PHYSICS FORMULAE

Chapter 1: Circular Motion

1. $s = r.\theta$ 2. $v = r\omega$

3. $a = r\alpha$ 4. $\vec{a} = \vec{a}_T + \vec{a}_r$

5. $\omega = \frac{d\theta}{dt}$ or $\omega = \frac{\theta}{t}$

6. $\omega = \frac{2\pi}{T} = 2\pi n$ 7. $n = \frac{1}{T}$

8. $\alpha = \frac{d\omega}{dT} = \frac{\omega_2 - \omega_1}{t}$

9. Centripetal acceleration

$$a = v.\omega = \frac{v^2}{r} = r\omega^2$$

10. Centripetal force

$$F = \frac{-mv^2}{r} = -mr\omega^2$$

11. Centrifugal force

$$F = \frac{mv^2}{r} = mr\omega^2$$

12. $\tan\theta = \frac{v^2}{rg}$ or

$$\theta = \tan^{-1}\left(\frac{v^2}{rg}\right)$$

13. $v = \sqrt{\mu rg}$

(Along horizontal road)

14. $v_{max} = \sqrt{rg\left[\frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}\right]}$

15. $v_{max} = v_0 = \sqrt{rg\tan\theta}$

(Ignoring friction)

Where v_0 is called optimum Speed

16. Period of conical Pendulum

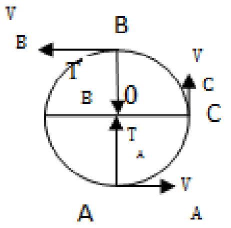
(a) $T = 2\pi\sqrt{\frac{r}{g\tan\theta}}$

(b) $T = 2\pi\sqrt{\frac{l\cos\theta}{g}}$

17. Tension acting along string of conical pendulum

$$T' = mg\sqrt{1 + \left(\frac{r}{h}\right)^2}$$

For vertical circular motion



18. $T_A = \frac{mv_A^2}{r} + mg$

19. $T_B = \frac{mv_B^2}{r} - mg$

20. $T_A - T_B = 6mg$

21. $v_A = \sqrt{5\,gr}$

22. $v_B = \sqrt{gr}$

23. $v_C = \sqrt{3gr}$

24. $h = r(1 - \cos\theta)$

25. Total energy, $E = \frac{5}{2}mgr$

Kinematical Equations

$\vec{\omega} = \vec{\omega_0} + \vec{\alpha}t$

$\theta = \vec{\omega_0}t + \frac{1}{2}\vec{\alpha}t^2$

$\omega^2 = \omega_0^2 + 2\alpha\theta$

Chapter 2: Gravitation

1. $F = \frac{Gm_1m_2}{r^2}$

2. $v_c = \sqrt{\frac{GM}{r}} = \sqrt{\frac{GM}{R+h}}$ (at height 'h')

3. $v_c = \sqrt{\frac{GM}{R}} = \sqrt{gR}$

(Very close to the earth surface)

4. Critical velocity $v_c = \sqrt{g_h r}$
$= \sqrt{g_h(R+h)}$ (at height 'h')

5. $v_c = \frac{2\pi r}{T}$

6. $T = 2\pi\sqrt{\frac{r^3}{GM}} = 2\pi\sqrt{\frac{(R+h)^3}{GM}}$

7. $T = 2\pi\sqrt{\frac{r}{g_h}} = 2\pi\sqrt{\frac{R+h}{g_h}}$

8. K.E of satellite
$= \frac{1}{2}mv_c^2 = \frac{GMm}{2(R+h)}$

9. P.E of satellite
$= -\frac{GMm}{r} = -\frac{GMm}{(R+h)}$

10. Total energy of satellite
$E = -\frac{GMm}{2r} = -\frac{GMm}{2(R+h)}$

11. B.E of satellite
E$= +\frac{GMm}{2r} = +\frac{GMm}{2(R+h)}$

12. B.E of body at rest on earth$= \frac{GMm}{R}$

13. Escape velocity
$v_e = \sqrt{\frac{2\,GM}{R}} = \sqrt{2gR}$

14. $v_e = \sqrt{2}v_c$

15. $g_h = \frac{gR^2}{(R+h)^2}$

16. $GM = gR^2$ (on earth surface)

