INDIAN SCHOOL MUSCAT

SENIOR SECTION

IMPORTANT FORMULAE & CONCEPTS IN CLASS XII PHYSICS

ELECTROSTATICS

1. Q = ne, quantization of charge $e=1.6 \times 10^{-19}$ C.

2. $F= q_1q_2/4\pi\varepsilon_0 r^2$ F- electrostatic force in air or vacuum, q_1,q_2 electric charges, r- distance, $\varepsilon_0 = 8.85 \times 10^{-11} C^2N^{-1}m^{-2}$.

3. $\varepsilon_r = F/F_M$ F_M- electrostatic force in a medium , ε_r- relative permittivity or dielectric constant of a medium.

4. $\varepsilon_r = E/E_m$, E –electric field in air , E_m - electric field in medium.

5. p= q(2a) , p – dipole moment ,q - electric charge, 2a – length of electric dipole , vector quantity , its direction is from –q to +q , unit C m.

6. Electric field at axial point of a short dipole, same direction as that of dipole moment
$E = 2p / 4\pi \varepsilon_0 r^3$, vector quantity , unit V/m.

7. Electric field at equatorial line of dipole direction from +q to –q, opposite to that of dipole moment
$E = p/4\pi \varepsilon_0 (r^2 +a^2)^{3/2}$, for long dipole .
$E = p / 4\pi \varepsilon_0 r^3$ for a short dipole.

8. Torque **τ=p x E,** τ- torque, τ= pE sinθ, direction of torque is perpendicular to **p** and **E,** obtained by right hand cork screw rule. vector quantity , unit Nm.

9. potential energy of a dipole U= -pEcosθ,
work done $W =-pE(\cos\theta_f- \cos\theta_i)$, θ_f – final orientation, θ_i–initial orientation of dipole. unit J.
0 to 180◦ - potential energy = 2pE maximum, highly unstable equilibrium.
0 to 90◦ -potential energy = pE, large value, unstable equilibrium.
90◦ to 0- potential energy = - pE, negative value, stable equilibrium.
180◦ to 0 - potential energy = - 2pE, minimum, highly stable equilibrium.

9.Electric potential at a point due to a point charge $V = q/ 4\pi \varepsilon_0 r^2$, scalar quantity unit volt.
10. Electric potential energy of a system of two charges $U = q_1q_2/4\pi\varepsilon_0 r$, unit J.
11.Relation between electric field strength E and electric potential V ,$E = -dV/dx$, electric field is negative gradient of electric potential.
12. Electric flux Ǿ = **E.A =** EAcosθ , It is the number electric field lines passing an area normal to it. scalar quantity, unit Vm or Nm^2/C .
13. Gauss theorem
The total Electric flux passing through a closed surface is equal to $1/\varepsilon_0$ times the total charge q enclosed by the surface. Ǿ = **E.A =q/** ε_0
14. Electric field at a point due to a linear charge $E = \lambda/2\pi \varepsilon_0 r$, λ – linear charge density.
15. Electric field at a point due to a thin infinite plane sheet of charge. $E = \sigma/2 \varepsilon_0$, σ – surface charge density.
16. Relation between charge Q, capacitance C, Potential V, Q = CV.
17. Energy stored in a capacitor $U = ½ CV^2 = 1/2\ QV = ½\ Q^2/2C$.
18. Common potential of two capacitors in parallel $V = (C_1V_1+C_2V_2)/ C_1+C_2$.

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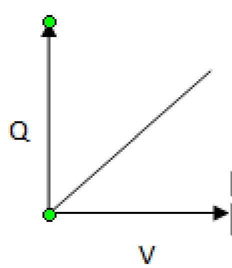


Area under the graph = energy stored in the capacitor= $½ CV^2$.

Slope = Q/V = C- Capacitance of the capacitor.

20. Energy density U/volume = $½ \varepsilon_0E^2$.
21. Effective capacitance of a number of capacitances in parallel C_p = C1+C2+C3+….
for n identical capacitors $C_p = n C$
22. Effective capacitance of a number of capacitances in series $1/ C_S = 1/C_1 +1/C_2 + \dots$
for n identical capacitors $C_s = C/n$
23. $C = \varepsilon_0A/d$ capacitance with out dielectric.

