductor that is moved in a magnetic field depends upon
   (a) Initial magnetic flux
   (b) Final magnetic flux
   (c) Rate of change of magnetic flux (D) Change in magnetic flux
   (d) The energy released per fission of
10. $_{92}U^{235}$ nucleus is nearly
    (a) 200 eV
    (b) 20 eV
    (c) ) 200 MeV
    (d) 2000 eV
11. What steady current can be drawn from an accumulator of capacity 80 Ah? 4 ampere for
    (a) 4 ampere for 20 hour
    (b) 40 ampere for 6 hour
    (c) 50 ampere for 4 hour
    (d) 20 ampere for 5 hour
12. A person cannot see objects clearly beyond 50 cm. The power of the lens to correct the vision is
    (a) +5 dioptre
    (b) -0.5 dioptre
    (c) -2 dioptre
    (d) +2 dioptre
13. A live wire is hidden in a wall. Its position can be located with the help of
    (a) Watt-meter
    (b) Moving coil galvanometer
    (c) Magnetic needle
    (d) The position of wire cannot be located without breaking the wall

14. The focal length of eye lens is controlled by
    (a) Iris
    (b) Cornea
    (c) Ciliary muscles
    (d) Optic nerve
15. The value of the magnetic field at a distance x from a long, straight current carrying conductor is proportional to
    (a) x
    (b) $X^2$
    (c) 1/ x
    (d) $1/ x^2$
16. Lenz's law is a consequence of the law of conservation of..
    (a) Charge
    (b) Mass
    (c) Energy
    (d) Type equation here.
    Momentum
17. The amount of heat produced in 5 minutes by an electric heater rated at 1000 W is
    (a) $2\times10^5$ J
    (b) $3\times10^5$ J
    (c) $4\times10^5$ J
    (d) 300 J
18. A chain reaction is continuous due to
    (a) large mass defect
    (b) large energy
    (c) production of more neutron in fission
    (d) none of these
19. A pieace of wire of resister R is cut into five equal parts. These parts are then connected is parallel. If equivalent resistence is $R^{l}$then the ratio of $R/R^{l}$ is
    (a) 1/25
    (b) 1/5
    (c) 5
    (d) 25
20. The frequency of direct current
    (a) Zero
    (b) 50Hz
    (c) 60Hz
    (d) 100Hz
21. The main component of gobar gas is
    (a) Methane
    (b) Carbon dioxide
    (c) Propane
    (d) Sulfur dioxide
22. Lenz law is a consequence of the law of conservation of
    (a) Charge
    (b) Mass
    (c) Energy
    (d) Momentum

## MPPSC FOREST SERVICE (MAIN) EXAMINATION 2020

1. An electric toaster uses nichrome for its heating element when a negligibly small current passes through it, its resistance at room temperature 25°C is found to be 75 ohm . When the toaster is connected to a 230 V supply, a steady state current of 2.3 A flows. The steady state temperature of the nichrome element will be (Take temperature co-efficient of resistance of nichrome 1.7 x $10^{-4}$ $c^{-1}$)
    (a) 1961"C
    (b) 1886°C
    (c) 1986"C
    (d) 1925°C
2. A magnetic needle is allowed to oscillate in an uniform magnetic field. Its magnetic moment is 6.7 x $10^{-2}$ $Am^2$ and moment of inertia is 7.5 x $10^{-6}$ Kg $m^2$ . It performs 10 complete oscillations in 6.0 sec. The magnitude of magnetic field is
    (a) 1.51 T



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(b) 1.02 T
(c) 0.12 T
(d) 0.012 T

3. The susceptibility of diamagnetic and paramagnetic materials is respectively
(a) Positive, positive
(b) Negative, positive
(c) Positive, negative
(d) Negative, negative

4. A wheel with 10 metallic spokes each 0.5 m long is rotated with speed 120 revolutions/ minute in a plane normal to horizontal component of Earth's magnetic field $H_E$ at a place. If $H_E = 4 \times 10^{-5}$T is at the place, what will happen to emf induced between axle and rim of wheel if same wheel has double metallic spokes ?
(a) Remains same
(b) Becomes double
(c) Becomes four times
(d) Reduces to half

5. Which of the following gas is released on incomplete combustion of carbon fuels ?
(a) CO
(b) $CO_2$
(c) $CO_2$+ $CH_4$
(d) $SO_4$