17. GM$=g_h(R+h)^2$
(At height h)

18. $g_h = g(1-\frac{2h}{R})$

19. $g_d = g(1-\frac{d}{R})$

20. $g' = g - R\omega^2 Cos^2\phi$
Where ø=latitude

Chapter 3: Rotational Motion

1. $I = \int r^2\, dm = Mr^2$

2. K.E$=\frac{1}{2}I\omega^2 = \frac{1}{2}L\omega = \frac{L^2}{2I}$

3. K.E of rolling motion,
$E = \frac{1}{2}Mv^2[1+\frac{K^2}{R^2}]$

4. $\tau = I\alpha$

5. $I = MK^2$ or $K = \sqrt{\frac{I}{M}}$

6. L$= I\omega$

7. for rolling motion without slipping

(i) Velocity, $v = \sqrt{\frac{2gh}{1+\frac{k^2}{R^2}}}$

(ii) Acceleration$=\frac{g\sin\theta}{1+\frac{k^2}{R^2}}$

8. Theorem of parallel axes
$I_0 = I_G + Mh^2$ or $I_0 = I_c + Mh^2$

9. Theorem of perpendicular axes
$I_z = I_x + I_y$

10. for rod, $I = \frac{ML^2}{12}$

11. for ring, $I = MR^2$

12. for disc, $I = \frac{MR^2}{2}$

13. for solid cylinder $I = \frac{MR^2}{2}$

14. for solid cylinder
$I = M[\frac{R^2}{4} + \frac{l^2}{12}]$ (About an axis passing through center and perpendicular to its length)

15. For solid sphere, $I = \frac{2}{5}MR^2$

16. For hollow sphere, $I = \frac{2}{3}MR^2$

17.For rectangular plate, $I = M\left(\frac{l^2+b^2}{12}\right)$

18. Torque, $\tau = \frac{dL}{dt}$

Chapter 4: Oscillations

1. F= - kx2. $\omega = \sqrt{\frac{k}{m}}$

3. $x = a\sin(\omega t + \alpha)$

where

$a =$ Maximum amplitude of oscillation

4.$x = a\sin\omega t$

(When particle moves from mean position)

5. $x = a\cos\omega t$

(From extreme position)

6.$v = \pm\omega\sqrt{a^2 - x^2}$

7. $v_{max} = \pm a\omega$

8. $A = -\omega^2 x,$

$where\ A = acceleration$

9. $A_{max} = \pm a\omega^2$

10.$T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{k/m}} = 2\pi\sqrt{\frac{m}{k}}$

11. Frequency of SHM,$n = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

12.K.E=$\frac{1}{2}m\omega^2(a^2 - x^2)$

$= \frac{1}{2}k(a^2 - x^2)$

13. P.E=$\frac{1}{2}m\omega^2 x^2 = \frac{1}{2}kx^2$

14. T.E=$\frac{1}{2}m\omega^2 a^2 = \frac{1}{2}ka^2$

15.$\omega = 2\pi n$

16.R=

$\sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos(\alpha_1 - \alpha_2)}$

17. $\delta=\tan^{-1}\left[\frac{a_1\sin\alpha_1+a_2\sin\alpha_2}{a_1\cos\alpha_1+a_2\cos\alpha_2}\right]$

18.$R = a_1 + a_2(in\ phase)$

19.$R = a_1 - a_2(out\ of\ phase)$

20.$R = \sqrt{a_1^2 + a_2^2}$

(phase difference is 90°)

21.$T = 2\pi\sqrt{\frac{l}{g}}$

22. $l = \frac{g}{\omega^2}$

(For second's pendulum)

23.Frequency of simple pendulum

$n = \frac{1}{2\pi}\sqrt{\frac{g}{l}}$

Chapter 5: Elasticity

1.Linear stress $= \frac{F}{A} = \frac{mg}{\pi r^2}$

2. Linear strain $= \frac{l}{L}$

3. Young's modulus $Y = \frac{FL}{Al} = \frac{mgL}{\pi r^2 l}$

4. Volume stress $= dp$

5. Volume strain $= -\frac{dv}{V}$

6.$Bulk\ modulus, k = -\frac{V.dP}{dV}$

7.Modulus of rigidity $= \eta = \frac{F}{A\theta}$,

$where\ \theta = tan\theta =<$ of shear

8. Poisson's ratio,

$\sigma = \frac{\text{lateral strain}}{\text{longitudinal strain}}$

9. $W = \frac{1}{2}F \times l = \frac{1}{2}Mgl$

10.Strain energy per unit volume

$= \frac{1}{2}\text{stress} \times \text{strain}$

$= \frac{1}{2}(strain)^2 \times Y$

$= \frac{1}{2}\frac{(\text{stress})^2}{Y}$

11.Thermal stress $= Y\,\alpha\,\Delta\theta,$

$Force = Y\alpha\,\Delta\theta.A,$

where A → area

12.Sag or depression

$$\delta = \frac{Wl^3}{4bd^3Y}$$

Where, W=load, l=length, b=breadth, d=depth, Y=Young's Modulus.