24.C= $(\varepsilon_0\, \varepsilon_r\, A)/d$ capacitance with dielectric.

25.Capacitors are used in i) ignition systems of automobiles , ii) radio tuning circuits .iii) blocking
capacitor in a detector to block dc noise.

CURRENT ELECTRICITY

1.Electric current $I = q/t$, $I = dq/dt$, q - charge ,t- time.

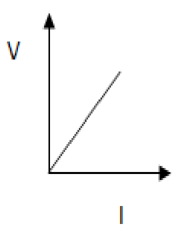
2. $V_d = eE\tau/m$, V_d – drift velocity , e- charge of electron ,E- electric field ,τ – relaxation time,m- mass of
electron.

3. Mobility μ = drift velocity /unit electric field = $e\tau/m$.

4. Resistance of a conductor $R = \rho l/A$, $R = ml/ ne^2A\,\tau$ n-number of free electrons /m^3 ,conductance
$G=1/R$

5 . Resistivity $\rho = RA/l$, $\rho = m/ne^2\tau$,Conductivity $= \sigma = 1/\rho$.

6.



slope of the graph gives $R = V/I$

7. Current density $J = I/A$, vector quantity , A/m^2 $J = \sigma E = E/\rho$

8.   Effective resistance in parallel $1/R_P = 1/R_1 + 1/R_2 + \ldots$

9. Effective resistance in Series $R_s = R_1 + R_2 + \ldots$
For n identical resistances $R_s = n\,R$.

9. Relation between emf ε, tpd V, and internal resistance r of a cell during discahrging
$V= \varepsilon - Ir$, during charging $V= \varepsilon + Ir$, In open circuit $V= \varepsilon$.

10.Series combination of n cells $\varepsilon_T = n\,\varepsilon$, $r_T = nr$, parallel combination of n cells $\varepsilon_T = \varepsilon$, $r_T = r/n$.

11. For n rows of m cells each $\varepsilon_T = m\,\varepsilon$, $r_T = m\,r/n$.

12. When two different cells in parallel $\varepsilon_T = (\varepsilon_1 r_2 + \varepsilon_2 r_1) / r_1 + r_2$, $r_T = (r1+r2)/ r_1 + r_2$

13. Kirchoff's I law : The algebraic sum of currents at a junction of electrical circuit is zero $\sum I = 0$.
I law is a consequence of conservation of charge.
Kirchoff's II law : The algebraic sum of EMF'S and products of currents and resistances in a

closed loop of electrical circuit is zero $\sum Ir + \sum \varepsilon = 0$.

II law is a consequence of conservation of energy.

14. $P/Q = R/S$, condition for balance in Wheatstone's bridge, where the letters P,Q,R & S are four

resistances at the 4 arms of the bridge.

15.Potential Gradient $K = V/L = ir$ where r is resistance per unit length of the potentiometer wire.

16.Emf of secondary cell $\varepsilon = kl = irl$, l is the balancing length for null deflection.

17.Heat energy $H = I^2Rt = VIt = V^2t/R$, where V, potential difference applied, I current ,R resistance of

the coil.

18.$P = H/t = I^2R = V^2/R = VI$, is the power dissipated.

19.Tempaerature coefficient of resistance $\alpha = (R_2 - R_1)/ R_1(t_2 - t_1)$

20. For power dissipation to be maximum, external resistance = internal resistance.

21. When P and Q are in the left and right gap respectively of a metre bridge, $P/Q = l/100-l$.

22. internal resistance of cell by potentiometer $r = (l_1/l_2 - 1) R$

23.Ratio of emf's $\varepsilon_1/\varepsilon_2 = l_1/l_2$.

MAGNETIC EFFECTS OF CURRENT & MAGNETISM

1. Force experienced by a moving charge q in a magnetic field $F = qvB \sin\theta$.

2.Magnetic flux $\acute{Ø} = BA\cos\theta$.

3.Biot Savart Law $dB = \mu_0 I dl \sin\theta / 4\pi r^2$, magnetic induction or field due to a current element carrying a current I.

4. Magnetic field due to a circular coil carrying current $B = \mu_0 I/2r$,at the centre.

for any circular section $B = (\mu_0 I/2r)\theta/360$.