6. The unit of measuring the intensity of sound is
(a) Watt
(b) Joule
(c) Calorie
(d) Decibels

7. An object is placed at (i) 10 cm, (ii) 5 cm in front of a concave mirror of radius of curvature 15 cm, then the nature of images is
(a) Magnified, real and inverted in both cases
(b) Magnified, virtual and erect in both cases
(c) Magnified, real and inverted in (i) case and magnified, virtual and erect in (ii) case
(d) Magnified, real and erect in (i) case and magnified, virtual and inverted in (ii) case

8. In a single U nucleus fission generates approximately 200 MeV of energy. Suppose each nucleus of 50 kg of $^{235}U$ undergoes fission, then energy released is approximately
(a) $4x10^{13}$J
(b) $4x10^{15}$ J
(c) $4x10^{12}$J
(d) $4x10^{9}$J

9. Cassegrain telescope is advantageous because it
(a) Provides large focal length in large telescope
(b) Provides short focal length in large telescope
(c) Provides short focal length .in short telescope –
(d) Provides large focal length in short telescope

10. X-rays travel in straight line are affected by
(a) Electric field only
(b) Magnetic field only
(c) Both electric and magnetic field
(d) Neither electric field nor magnetic field

11. A solar-cell is based upon
(a) Photovoltaic effect
(b) Thermoelectric effect
(c) Piezoelectric effect
(d) Electromagnetic effect

# MPPSC FOREST SERVICE (MAIN) EXAMINATION 2021

1. If two conducts of resistance $R_1$ & $R_2$with resistance temperature coefficients $\alpha_1$ & $\alpha_2$ are joined together in series , then the equivalent resistance temperature coefficient is _____.[ MHPSC Forest 2021]
   (a) $\alpha_1 + \alpha_2$
   (b) $\frac{\alpha 1 + \alpha 2}{2}$
   (c) $\alpha_1 - \alpha_2$
   (d) None of the above
2. The change in temperature of body is $50^0$C, then the change in temperature on Kelvin scale will be : [MHPSC Forest 2021]
   (a) 70 K
   (b) 20 K
   (c) 50 K
   (d) 323 K
3. Which of the following determine output from wind energy converter ? [MHPSC Forest 2021]
   (A) The wind speed
   (B) The cross- section of wind swept by rotor
   (C) The intensity of sun light
   (D) The overall conversion efficiency of the rotor, transmission system and generator
   Select the correct option:
   (a) (A) only
   (b) (A), (B) and (D) only
   (c) (C) only
   (d) (A), (B) and (C) only
4. Light transmitted by Nichol prism is : [MHPSC Forest 2021]
   (a) Unpolarized
   (b) Plane Polarized
   (c) Circularly Polarized
   (d) Elliptically Polarized
5. Select the correct statements : [MHPSC Forest 2021]
   (A) Resistive force is directly proportional to the first power of velocity.
   (B) Translational motion is the result of a force.
   (C) Each particle of a rigid body has the same linear velocity in translational motion.
   (D) Linear velocities of the particle of the rigid body are not the same during rotational motion around a fixed axis passing through it
   Select the correct option:
   (a) (A) and (B) only
   (b) (A), (B) and (C) only
   (c) (B), (C) and (D) only
   (d) (A) , (B), (C) and (C)
6. The current flowing through an electric bulb rated 120V, 60W is : [MHPSC Forest 2021]
   (a) 2 A
   (b) 7.2 A
   (c) 0.5 A
   (d) 1.5 A
7. Resistivity of 1cm long copper wire is $\rho_1$ and 1000 cm long wire is $\rho_2$ having same cross section area . Then : [MHPSC Forest 2021]
   (a) $\rho_1 = \rho_2$
   (b) $\rho_1 > \rho_2$
   (c) $\rho_1 < \rho_2$
   (d) None of the above



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# MPPSC FOREST SERVICE (MAIN) EXAMINATION 2022