Chapter 6: Surface tension

1.Surface tension , $T = \frac{F}{l}$

2.$T = \frac{dW}{dA}$ or $T = \frac{W}{A}$

3. Surface energy=T.dA

4.For equilibrium of liquid surface,

$$\cos\theta = \frac{T_2 - T_1}{T_3}$$

T_1→force due to S.T at liquid–solid interface

T_2→force due to S.T at air-solid interface

T_3→force due to S.T at air-liquid interface

5. Laplace's law:

Excess pressure,

$$(P_i - P_0) = \frac{2T}{r} = \frac{4T}{r}$$

(Incase of soap bubble)

6. Work done in merging the droplets to form a single drop of radius R (from n droplets of equal size) is

$$W = 4\pi R^2 T\left(n^{\frac{1}{3}} - 1\right)$$

7.$h = \frac{2T\cos\theta}{r\rho g}$

8. S.T. :(i)$T = \frac{rh\rho g}{2\cos\theta}$

(ii)$T = \frac{rhg}{2}$ (for water)

9.$h\alpha\frac{1}{r}$ or $h_1 r_1 = h_2 r_2$

10. Difference in height of a liquid in U-tube

$$h = \frac{2T\cos\theta}{\rho g}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

Chapter 7: Wave motion

1.$v = n\lambda = \frac{\lambda}{T}$,

$n = \frac{1}{T}$, $T = time\ period$

2.$\delta = \frac{2\pi x}{\lambda}\delta = phase$

3.$\lambda = 2\pi n\delta t$

4. Wave travelling along +X-axis:

(i) $y = a\sin 2\pi\left(\frac{t}{T} - \frac{X}{\lambda}\right)$,

(ii)$y = a\sin 2\pi\left(nt - \frac{X}{\lambda}\right)$,

(iii) $y = a\sin\frac{2\pi}{\lambda}(vt - x)$,

(iv) $y = a\sin 2\pi n\left(t - \frac{x}{v}\right)$

5. Wave travelling along –X axis:

$$\alpha = a\sin 2\pi\left(\frac{t}{T} + \frac{x}{\lambda}\right)$$

6. $y = y_1 + y_2$

7.$y = R, Y = A\sin 2\pi nt$

Where $A = 2a\cos\pi(n_1 - n_2)t$

8. Beat frequency,$N = n_1 - n_2$

Period of beats,$T = \frac{1}{n_1 - n_2}$

9. $n_a = n\left(\frac{V \pm V_0}{V \mp V_S}\right)$

Where n_a = apparent frequency

V=Velocity of sound, V_0=Velocity of the listener observer

Vs=Velocity of source

10. Listener is at rest

$$n_a = n\left(\frac{V}{V \pm V_s}\right)$$

(i) $n_a = n\left(\frac{V}{V-V_s}\right)$ When source is approaching

(i) $n_a = n\left(\frac{V}{V+V_s}\right)$ When source is Receding

11. Source is at rest

$$n_a = n\left(\frac{V \pm V_0}{V}\right)$$

(i) $n_a = n\left(\frac{V+V_0}{V}\right)$ When listener is approaching

(ii) $n_a = n\left(\frac{V-V_0}{V}\right)$ When listener is receding

12. $n_a = n\left(\frac{V + V_0}{V - V_S}\right)$

when both are approaching towards each other

13. $n_a = n\left(\frac{V-V_0}{V-V_S}\right)$ When both are receding

Chapter 8: Stationary waves

1. $v = \sqrt{\frac{T}{m}}$ 2. $n = \frac{1}{2l}\sqrt{\frac{T}{m}}$

3. $n \propto \frac{1}{l}$,If T and m are constant

4. $n \propto \sqrt{T}$ If l and m are constant

5. $n \propto \frac{1}{\sqrt{m}}$ If T, l are constant

