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REVISION NOTES · CLASS 11 AND 12

# NEET Biology High-Yield Notes

NEET biology rewards exact NCERT facts. These notes collect the numbers, names and ratios that turn up again and again, chapter by chapter, so you can revise the whole syllabus in an evening.

NEET | CBSE 12

## 01 The cell

**Cell theory** – Schleiden and Schwann; Virchow added that new cells come from existing cells (omnis cellula e cellula)

**Ribosomes** – prokaryotes 70S (50S + 30S); eukaryotes 80S (60S + 40S)

**Semi-autonomous organelles** – mitochondria and chloroplasts have their own circular DNA and 70S ribosomes

**Membrane model** – fluid mosaic model, Singer and Nicolson (1972)

**Centrioles and cilia** – centriole 9 + 0 triplets; cilia and flagella 9 + 2 axoneme

**Lysosomes** – hydrolytic enzymes, active at acidic pH

## 02 Cell cycle and division

**Interphase** – $G_1$, S (DNA replicates), $G_2$

**Mitosis** – metaphase is the best stage to study chromosome morphology

**Prophase I of meiosis** – synapsis in zygotene; crossing over in pachytene; chiasmata seen in diplotene; terminalisation in diakinesis

**Meiosis I** – reductional division; meiosis II is equational

## 03 Molecular biology

**DNA structure** – Watson and Crick (1953); B-DNA has about 10 bp per turn and a pitch of 3.4 nm

**Base pairing** – A = T (2 hydrogen bonds); G ≡ C (3 hydrogen bonds); Chargaff's rule A + G = T + C

**Replication** – semi-conservative (Meselson and Stahl, using $^{15}N$); Okazaki fragments form on the lagging strand

**Genetic code** – triplet, degenerate, nearly universal; start codon AUG; stop codons UAA, UAG, UGA

**Lac operon** – Jacob and Monod; lactose (allolactose) is the inducer

**Human genome (NCERT figures)** – 3164.7 million bp; about 30,000 genes; under 2 per cent codes for proteins

## 04 Genetics

**Mendelian ratios** – monohybrid $F_2$ 3:1 (genotype 1:2:1); dihybrid 9:3:3:1; test cross 1:1

**Incomplete dominance** – snapdragon flower colour, $F_2$ 1:2:1

**Co-dominance** – ABO blood groups ($I^A$, $I^B$, i)

**Sex determination** – humans XX–XY; grasshopper XX–XO; birds ZW female, ZZ male

**X-linked recessive** – haemophilia, colour blindness

**Sickle-cell anaemia** – glutamic acid replaced by valine at position 6 of β-globin

**Chromosomal disorders** – Down syndrome trisomy 21; Klinefelter 47,XXY; Turner 45,X0

## 05 Human physiology

**Muscle contraction** – sliding filament theory; $Ca^{2+}$ binds troponin, exposing actin's binding sites to myosin heads; ATP powers the cross-bridges

**Nerve impulse** – the $Na^+/K^+$ pump moves 3 $Na^+$ out for every 2 $K^+$ in; chemical synapses pass the signal with neurotransmitters such as acetylcholine

**Breathing** – tidal volume about 500 mL; vital capacity = IRV + TV + ERV

**Gas transport** – $O_2$ about 97% as oxyhaemoglobin; $CO_2$ about 70% as bicarbonate, 20–25% as carbaminohaemoglobin, 7% dissolved

**Heart** – SA node is the pacemaker (70–75 beats/min); cardiac output ≈ 70 mL × 72 ≈ 5 L/min; normal BP 120/80 mm Hg

**ECG** – P wave atrial depolarisation; QRS ventricular depolarisation; T wave ventricular repolarisation

**Kidney** – GFR about 125 mL/min (180 L/day); PCT reabsorbs 70–80% of water and electrolytes; ADH acts on DCT and collecting duct