1. An object of height 90 cm is moved away from the base of lamp post at a speed of 1.2 m/s. If the lamp is 3.6 m above the ground, then the length of the shadow of object after 4 seconds will be
   (a) 1.6 m
   (b) 4.8 m
   (c) .9 m
   (d) 1.2 m
2. Which isotope of hydrogen is radioactive?
   (a) Helium
   (b) Deuterium
   (c) Protium
   (d) Tritium
3. Two 'deuterons fuse to form a triton and a proton. The energy liberated in this nuclear reaction will be (Take masses of deuteron, triton and proton as 2.014102 u, 3.016049 u and 1.007825 u respectively)
   (a) 200 Volt
   (b) 100 MeV
   (c) 4.03 MeV
   (d) 2.15 MeV
4. The percentage of the incoming radiation from the Sun reflected back to space by the Earth is
   (a) 10%
   (b) 20%
   (c) 30%
   (d) 40%
5. The maximum air temperature inside a box type solar cooker is around The relationship between
   (a) 140°C-160°C
   (b) ] 50 °C- 100 °C
   (c) 180°C-260°C
   (d) 200° C - 300 °C
6. Consider the four statements given below related to the images in a converging lens and choose the correct answer depicting the correct statements from the given options :
   (a) When the object is at a distance 2F from the lens, the image is real, inverted and of the same size as that of the object
   (b) When the object is between 2F and F, the image is real, inverted and bigger than the object.
   (c) When the object is farther than 2F from the lens, the image is real, inverted and smaller than the object. [
   (d) When the object is nearer than F, the image is inverted magnified and virtual.

   Codes

   (A) (a) (b) and (c) only
   (B) (a), (b) and (d) only
   (C) (b), (c) and (d) only
   (D) (a), (c) and (d) only
7. The near point N of a defective eye is 30 cm from the eye. If the will be normal near point is 25 cm from the eye, the power of the lens needed to correct this defect will be
   (a) 0.25 Gauss
   (b) 0.50 D
   (c) 0.67 D
   (d) 1.0 D
8. A magnetic field is measured in Tesla (T) as well as in Gauss (G). The relationship between these two units is given by
   (a) $1\ T = 10^{-6}\ G$
   (b) $1\ T = 10^{-5}\ G$
   (c) $1\ T = 10^{4}\ G$
   (d) $1\ T = 10^{-3}\ G$
9. What is the peak value of an alternating current

that produces three times the heat per second size as that of the object. as a direct current of 2.0 A in a resistance R?

(a) 3.46 A

(b) 4.9 A

(c) 2.45 A

(d) 2.0 A

10. A battery of e.m.f. 1.5 V has a terminal potential difference of 1.25 V when an external resistance of 25 Ohm is connected to it. The 131. The internal resistance of the battery will be

(a) 25 Ohm

(b) 15 Ohm

(c) 5 Ohm

(d) 0 Ohm

11. Find the atomic number of the element that has a X-ray line whose wavelength is 0.135 nm. Take Ryberg constant R = 1-097 xlO$^{-7}$m$^{-l}$

(a) 25

(b) 26

(c) 28

(d) 32

12. A wire carrying a current of 10 A and 200 cm in length is placed in a magnetic field of flux density 0.5 T. What is the force on the wire if it is placed at 30° angle to the field?

(a) 10 N

(b) 8.66 N

(c) 7.1 N

(d) 5 N





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# CHAPTER 1

# LIGHT

Syllabus : Light - Nature of light reflection of light, laws of reflection, reflection from plane and curved surface, image formation by plane convex and concave mirror, relation between focal length and radius of curvature, determination of focal length of concave mirror by single pin method. Relation between u-v-f [numerical examples]. Refraction of light laws of refraction, refraction by glass slab, critical angle, total internal reflection, use of total internal reflection in daily life. lens [converging and diverging lens]. Definition focal length optical centre image formation by lens Human eye. its defects and remedies. Comparison between photographic camera and human eye. Simple telescope and astronomical telescope- Construction, working, uses, ray diagram [no formula derivation].

## 6.1 प्रकाश क्या है?

The sensation of vision arises when our retinas are excited by light, a form of energy that acts as the physical cause of this experience. (दृष्टि की अनुभूति तब उत्पन्न होती है जब हमारी रेटिना प्रकाश से उत्तेजित होती है, ऊर्जा का एक रूप जो इस अनुभव के भौतिक कारण के रूप में कार्य करता है)