6. $m = \pi r^2 \rho, n \propto \frac{1}{r}, n \propto \frac{1}{\sqrt{\rho}}$

7. Specific gravity (σ)

$$\frac{n1}{n2} = \sqrt{\frac{T_1}{T_2}} = \sqrt{\frac{\sigma}{\sigma - 1}}$$

8. Melde's Experiment:

(i) Parallel position,

$$N = 2n = \frac{P}{l}\sqrt{\frac{T}{m}}$$

(ii) Perpendicular position,

$$N = n = \frac{P}{2l}\sqrt{\frac{T}{m}}$$

(iii) $p_2=2p_1$

Where P_1=no. of loops in parallel position

P_2=no. of loops in perpendicular position

(iv) TP^2=constant

9. Closed tube:

(i) $n = \frac{V}{4L}$

(ii) Frequency of p^{th} overtone,

$n_p = (2p + 1)n$

10. Open tube:

$(i) n = \frac{V}{2l}$

(ii) Frequency of p^{th} overtone

$n_p=(p+1)n$

11. Resonance tube:

(i) End correction, e=0.3D, where, D-diameter of the tube

(ii) V=4nL where L= l +e

(iii) V=2n (l_2- l_1) when end correction is eliminated

$(iv) e = \frac{l_2-3l_1}{2}$

Where $l_1 \rightarrow$ vibrating length in first mode (fundamental work) of vibration

$l \rightarrow$ Vibrating length in second mode of vibration

12. (i) End correction for a closed pipe, $e = \frac{n_2 l_2 - n_1 l_1}{n_1 - n_2}$

(ii)End correction for pipe open at both end,

$$e = \frac{n_2 l_2 - n_1 l_1}{2(n_1 - n_2)}$$

Chapter 9: Kinetic theory of Gases and Radiation

1. Perfect gas equation:

PV= nRT, where

$$n = \frac{Mass\ of\ the\ gas}{Molecular\ weight\ of\ the\ gas}$$

2. Mean velocity $\bar{C} = \frac{C_1+C_2+\cdots+C_N}{N}$

3. Mean square velocity

$$\bar{C}^2 = \frac{{C_1}^2 + {C_2}^2 + \cdots + {C_N}^2}{N}$$

4. RMS velocity

$$C_{RMS}=\sqrt{\bar{C}^2} = \sqrt{\frac{{C_1}^2+{C_2}^2+\cdots+{C_N}^2}{N}}$$

5. $P=\frac{1}{3}(\boldsymbol{\rho} C_{RMS}^2)=\frac{1}{3}\frac{NmC_{RMS}^2}{V}$

6. RMS speed $C = \sqrt{\frac{3RT}{M}}$

$C \propto \sqrt{T}$, $C=\sqrt{\frac{3P}{\rho}}$

7. K.E per kilo mole $=\frac{3}{2}$ RT

8. K.E per kg $=\frac{3RT}{2M}$

9. K.E per molecule $= \frac{3RT}{2N_o}$,

Where N_o=Avogadro number

10. K.E per unit volume

= (3/2)P

11. (a) For monoatomic gases,

$$\gamma = \frac{Cp}{Cv} = \frac{\frac{5}{2}R}{\frac{3}{2}R} = \frac{5}{3}$$

(b) For diatomic gases,

$$\gamma = \frac{Cp}{Cv} = \frac{\frac{7}{2}R}{\frac{5}{2}R} = \frac{7}{5}$$

(For rigid molecule)And,

$$\gamma = \frac{Cp}{Cv} = \frac{\frac{9}{2}R}{\frac{7}{2}R} = \frac{9}{7}$$

(If molecule is not rigid)

(c) For polyatomic gases,

$$\gamma = \frac{Cp}{Cv} = \frac{4+f}{3+f}$$

Where f is certain number of Vibrational modes

12. Specific heat capacity of

(i)Water, $C = \frac{\Delta Q}{\Delta T} = \frac{\Delta U}{\Delta T} = 9R$

(ii)Solid, $C = \frac{\Delta Q}{\Delta T} = \frac{\Delta U}{\Delta T} = 3R$

13.$\Delta Q=\Delta U+\Delta W$ (principal of conservation of energy)