5. Magnetic field due to a straight conductor carrying current. $B = \mu_0 I/2\pi r$.

6. Magnetic field due to a solenoid along its axis $B = \mu_0 n I$, n number of turns / unit length.

7. Magnetic field due to a solenoid at its ends $B = \mu_0 n I/2$

8.Charged particle moving perpendicular to a uniform magnetic field

radius of circular path $r = mv/qB$

period of revolution $T = 2\pi m/qB$

9. Force experienced by a current carrying conductor in a magnetic field $F = BIl \sin\theta$.

10.Force between two parallel current carrying conductors $F = \mu_0 I_1 I_2 l / 2\pi r$.

11.Torque experienced by a current loop in a magnetic field $\tau = NABI \sin\theta$.

$\tau = MB \sin\theta$

12. Potential energy of a magnetic dipole $U = -MB\cos\theta$.

Work done in changing its orientation $U = MB(\cos\theta f - \cos\theta i)$

13. Current Sensitivity of a galvanometer $= \theta/I = NBA/k$.

Voltage Sensitivity of a galvanometer= NBA/kR

14. By connecting a small resistance called shunt S in parallel a galvanometer can be converted into an
ammeter $S = I_g G/I - I_g$.

15. By connecting a high resistance in series to a galvanometer it can be converted into a
voltmeter $R = V/I_g - G$.

16.Frequency of cyclotron $=\nu = qB/2\pi m$.

17. Kinetic energy of a charged particle in a magnetic field $= q^2B^2R^2/2m$.

18.Magnetic moment M= 2lm, m – pole strength, 2l – length of magnetic dipole.

19. Magnetic field due to a short bar magnet at a point along its axial line $B = \mu_0 2M/4\pi r^3$.

20. Magnetic field due to a short bar magnet at a point along itsequatorial line $B = \mu_0 M/4\pi r^3$.

21. Magnetic moment M of a current loop M = IA .

22.Magnetising field strength H = nI or B/ μ

23. Intensity of magnetization I= Magnetic Moment / volume of the specimen = M/V
= pole strength/ area =m/A.

24.Magnetic Susceptibility $\chi = I/H$.

25.Relative Permeability $\mu_r = \mu/ \mu_0 = B/B_0$.

26.Declination θ, is the angle between the magnetic meridian and geographic meridian at a place.

27.Angle of dip or inclination δ, it is the angle made by total intensity of earth's magnetic field B with
horizontal component B_H.

28. $B_{H,}$ it is the component of earth's magnetic field B in the horizontal direction.

29. At poles $\delta = 90^\circ$, Bv = B , $B_H = 0$. at equator $\delta = 0^\circ$, Bv =0 , $B_H = B$

30. $B_H = B\cos\theta$, horizontal component. $Bv = B\sin\theta$,vertical component of earth's magnetic field.
$B = (B^2\cos^2\theta + B^2\sin^2\theta)^{1/2}$.

ELECTROMAGNETIC INDUCTION & ALTERNATING CURRENT

1.Faraday's I law: Whenever there is a change in magnetic flux linked with a coil, there is an emf induced
in the coil and it lasts as long as there is a change in magnetic flux.
Faraday's I I law: The magnitude of the emf induced is directly proportional to the rate of change of
magnetic flux linked with the coil. $\varepsilon \propto d\varphi/dt$.

2.Lenz's law : The current induced in the circuit always flows in a direction such as to oppose the cause
or change that produced it. induced emf $\varepsilon = - d\varphi/dt$.

3.Methods of inducing emf
i) induced emf $\varepsilon = -A\cos\theta\, dB/dt$ ii) $\varepsilon = - A\cos\theta\, dB/dt$ iii) $\varepsilon = -BA\, d(\cos\theta) /dt$.

4. induced emf $\varepsilon = - BLV$, L length of the conductor , V speed of motion of the conductor in a

perpendicular magnetic field B.

5.In AC generator , induced emf $\varepsilon = NBA\omega\sin\omega t$, N number of turns of coil, A area of coil, ω angular frequency of the coil.