### ➢ PROPERTIES OF VISIBLE LIGHT

- No material medium is required for the propagation of light energy, i.e., it travels even in **vacuum.**
- Its velocity is constant in all inertial frames i.e. it is an absolute constant. It is independent of the relative velocity between the source and the observer.
- Its velocity in vacuum is maximum whose value **is $3 \times 10^8$ m/s.**
- It lies in the visible region of **electromagnetic spectrum** whose wavelength range is from **4000 Å to 8000 Å.**
- Its energy is of the order of eV.
- It propagates in straight line.
- It exhibits **the phenomena of reflection, refraction, interference, diffraction, polarisation and double refraction.**
- It can emit electrons from metal surface i.e. it can produce **photoelectric effect.**
- It produces thermal effect and exerts pressure when incident upon a surface. It proves that light has **momentum and energy.**
- Its velocity is different in different media. In rarer medium it is more and in denser medium it is less.
- Light energy propagates via two processes.
  (a) The particles of the medium carry energy from one point of the medium to another.

(b) The particles transmit energy to **the neighbouring particles** and in this way energy propagates in the form of a disturbance.

➢ **DIFFERENT THEORIES OF LIGHT**

- Newton's corpuscular theory of light.
- **Hygen's wave theory of light.**
- **Maxwell's electromagnetic theory of light**.
- **Plank's Quantum theory of light.**
- De-Broglie's dual theory of light

➢ **NEWTON'S CORPUSCULAR THEORY OF LIGHT** : This theory was enunciated by Newton.

Characteristics of the theory

- Extremely minute, very light and elastic particles are being constantly emitted by all luminous bodies (light sources) in all directions
- These corpuscles travel with the speed of light.
- When these corpuscles strike the retina of our eye then they produce the sensation of vision.
- The velocity of these corpuscles in **vacuum is $3 \times 10^8$ m/s.**
- The different colours of light are due to different size of these corpuscles.
- The rest mass of these corpuscles is zero.
- The velocity of these corpuscles in an isotropic medium is same in all directions but it changes with the change of medium.
- These corpuscles travel in **straight lines.**
- These corpuscles are invisible.

- **The phenomena explained by this theory**

(a) Reflection and refraction of light.

(b) Rectilinear propagation of light.

(c) Existence of energy in light.

- **The phenomena not explained by this theory**

(a) Interference, diffraction, polarisation, double refraction and total internal reflection.

(b) Velocity of light being greater in rarer medium than that in a denser medium.

(c) Photoelectric effect and Crompton effect.

➢ **WAVE THEORY OF LIGHT** : This theory was enunciated by **Hygen** in a hypothetical medium known as aluminiferous ether. Ether is that imaginary medium which prevails in all space, in isotropic, perfectly elastic and massless. The different colours of light are due to different wave lengths of these waves. The velocity of light in a medium is constant but changes with change of medium. This theory is valid for all types of waves.

- The locus of all ether particles vibrating in same phase is known as wavefront.
- Light travels in the medium in the form of wavefront.
- When light travels in a medium then the particles of medium start vibrating and consequently a disturbance is created in the medium.
- Every point on the wave front becomes the source of secondary wavelets. It emits secondary wavelets in all directions which travel with the **speed of light**



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# CHAPTER 2 ELECTROSTATIC

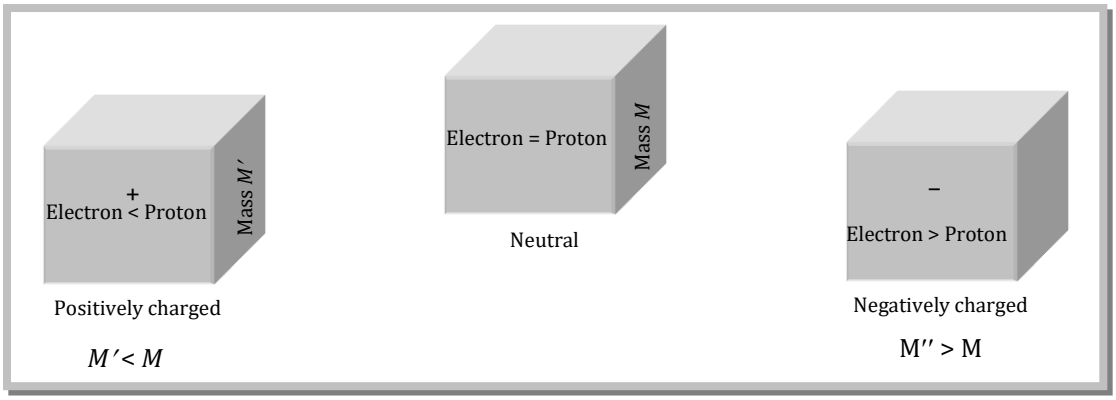
Syllabus: Electricity and its effects -electric intensity, potential, potential difference,

## 7.1 Electric Charge

**Definition :** **Charge is the property associated with matter due to which it produces and experiences electrical and magnetic effects**.