14. for isothermal process,

$P_1V_1=P_2V_2$

15. For adiabatic process,

$P_1V_1^{\gamma} =P_2V_2^{\gamma}$

(i) Efficiency of heat engine

$$\eta = \frac{W}{Q}$$

Where, W=work done

Q= heat absorbed by the system or input heat

(ii) According to first law of thermodynamic over one complete cycle,

$$\eta = 1 - \frac{Q2}{Q1}$$

Where, Q_1=heat absorbed by the system,

Q_2=heat rejected to environment

17. Coefficient of performance of a refrigerator

(i) $\alpha = \frac{Q_2}{W}$ (b) $\alpha = \frac{Q_2}{Q_1 - Q_2}$

Where Q_1=heat released to the hot reservoir,

Q_2=heat extracted from the cold reservoir,

W=work done

18. $\frac{Qa}{Q} = a, \frac{Qr}{Q} = r, \quad \frac{Qt}{Q} = t$

19. a + r + t = 1

20. $e = \frac{E}{E_b}$

21. a = e

22. $E_b = \frac{Q}{At}$

For perfectly black body:

(i) $\frac{dQ}{dt} = A\,\sigma\,T^4$

(ii) $\frac{dQ}{dt} = A\,\sigma\,[T^4 - T_o{}^4]$

24. for any other body:

(i) $\frac{dQ}{dt} = eA\,\sigma\,T^4$

(ii) $\frac{dQ}{dt} = eA\,\sigma\,[T^4 - T_o{}^4]$

25. $\frac{dQ}{dt} = k(\theta - \theta_o)$

26. $\frac{d\theta}{dt} = \frac{k}{ms}(\theta - \theta_o)$

i.e. $\frac{d\theta}{dt} = c\,(\theta - \theta_o) \quad c = \frac{k}{ms}$

27. $\lambda_{max} \propto \frac{1}{T}$ or $T.\lambda_{max} = b,$

Where, b= Wien's constant

Chapter 10: Wave Theory of Light

1. ${}_1\mu_2 = \frac{\mu_2}{\mu_1} = \frac{\sin i}{\sin r}$

2. ${}_1\mu_2 = \frac{C_1}{C_2}$

3. C=nλ

4. ${}_1\mu_2 = \frac{\lambda_1}{\lambda_2}$ & wave number $= \frac{1}{\lambda}$

5. ${}_a\mu_g = \frac{V_a}{V_g} = \frac{\lambda_a}{\lambda_g}$

6. $\frac{\text{Band width in medium 2}}{\text{Band width in medium 1}}$

$= \frac{\cos r}{\cos i}$

7. (i) $\mu = \tan i_p$,

Where, i_p = polarizing angle

(ii) $\mu = \frac{1}{\sin i_c}$

Where, i_c is critical angle

8. Doppler effect:

$$(i)\ v' = \frac{v(1 \pm \frac{Vr}{c})}{\sqrt{1 - \left(\frac{V_r}{c}\right)^2}}$$

(+ Sign for V_r towards the observer, - sign for V_r away from the observer)

$$(ii)\ v' = v(1 \pm \frac{Vr}{c})$$

When V_r<<c

$$(iii)\ \frac{\Delta v}{v} = \frac{\Delta\lambda}{\lambda} = \frac{V_r}{c}$$

Where, V_r = radial component of the velocity of the source

Chapter 11: Interference and Diffraction

1. (i) Intensity $I \propto a^2$

(ii) $I_{max} \propto (a_1 + a_2)^2$

(iii) $I_{min} \propto (a_1 - a_2)^2$

2. Condition for bright point (or constructive interference):

P.d = nλ, Where n = 0, 1, 2, 3,...

3. $X_n = \frac{n\lambda D}{d} = n.X$,

Where X = bandwidth

4. Condition for dark point (or destructive interference):

$P.d = (2m \pm 1)\frac{\lambda}{2}$, Where m=1, 2, 3…

5. $X_m = (2m-1)\frac{\lambda D}{2d}$

$= (2m-1)\frac{X}{2}$

6. $X = \frac{\lambda D}{d}$ or $\lambda = \frac{Xd}{D}$

7. (i) $\frac{d_1}{d} = \frac{v}{u}$

(ii) $\frac{d_2}{d} = \frac{u}{v}$

$iii) d = \sqrt{d_1 d_2}$

Diffraction:

8. Position of minima (intensity), $sin\theta_n = \frac{n\lambda}{a}$

Where a →width of slit,

θ →angle of inclination

$n \rightarrow \pm1, \pm2, \pm3 \ldots\ldots$

9. Position of Secondary maxima,

$sin\theta_n = (2n+1)\frac{\lambda}{2a}$

10. Width of central maxima, $w = \frac{2\lambda D}{a} = \frac{2\lambda f}{a}$

Where D→distance between slit and screen.