6. induced emf between the ends of a metal rod rotating with a frequency ν in a perpendicular magnetic field $\varepsilon = \pi B l^2 \nu$.

7. Magnetic flux in a coil of self inductance L, $\varphi = LI$, self induced emf $\varepsilon = -LdI/dt$.

8. Magnetic flux linked in a coil of by mutual inductance M , $\varphi_2 = MI_1$, $\varepsilon_2 = -MdI_1/dt$.

9.Energy stored in a current carrying inductor $U = ½ LI^2$.

Energy density of a current carrying inductor = $½ B^2/\mu_0$.

10.Self inductance of a solenoid $L = \mu_0 N^2 A/ l$.

Mutual inductance of a pair of solenoids of same lengths , same C.S.area , $M = \mu_0 N_1 N_2 A/ l$.

11. Equations of instantaneous current I and emf ε $I = I_O \sin\omega t$, $\varepsilon = \varepsilon_o \sin\omega t$.

12.R.M.S value of current and emf $I_{rms} = I_O/ \sqrt{2}$, $\varepsilon_{rms} = \varepsilon_o/\sqrt{2}$.

13. In an ac circuit with inductor L emf leads the current by $\pi/2$. power factor = $\cos\varphi = 0$
inductive reactance $X_L = 2\pi\nu L$. X_L is the opposition to the flow of current by offered L .
Power dissipated in a full cycle of AC is zero.

14. In an ac circuit with capacitor C , the current leads emf by $\pi/2$. power factor = $\cos\varphi = 0$
Capacitive reactance $Xc = 1/2\pi\nu C$. X_C is the opposition to the flow of current offered by C .
Power dissipated in a full cycle of AC is zero.

15. In an AC circuit with inductance , capacitance ,& resistance, when $X_L = X_C$ the circuit is in **resonance .** Current and emf are in phase with each other.
power factor = $\cos\varphi = 1$
Power dissipated in a full cycle of AC is $P = \varepsilon_{rms} I_{rms} = ½ \varepsilon_o I_O$
Current is maximum. Opposition to the flow of current offered by combination of reactance and resistance is impedance Z . Z =R and it is minimum in a resonance circuit.

16.Resonance is used i) in tuning TV and radio ii) remote control devices iii) metal detector.

17.When a metallic conductor is placed in a varying magnetic field , closed loops of currents are produced. They are known as Eddy currents. Uses : i) brakes in electric trains ii) induction furnaces iii) speedometers iv) damping of galvanometers.

ELECTROMAGNETIC WAVES

1. EM waves are variations in electric field and magnetic field which are perpendicular to each other and perpendicular to the the direction of propagation of waves .

2. Equations of EM waves propagating in x direction
$B_y = B_0 \sin(kx+\omega t)$; $E_z = E_0 \sin(kx+\omega t)$ where $k = 2\pi/\lambda$ and $\omega = 2\pi\nu$.

3. $C = \nu \lambda = 1/(\sqrt{\mu_0\varepsilon_0}) = 1/(\sqrt{\mu\varepsilon}) = E_0/ B_0$, $C = 3x10^8$ m/s .

RAY OPTICS ,WAVE OPTICS & OPTICAL INSTRUMENTS

1. r = 2f , r-radius of curvature , f – focal length of spherical mirror of small aperture.

2. Mirror formula 1/f = 1/u + 1/v , f- focal length of spherical mirror , u –object distance , v- image distance. magnification m = -(v/u) = hi /ho , hi - height/size of image, ho - height/size of object .

3.Critical angle i_c is the angle of incidence in the denser medium above which total internal reflection takes place.

4.Refracive index of a denser medium in terms

i) of Critical angle i_c n= 1/sin i_c

ii) of speed of light n = C/V , C- speed of light in vacuum , V- speed of light in medium

iii) n = apparent depth / actual depth for observer under water

iv) n= actual depth / apparent depth for an observer in air

v) n= tani_p i_p – polarising angle

vi) n =sini/sinr = (sin(A+D) /2)/ sinA/2 in a prism A angle of the prism ,D angle of minimum deviation.