**Origin of electric charge :** It is known that every atom is electrically neutral, containing as many electrons as the **number of protons in the nucleus**.

Charged particles can be created by disturbing neutrality of an atom. Loss of electrons gives positive charge (as then $n_p > n_e$) and gain of electrons gives negative charge (as then $n_e > n_p$) to a particle. When an object is negatively charged it gains electrons and therefore its mass increases negligibly. Similarly, on charging a body with positive electricity its mass decreases. Change in mass of object is equal to $n \times m_e$. Where, $n$ is the number of electrons transferred and $m_e$ is the mass of electron $= 9.1 \times 10^{-31}\ Kg$ .

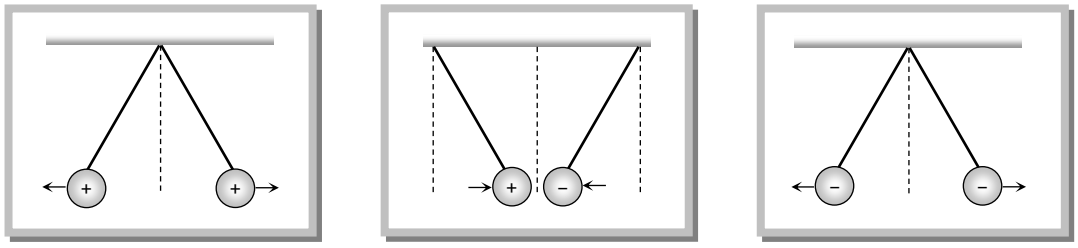



**Type** : There exists two types of charges in nature

- Positive charge
- Negative charge

Charges with the same electrical sign repel each other, and charges with opposite electrical sign attract each other.

**Unit and dimensional formula :** **Rate of flow of electric charge is called electric current** *i.e.,*



$i = \frac{dQ}{dt} \Rightarrow dQ = idt$ , hence S.I. unit of charge is – *Ampere* × *sec* = *coulomb* (*C*), smaller S.I. units are *mC*, $\mu C$, *nC* $(1mC = 10^{-3}C, 1\mu C = 10^{-6}C, 1nC = 10^{-9}C)$. C.G.S. unit of charge is – *Stat coulomb* or *e.s.u*. Electromagnetic unit of charge is – *ab coulomb* $1C = 3 \times 10^9$ *stat coulomb* $= \frac{1}{10}$ *ab coulomb* .

Dimensional formula $[Q] = [AT]$

- Benjamin Franklin was the first to assign positive and negative sign of charge.
- The existence of two type of charges was discovered by Dufog.
- **Franklin (*i.e. e.s.u.* of charge) is the smallest unit of charge while faraday is largest (1 *Faraday* = 96500 *C*).**
- The *e.s.u.* of charge is also called stat coulomb or Franklin (*Fr*) and is related to *e.m.u.* of charge through the relation $\frac{\text{emu of charge}}{\text{esu of charge}} = 3 \times 10^{10}$

**Point charge :** A finite size body may behave like a point charge if it produces an inverse square electric field. For example an isolated charged sphere behave like a point charge at very large distance as well as very small distance close to it's surface.

**Properties of charge**

- **Charge is transferable :** If a charged body is put in contact with an uncharged body, uncharged body becomes charged due to transfer of electrons from one body to the other.
- **Charge is always associated with mass**, *i.e.*, charge can not exist without mass though mass can exist without charge.
- **Charge is conserved :** Charge can neither be created nor be destroyed. *e.g.* In radioactive decay the uranium nucleus (charge $= +92e$ ) is converted into a thorium nucleus (charge $= +90e$ ) and emits an $\alpha$ -particle (charge $= +2e$ )

  ${}_{92}U^{238} \rightarrow {}_{90}Th^{234} + {}_{2}He^{4}$ . Thus the total charge is $+92e$ both before and after the decay.
- **Invariance of charge** : The numerical value of an elementary charge is independent of velocity. It is proved by the fact that an atom is neutral. The difference in masses on an electron and a proton suggests that electrons move much faster in an atom than protons. If the charges were dependent on velocity, the neutrality of atoms would be violated.