f →focal length of the lens

11. $dx = \frac{\lambda}{2\mu sin\theta} = \frac{\lambda}{2(N.A)}$

Where, dx = distance of separation between two point objects,

μsinθ = numerical aperture (N.A)

12.R.P.of Microscope $= \frac{2\mu sin\theta}{\lambda} = \frac{2.(N.A)}{\lambda}$

13.R.P. of telescope $= \frac{1}{d\theta} = \frac{a}{1.22\lambda}$

Where, dθ = represent the limit of resolution of telescope

Chapter 12: Electrostatics

1. Gauss's Theorem:

$$\mathrm{T.N.E.I} = \sum_{i=1}^{i=n} q_i = Q$$

2. Electric field intensity outside a charged sphere,

$E = \frac{q}{4\pi\epsilon r^2} = \frac{q}{4\pi\epsilon_0} \cdot \frac{1}{kr^2}$

$= \frac{\sigma R^2}{k\epsilon_0 r^2}$

3. Electric field intensity outside a charged cylinder,

$E = \frac{q}{2\pi\epsilon r} = \frac{q}{2\pi k\epsilon_o r} = \frac{\sigma R}{k\epsilon_o r}$

4. Electric field intensity near a charged conductor, $E = \frac{\sigma}{k\epsilon_0}$

5. Electric field intensity outside a charged thin plate sheet, $E = \frac{\sigma}{2\epsilon} = \frac{\sigma}{2\epsilon_{0K}} =$

6. $P = x_e E = \frac{dipole\ moment}{volume}$,

Where, P→ Polarization

χ_e → Electric susceptibility of dielectric material,

E→ Intensity of electric field

7. $P = \frac{q_p}{A} = \sigma_p$

Where, q_p →polarization charges,

A→area of cross section,
σ_p →Charge density of polarization charges

8. Surface charge density, $\sigma = \frac{Q}{A}$
9. Mechanical force per unit area of charged conductor,
$\frac{F}{ds} = f = \frac{\sigma^2}{2k\epsilon_o}$ and
$f = \frac{1}{2} k\epsilon_o E^2$
10. Electrostatic Energy per unit volume,
$\frac{1}{2}\epsilon_o E^2 = \frac{dU}{dV} = \frac{\sigma^2}{2k\epsilon_o} = \frac{1}{2} k\epsilon_o E^2$
11. $C = \frac{Q}{V}$
12. Capacity of parallel plate capacitor,
$C = \frac{Ak\epsilon_o}{d}, C_{air} = \frac{A\epsilon_o}{d}, (k = 1)$
$K = (\frac{C}{C_{air}})$

13. Energy of charged capacitor,
$U = \frac{1}{2}CV^2 = \frac{Q^2}{2C} = \frac{1}{2} QV$
14. Capacitors in series:
$(i) \frac{1}{Cs} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots + \frac{1}{C_n}$
$(ii) C_s = \frac{C}{n}$ (If all capacitors are of equal value)
15. Capacitor in parallel:
$(i) C_p = C_1 + C_2 + C_3 + \cdots + C_n$
$(ii) C_p = nC$
(If all capacitors are of equal value)

Chapter 13: Current Electricity

1. Kirchhoff's law:
$\sum I = 0$
$\sum IR + \sum E = 0$
2. Whetstone's network :
Balancing condition,
$\frac{R_1}{R_2} = \frac{R_3}{R_4}$
3. Meter bridge:
a. $X = R.\left(\frac{l_x}{l_r}\right)$
b. Kelvin's method, $X = R\left(\frac{l_g}{l_r}\right)$
4. Potentiometer :
a. Potential gradient (or fall of potential per unit length)
$= \frac{ER}{(R+r+R')L}$
Where, E = E.M.F. of a cell,
R = Resistance of a wire
r = internal resistance of a cell,
R' = External resistance of a cell
b. E = (potential gradient) x*l*,
Where, *l* = Balancing length
5. $\frac{E_1}{E_2} = \frac{l_1}{l_2}$ (Direct method)
6. $\frac{E_1}{E_2} = \frac{l_1+l_2}{l_1-l_2}$ (Sum and diff. method)
7. $r = R\left(\frac{l_1-l_2}{l_2}\right) = R(\frac{E1}{V} - 1)$
Where, r = internal resistance of a cell