5. VIBGYOR - Physical quantities which **increase** from **violet to Red** are wavelength, speed in a glass prism or slab, focal length of a lens w.r.to colour , band width

Physical quantities which **increase** from **red to violet** are frequency, energy, angle of deviation, lateral deviation, amount of scattering in the atmosphere, refractive index, power of a lens , resolving power of a microscope,telescope.

6. Rayleigh's law of scattering : amount of light scattered in the atmosphere is inversely proportional to fourth power of wavelength.

7. Lens maker's formula 1/f = (n_2- n_1)/ n_1 (1/R_1 – 1/ R_2) , n_2 - refractive index of lens, n_1- refractive index of surrounding medium , R_1 , R_2 are radii of curvature of the two surfaces of a lens.

when $n_2 < n_1$, the convex lens diverges & concave lens converges,

when $n_2 = n_1$, no refraction will take place and the lens is invisible

when $n_2 > n_1$, lenses refract in normal way, ie convex converges & concave diverges.

8.Power of a lens is the reciprocal of its focal length P=1/f unit dioptre.

Power of lenses in combination is P = $P_1+P_2+P_3$ +…

9.Magnifying power of a simple microscope when the image is formed at

i) Near point M = 1+D/f where D=25cm , f focal length of convex lens ii) infinity (normal adjustment position) M= D/f

10. Magnifying power of a compound microscope when the image is formed at i) Near point

$M = L/f_o (1+D/f_e)$ ii) infinity (normal adjustment position) $M= LD/ f_o f_e$ L - length of microscope

11. Magnifying power of an astronomical telescope when the image is formed at i) Near point
    $M = (f_o/ f_e)(1+ f_e/D)$, ii) ii) infinity (normal adjustment position) $M= f_o/ f_e$
    f_o- focal length of objective lens f_e- focal length of eye piece
    L - length of telescope $L = f_o+ f_e$

12. Resolving Power of a microscope is the reciprocal of its limit of resolution dmin
    $R.P = 1/ d_{min} = 2n\sin\beta/ 1.22\lambda$, $n\sin\beta$ –is numerical aperture , λ- wave length of light used.
    n – refractive index of medium between objective and objective lens

13. Resolving Power of a telescope is the reciprocal of its limit of resolution dmin
    $R.P = 1/ d_{min} = D/ 1.22\lambda$, D –aperture or diameter of objective lens

14. Malus law :When polarised light is passed through an analyser the Intensity of Light 'I' emerging
    from it is $I = I_o \cos^2\theta$, I_o Intensity of incident Light , θ – between the plane of transmission of
    polariser and analyser.

15. Resultant Intensity of Light at a point on the screen when light waves of intensity I_1 & I_2 arrive at the
    point with a phase difference of φ is $I = I_1^2 + I_2^2 + 2(\sqrt{I_1 I_2})\cos \varphi$

16. Condition for maxima & minima in Young's double slit experiment
    For Maxima Path difference $\delta = xd/D = n\lambda$, n=0,1.2.3… Phase difference $=2n\pi$
    For minima Path difference $\delta = xd/D = (2n-1)\lambda/2$ n =1,2.3,…
    d – separation between two slits , D- separation between the plane of the slits and the screen
    x- separation between the central bright band and a point P

17. Band width or fringe width is the separation between two successive bright fringes or dark fringes
    $\beta = \lambda D/d$.

18. $I_{max} \propto (a_1+a_2)^2$, $I_{min} \propto (a_1- a_2)^2$ a_1, a_2 are the amplitudes of two waves interfering
    $w_1 / w_2 = I_1/I_2 = a_1^2/ a_2^2$ where w_1 and w_2 are the widths of the two slits.

19. Width of central maximum $w = 2 \lambda D/d$ d – width of the single slit

20. When the Young's double slit set up is kept in a transparent medium of refractive index n
    the band width becomes $\beta' = \lambda D/ nd$.

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DUAL NATUREOF MATTER & PHOTOELECTRIC EFFECT

1. Debroglie relation $\lambda = h/mv = h/p$
2. For electron accelerated by a p.d of V volt , $\lambda = 12.27/\sqrt{V}$
3. Graph between kinetic energy of electron along y-axis & frequency along X-axis gives
   a) threshold frequency= X intercept b) Slope =Planck's constant c) work function = -ve of y intercept.