**Charge produces electric field and magnetic field** : A charged particle at rest produces only electric field in the space surrounding it. However, if the charged particle is in unaccelerated motion it produces both electric and magnetic fields. And if the motion of charged particle is accelerated it not only produces electric and magnetic fields but also radiates energy in the space surrounding the charge in the form of electromagnetic waves.

# CHAPTER 3

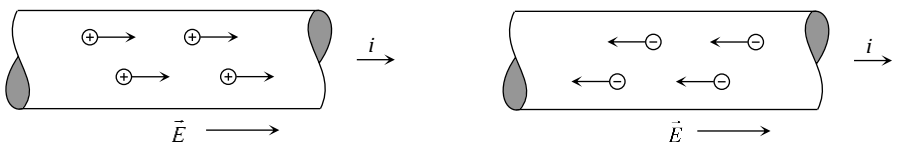
# ELECTRIC CURRENT

**Syllabus :** electric current Ohm's law. Resistance specific resistance, influencing factors, combination of resistance and related numerical examples thermal effect of current it's use, calculation of power and electrical energy spent,(numerical) precautions observed in electric experiments. Chemical effects of electric current. Primary and secondary cells their properties and drawback. Leclanche cell, dry cell, lead accumulator cell, construction. Magnetic effect of current - Oersted experiment, electromagnetic induction, electric motor, working principle and use of generator, general studies of alternating current and direct current,

## 8.1 Electric Current

**Definition : The time rate of flow of charge through any cross-section is called current. So if through a cross-section, $\Delta Q$ charge passes in time $\Delta t$ then $i_{av} = \frac{\Delta Q}{\Delta t}$ and instantaneous current $i = \underset{\Delta t \to 0}{Lim} \frac{\Delta Q}{\Delta t} = \frac{dQ}{dt}$. If flow is uniform then $i = \frac{Q}{t}$. Current is a scalar quantity. It's S.I. unit is *ampere* (*A*) and C.G.S. unit is *emu* and is called *biot* (*Bi*), or *ab ampere*. 1*A* = (1/10) *Bi* (*ab amp.*)**

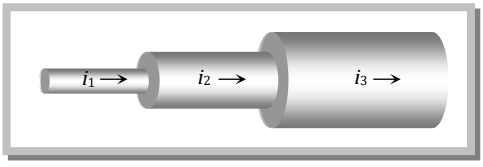
**The direction of current :** The conventional direction of current is taken to be the direction of flow of positive charge, *i.e.* field and is opposite to the direction of flow of negative charge as shown below.




Though conventionally a direction is associated with current (Opposite to the motion of electron), it is not a vector. It is because the current can be added algebraically. Only scalar quantities can be added algebraically not the vector quantities.

**Charge on a current carrying conductor :** In conductor the current is caused by electron (free electron). The no. of electron (negative charge) and proton (positive charge) in a conductor is same. Hence the net charge in a current carrying conductor is zero.

**Current through a conductor of non-uniform cross-section :** For a given conductor current does not change with change in cross-sectional area. In the following figure $i_1 = i_2 = i_3$



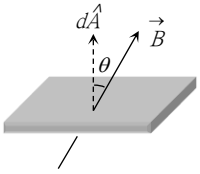
# CHAPTER 5

# MAGNETIC FLUX

Syllabus : Magnetism - Magnet and it's types artificial magnet, methods of preparing magnets, molecular theory of magnetism, demagnetization, magnetic keepers, magnetic lines of force and their properties. Plotting the lines of force Terrestrial magnetism, magnetic storm, magnetic meridian geographical meridian, relation between VH1 and ϕ

## 10.1 Magnetic Flux

**The total number of magnetic lines of force passing normally through an area placed in a magnetic field is equal to the magnetic flux linked with that area.**




For elementary area *dA* of a surface flux linked $d\phi = B\,dA\cos\theta$ or $d\phi = \vec{B}\cdot d\vec{A}$

So, Net flux through the surface $\phi = \oint \vec{B}\cdot d\vec{A} = BA\cos\theta$