Chapter 14: Magnetic Effect of Electric Current

1. Ampere's law : $\oint \vec{B}.\vec{dl} = \mu_o . I$
2. Magnetic induction at a point near a long straight conductor :
$B = \frac{\mu_o}{4\pi} X \frac{2I}{r}$

3. Magnetic induction

a. Inside a long solenoid : $B = \mu_0 nI$

b. At a point near the end of solenoid : $B = \frac{\mu_0 nI}{2}$

4. Magnetic induction along the axis of toroid :

$$B = \frac{\mu_0 NI}{2\pi r}, n = \frac{N}{2\pi r} \therefore B = \mu_0 nI$$

5. Moving coil galvanometer:

$$I = \frac{k}{nAB}.\theta$$

6. $S_i = \frac{d\theta}{dI} = \frac{nAB}{k}, S_v = \frac{d\theta}{dV} = \frac{S_i}{G}$

7. Ammeter:

a. $S = \frac{I_g G}{I - I_g}$

b. $S = \frac{G}{n-1}$ Where, $n = \frac{I}{I_g}$

8. Voltmeter:

i) $R = \frac{V}{I_g} - G$

(ii) $R = G(n-1)$

Where, $n = \frac{V}{V_g}$

9. Cyclotron:

a. Radius of Cyclotron, $r = \frac{m.v}{B.q}$

b. Period, $T = \frac{2\pi m}{qB}$

c. Frequency, $f = \frac{qB}{2\pi m}$

d. Velocity, $v = \frac{Bqr}{m}$

e. Kinetic energy, $E_k = \frac{B^2 q^2 r^2}{2m}$

Chapter 15: Magnetism

1) Magnetic Dipole Moment, $M = m \times 2l$

2) $M = nIA$, n=no. of turns.

Where, I→ current flowing through loop, A→ Area of the loop

3) Gyromagnetic ratio=$\frac{M}{L} = \frac{e}{2m_e}$

4) Magnetic Moment Associated with circular current

a) $M = \frac{evr}{2}$ b) $M = \frac{e}{2m_e}L$

c) Circulating current $I = \frac{ev}{2\Pi r}$

d) Angular momentum of electron $L = m_e vr$

5) a) Magnetization,

$$M_z = \frac{\text{Netmagneticmoment}}{\text{volume}}$$

$$= \frac{M}{V} = \chi H$$

Where, x=magnetic susceptibility

b) Curie's Law: $M_z = C \times \frac{B_{ext}}{T}$

where,

$B_{ext} \rightarrow$ Externalmagneticfield

T→ Absolute temperature

C→ Curie's constant

6) Magnetic field inside a coil:

a) When iron core is not Present,$B_0 = \mu_0 nI$

b) When iron core is present, $B = B_0 + B_m$

where, $B_m = \mu_0 Mz$

the magnetic field contributed by iron core.

c) $B = \mu_0 (H + M_z)$

d) Magnetic intensity, H=nI

e) $B = \mu H$

f) Permeability,$\mu = \mu_0 \mu_r$

g) Relative permeability,

$\mu r = 1 + x$

Chapter 16:

Electromagnetic Induction

1) $E = \frac{d\phi}{dt} = \frac{d}{dt}(BA) = B\frac{dA}{dt}$

or $e = A\frac{dB}{dt}$

2)$e = BLV$

3)$e = \pi L^2 f B (for rod)$

4)$e = -L\frac{di}{dt}$

5)$e_s = -M\frac{di_p}{dt}$

6)$\frac{e_s}{e_p} = \frac{N_s}{N_p} = \frac{i_p}{i_s}$

7) $\eta = \frac{e_s i_s}{e_p i_p}$

8)$e = e_0 sin\omega t$, where

$e_0 = 2\pi f nAB(peak emf)$

9) $i = \frac{e}{R} = \frac{e_0}{R}\ sin\ \omega t = i_0 \sin \omega t$,

Where,i_0=$\frac{e_0}{R}$(peak current)

10) $i_{r.m.s.} = \frac{i_0}{\sqrt{2}}$

11)$e_{r.m.s.} = \frac{e_0}{\sqrt{2}}$

12) Inductive reactance:

$X_L = \omega L = 2\pi f L$

13) Capacitive reactance

$X_c = \frac{1}{\omega c} = \frac{1}{2\pi f C}$

14) Impedance:

Z=$\sqrt{R^2 + (X_L - X_c)^2}$

15) Power: P=$e_{r.m.s.} \times i_{r.m.s.}$

(For pure resistance)