4. Photoelectric current α intensity of incident radiation
P.E.current doesnot depend on frequency, stopping potential.
5.Kinetic energy of photoelectron α frequency of incident radiation,
K.E is less for a photosensitive material with more work function .
6. Einstein's equation for photoelectric emission K.E =hν – hν_0.
If $\nu < \nu_0$,No photoelectric emission, If $\nu = \nu_0$, No photoelectric current as emitted photo electrons
have zero kinetic energy, If $\nu > \nu_0$ there is photoelectric current.
7.Matter in motion is associated with waves called matter waves.
8. Davisson and Germer experiment verified the existence of matter waves.
9. Electron waves are used in electron microscope ,as they can be focused by electric & magnetic fields
electron microscope is an application of matter waves.
10.Even though X –rays have same wave length as that of electron waves , they cannot be used in
electron microscopes because ,X-rays are em waves which cannot be focused by electric & magnetic
fields.
11. Photo electric emission is possible in many photo sensitive materials with UV rays as they have more
frequency and energy than visible and IR rays.
12.Wave length of electron waves detected in Davisson and Germer experiment is 1.66A◦.
13.Photo electric cells are vacuum tubes with concave cathode electrodes coated with caesium ,which
has low work function , anode platinum wire at the focus of cathode to collect more photoelectrons
emitted.
14. Uses of photo electric cells : in cinema to record & reproduce sound in films, burglar and fire alarms.

ATOMS & NUCLEI.

1.Distance of closest approach = radius of nuclear radius = r= $2Ze^2/4\pi\varepsilon_0$ xKE , e- electronic charge , Z= 79 for Au nucleus, ε_0- permittivity of free space.
2. r =$r_0 A^{1/3}$, A –mass number of the nucleus, r_0 = 1.2 F= 1.2 $\times 10^{-15}$m
3.Nuclear density D= 3 $m_n/ 4\pi r_0^3$, r_0 = 1.2 F= 1.2 $\times 10^{-15}$m , m_n = 1.66 $\times 10^{-27}$ kg
4. energy equivalent of 1amu = 931MeV
5.Mass defect = difference in between total mass of constituents of a nucleus and actual mass of the
nucleus (Or) difference between mass of the reactants and mass of the products.
6. Binding energy = Mass defect in x 931MeV.

7. In alpha emission A decreases by 4 & Z decreases by 2

In beta $^+$ emission no change in A , Z decreases by 1.

In beta $^-$ emission Z no change in A , increases by 1.

In gamma emission No change in either A or Z , but energy decreases by gamma emission to attain stability.

8. Half life T = 0.693/λ , λ – decay constant,T half life.

9.Mean life τ = 1/λ , reciprocal of decay constant.

10. Total energy of electron E_T= -E_K , E_T= ½ E_P E_k= kinetic energy , E_k= potential energy.

SOLIDS & SEMICONDUCTOR DEVICES

1. $n_i^2 = n_e \times n_h$, n_i intrinsic carrier concentration, n_e , n_h electron and hole concentration in an extrinsic semiconductor.

2. Depletion layer : a layer near the junction of P-N junction diode , which is depleted of Majority charge carriers.

3. Internal potential barrier: a potential difference due to minority charge carriers near the njunction of PN junction diode.

4 . Forward bias:P side and N side of diode are connected to the positive and negative of battery respectively.

Width of Depletion layer decreases and Internal potential barrier is overcome .

5. Reverse bias:P side and N side of diode are connected to the negative and positive of battery respectively.

Width of Depletion layer increases and Internal potential barrier increases.

6. Ideal diode has zero resistance and infinite resistance during forward and reverse bias respectively.

7. P- N junction diode is used as rectifier which changes AC to DC.

8. Zener diode is used as voltage regulator and gives regulated voltage .

9. LED – used in LED tvs. Source of light, digital displays

10. Photodiode used as a detector of optical signals.

11.solar cell used in calculators ,watches,

Solar panels in satellites ,domestic power generation

12.Ga S is used in solar cell due to its large light absorption coefficient.

13. GaP,GaAsP – used in LEDs emitting visible light. GaAs used in infra red LEDs

ALL THE BEST FOR BOARD EXAMS –department of Physics