For *N*-turns coil $\phi = NBA\cos\theta$

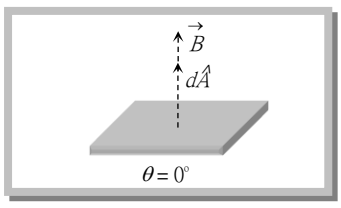
**Unit and Dimension**

Magnetic flux is a scalar quantity it's S.I. unit is *weber* (*wb*), CGS unit is *Maxwell* or *Gauss* × $cm^2$; $1\,wb = 10^8\ Maxwell$ . Other units : *Tesla* × $m^2$ $= \dfrac{N\times m}{Amp} = \dfrac{Joule}{Amp} = \dfrac{Volt\times Coulomb}{Amp} = Volt\times sec$ = *Ohm* × *Coulomb* = *Henry* × *Amp*. It's dimensional formula $[\phi] = [ML^2T^{-2}A^{-1}]$

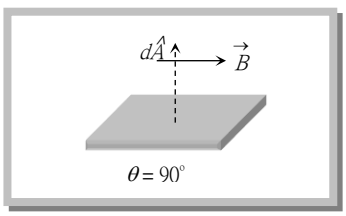
**Maximum and Zero flux**

If $\theta = 0^o$, *i.e.* plane is held perpendicular to the direction of magnetic field then flux from the surface is maximum and if $\theta = 90^o$ *i.e.* plane is held parallel to the direction of magnetic field then flux linked with the surface is zero.

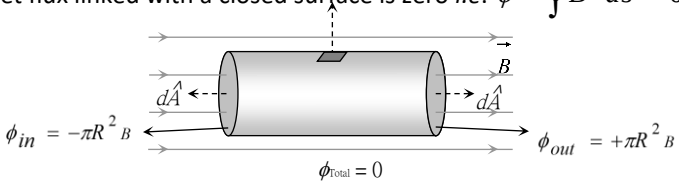
$\phi_{max} = BA$




$\phi = 0$



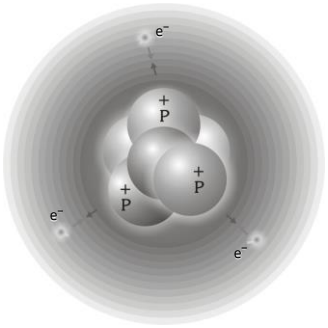

In case of a body present in a field, either uniform or non-uniform, outward flux is taken to be positive while inward negative and Net flux linked with a closed surface is zero *i.e.* $\phi = \oint \vec{B}\cdot d\vec{s} = 0$



CHAPTER 6

# NUCLEUS AND NUCLEAR ENERGY

Syllabus : Nuclear energy, nuclear Fission, Fusion, chain reaction, nuclear reactor, uses and harms of nuclear energy.




**Rutherford's $\alpha$-scattering experiment established that the mass of atom is concentrated with small positively charged region at the centre which is called 'nucleus'.**

Nuclei are made up of proton and neutron. The number of protons in a nucleus (called the atomic number or proton number) is represented by the symbol *Z*. The number of neutrons (neutron number) is represented by *N*. The total number of neutrons and protons in a nucleus is called it's mass number *A* so *A* = *Z* + *N*.

**Neutrons and proton, when described collectively are called *nucleons*.**

Nucleus contains two types of particles : Protons and neutrons

Nuclides are represented as ${}_{Z}X^{A}$; where *X* denotes the chemical symbol of the element.

- **Neutron.**

  Neutron is a fundamental particle which is essential constituent of all nuclei except that of hydrogen atom. It was discovered by Chadwick.

  - The charge of neutron : It is neutral
  - The mass of neutron : $1.6750 \times 10^{-27}$ *kg*
  - It's spin angular momentum : $\frac{1}{2} \times \left(\frac{h}{2\pi}\right) J - s$
  - It's magnetic moment : $9.57 \times 10^{-27}$ *J/Tesla*
  - It's half life : 12 minutes
  - Penetration power : High
  - Types : Neutrons are of two types slow neutron and fast neutron, both are fully capable of penetrating a nucleus and causing artificial disintegration.

  A free neutron outside the nucleus is unstable and decays into proton and electron

  $${}_{0}n^{1} \rightarrow \underset{\text{Proton}}{{}_{1}H^{1}} + \underset{\text{Electron}}{{}_{-1}\beta^{0}} + \underset{\text{Antinutrin o}}{\bar{\nu}}$$

- ***Thermal neutrons***

  Fast neutrons can be converted into slow neutrons by certain materials called moderator's (Paraffin wax, heavy water, graphite) when fast moving neutrons pass through a moderator, they collide with the molecules of the moderator, as a result of this, the energy of moving neutron decreases while that of the

# CHAPTER 7

# ENERGY

Syllabus : Source of Energy - Conventional and new sources of Energy, source of solar energy, causes of origin of energy in the Sun, solar heating devices, solar cooker, solar cell, wind energy, biogas, fossil fuels, ideal fuel, properties of ideal fuel.