$P = e_{r.m.s.} \times i_{r.m.s.} \cos \phi$

(for LCR circuit)

16) Power factor

$\cos \phi = \frac{R}{Z} = \frac{\text{Truepower}}{\text{Apparentpower}} = \frac{P}{P'}$

17) L-C-R series responses

$X_L = X_C, f_0 = \frac{1}{2\Pi\sqrt{LC}}$

18) Parallel resonance

$i_l = i_c, f_0 \frac{1}{2\Pi\sqrt{LC}}$

Chapter 17:

Electrons and Photons

1) $E = h\upsilon = \frac{hc}{\lambda}$

2) $c = \upsilon\lambda$

3)$W_0 = h\upsilon_0 = \frac{hc}{\lambda_0}$

4)$h\upsilon = W_0 + \frac{1}{2}mv_{max}^2$

5)

$\frac{1}{2}mv_{max}^2 = h\upsilon - W_0 = h\upsilon - h\upsilon v_0$

$= h(\upsilon - \upsilon_0) = hc(\frac{1}{\lambda} - \frac{1}{\lambda_0})$

6)$v_{max} = \sqrt{\frac{2h(v - v_0)}{m}}$

7)$\frac{1}{2}mv_{max}^2 = e.V_s$

Where V_s →stopping potential

Chapter 18:

Atoms, Molecules and Nuclei

1) Bohr's Postulates

i) $\frac{mv^2}{r} = \frac{1}{4\Pi\epsilon_0}\frac{e^2}{r^2}$

ii) $mvr = \frac{nh}{2\pi}$

iii)$E_i - E_f = h\upsilon$

2) i)$r = \frac{n^2h^2\epsilon_0}{\pi me^2}$

ii) $w = \frac{\pi me^4}{2\epsilon_0 h^3 n^3}$

iii) $f = \frac{me^4}{4\epsilon_0^2 h^3 n^3}$

iv) $T = \frac{4\epsilon_0^2 h^3 n^3}{me^4}$

v) $a = \frac{\pi e^6}{4\epsilon_0^3 h^4 n^4}$

3) $K.E. = \frac{e^2}{4\pi\epsilon_0 r} = \frac{me^4}{8\epsilon_0^2 h^2 n^2}$

4) $P.E. = -\frac{e^2}{4\pi\epsilon_0 r} = -\frac{me^4}{4\pi\epsilon_0^2 h^2 n^2}$

5) $E. = -\frac{e^2}{8\pi\epsilon_0 r} = -\frac{me^4}{8\epsilon_0^2 h^2 n^2}$

$E \propto \frac{1}{n^2}$ and $E = -\frac{Rch}{n^2}$

6) $K.E. = -E$ and $P.E. = +2E$

7) $v_n = \frac{e^2}{2\epsilon_0 nh}, v_n \ \alpha \ \frac{1}{n}$

8) $\frac{1}{\lambda} = R[\frac{1}{n_1^2} - \frac{1}{n_2^2}]$

9) $R = \frac{me^4}{8\epsilon_0^2 h^3 c}$

10) Energy Photon

$E = hv = \frac{hc}{\lambda}$

11) Mass defect,

i) $A = Z + N$

ii)

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

Where, Z→atomic number

m_p→mass of proton

m_n→mass of neutron

N=$(A-Z)$→number of neutrons

A→mass number

M→mass of nucleolus

12) *Binding* energy of nucleus

$$E_B = \Delta m.C^2 = [Z.m_p + (A-Z)m_0 - M]c^2$$

13) B.E. per nucleons

$$= \frac{Binding\ enegy\ of\ nucleous}{A}$$

$$E = [\frac{[Zm_p + (A-Z)m_n - M]}{A}]c^2$$

14) Decay Laws

i) $\frac{dN}{dt} \propto N$

ii) $N = N_0 e^{-\lambda t}$

15) Half life period, $T = \frac{0.693}{\lambda}$

De Broglie Theory

16) $\lambda = \frac{h}{mv} = \frac{h}{p}$

17) $E = h\upsilon = \frac{hc}{\lambda}$

18) $v = \sqrt{\frac{2ev}{m}}$

19) $p = mv = m\sqrt{\frac{2eV}{m}} = \sqrt{2meV}$

20) $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2meV}}$

21) $\lambda = \frac{12.27}{\sqrt{V}} A^0$

$= \frac{12.27}{\sqrt{V}} \times 10^{-10}\ m$