## 11.1 ENERGY

'Energy' The word 'energy' is derived from the Greek word 'en – ergon', meaning 'in work' or 'work stuff.' Work output depends on input energy, ability to do work depends on controlling and using energy. Primitive man depended on physical labor and had limited production. Energy is universally recognized as a vital input for economic growth and human development. Access to modern energy services is essential to meet social needs, fuel economic growth and accelerate development. Energy services affect productivity, health, education, water quality and communication services. Modern services such as electricity, natural gas, cooking fuel and mechanical energy are important for better health, education, information access and industrial/agricultural productivity. Thus, a secure, reliable, affordable, clean and equitable energy supply is fundamental to global economic growth and human development. There are broadly four major energy end-use sectors.

- Commercial
- Industrial
- Transportation

## 11.2 Classification of energy sources

Energy resources can be classified on the basis of the following criteria.

Classification of energy on the basis of utility

(a) **Primary resources:** These include resources embodied in nature before undergoing any man-made transformation or change. It only involves extraction. Examples of primary energy resources are coal, crude oil, sunlight, wind, flowing rivers, vegetation and radioactive materials like uranium etc. These resources are generally available in raw form. Therefore these are known as raw (primary) energy resources. Normally, this form of energy cannot be used this way. These are discovered, explored, extracted, processed and converted from one form to another as per the requirement of the consumer. Thus, some energy is

spent in making the resource available to the user in a useful form. The energy yield ratio of an energy extraction process is defined as follows:

Energy yield ratio = Energy obtained from the raw (primary) source Energy yield / Energy expended to obtain the raw energy source

Those resources for which the energy yield ratio is high enough are considered worth exploration.

(b) Secondary Resources: Secondary Resources Energy resources supplied directly to the consumer for use after one or more stages of transformation are known as secondary or usable energy, for example. Electrical energy, thermal energy (in the form of steam or hot water), refined fuel or synthetic fuel such as hydrogen fuel, etc.

Based on traditional use: Energy has been divided into two parts on the basis of traditional use.

a. Traditional Energy Resources: Energy resources which have been used traditionally for many decades and which were in common use at the time of the 1973 oil crisis are called traditional energy resources, such as fossil fuels, nuclear and hydroelectric power.

b. Non-conventional energy resources, which are considered for use on a large scale after the oil crisis of 1973, are called non-conventional energy sources, such as solar, wind, biomass, etc.

**11.4** Based on availability

(a) Non-renewable resources: Non-renewable resources are those resources that are limited and are not replenished after consumption, hence they are called non-renewable, such as fossil fuels, uranium, etc. These are likely to be depleted over time.

(b) Renewable resources: Renewable energy is energy derived from sources that are essentially inexhaustible. Examples of renewable resources include wind energy, solar energy, geothermal energy, tidal energy, and hydroelectric energy. The most important feature of renewable energy is that it can be used without releasing harmful pollutants.

**11.5** Based on commercial application:

(a) Commercial energy resources: Energy sources that are available in the market at a certain price are known as commercial energy. So far, the most important forms of commercial energy have been electricity, coal and refined petroleum products. Commercial energy forms the basis for industrial, agricultural, transport and commercial development in the modern world. In industrialized countries, commercial fuels are the major source not only for economic production but also for many household tasks of the general population.

(b) Non-commercial energy: Non-commercial energy are those energy sources which are not available at a price in the commercial market, they are classified as non-commercial energy. Non-commercial energy sources include fuels such as firewood, cow dung and agricultural waste, which are traditionally collected and not bought at a price, are used especially in rural households. Non-commercial energy is often overlooked in energy accounting. Examples of non-commercial energy are: Firewood, agricultural waste in rural areas, solar energy for water heating, animal power for transportation, irrigation and sugarcane crushing etc.



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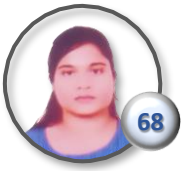


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