**Hormones** – insulin (β cells) lowers blood glucose, glucagon (α cells) raises it; ADH and oxytocin are made in the hypothalamus and released by the posterior pituitary

## 06 Plant physiology

**Photosystems** – PS I reaction centre P700; PS II P680; water splits at PS II

**$C_3$ and $C_4$** – Calvin cycle's first stable product is 3-PGA; Hatch–Slack ($C_4$) first product is OAA, with Kranz anatomy (maize, sugarcane)

**RuBisCO** – the most abundant enzyme on Earth; its oxygenase activity causes photorespiration in $C_3$ plants

**Respiration** – glycolysis gives a net 2 ATP; Krebs cycle in the matrix; ETS on the inner membrane; NCERT net gain 38 ATP per glucose

**Respiratory quotient** – carbohydrates 1; fats about 0.7; proteins about 0.9

**Plant hormones** – auxin (apical dominance, rooting); gibberellins (bolting, malting); cytokinins (cell division, delay ageing); ethylene (ripening); ABA (stress, stomatal closure, dormancy)

## 07 Reproduction

**Flowering plants** – double fertilisation, syngamy plus triple fusion (triploid endosperm)

**Menstrual cycle** – about 28 days; ovulation about day 14 after the LH surge; corpus luteum secretes progesterone

**Testes** – Sertoli cells nourish developing sperm; Leydig cells secrete testosterone

**Pregnancy** – implantation at the blastocyst stage; hCG maintains the corpus luteum

## 08 Ecology

**Energy flow** – Lindeman's 10 per cent law; the pyramid of energy is always upright

**Inverted pyramids** – biomass in the sea; numbers in a single tree

**Species–area relationship** – log S = log C + Z log A, Z usually 0.1 to 0.2

**Biodiversity** – 34 hotspots worldwide; India has the Western Ghats–Sri Lanka, Indo-Burma and Himalaya

**Rivet popper hypothesis** – Paul Ehrlich

**Causes of loss (the Evil Quartet)** – habitat loss and fragmentation, over-exploitation, alien species invasions, co-extinctions

**Conservation** – in situ (biosphere reserves, national parks, sanctuaries, sacred groves); ex situ (zoos, botanical gardens, seed banks, cryopreservation)

## 09 Biotechnology and health

**Restriction enzyme** – EcoRI cuts at GAATTC

**PCR** – denaturation, annealing, extension with Taq polymerase (Thermus aquaticus)

**Vector pBR322** – ori, ampicillin and tetracycline resistance genes

**Bt crops** – cry genes from Bacillus thuringiensis; cryIAc and cryIIAb for cotton, cryIAb for corn

**RNA interference** – protects tobacco from the nematode Meloidogyne incognita

**Firsts** – gene therapy for ADA deficiency (1990); Rosie, the transgenic cow whose milk carried human α-lactalbumin (1997)

**Diseases** – malaria, Plasmodium via female Anopheles; typhoid, Salmonella typhi (Widal test); dengue and chikungunya via Aedes; filariasis, Wuchereria via Culex

**AIDS** – caused by HIV, a retrovirus that destroys helper T cells; ELISA detects infection

### How to use these notes

1. Read the matching NCERT paragraph after each section: NEET often lifts the exact sentence.
2. Make your own list of examples (organisms, diseases, hormones); they are easy marks.
3. Revise diagrams with labels: they carry both one-mark and assertion–reason questions.

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REVISION NOTES · CLASS 11 AND 12

# Chemistry Quick Revision for JEE and NEET

Physical chemistry formulas, inorganic trends and the organic reactions examiners return to most often, condensed onto a few pages for the last weeks before JEE or NEET.

JEE | NEET | CBSE 12

## 01 Mole concept and solutions

**Moles** – $n = \text{mass/molar mass} = \text{number of particles}/N_A$

**Molarity** – $M$ = moles of solute/litres of solution; molality $m$ = moles of solute/kg of solvent

**Mole fraction** – $x_A = n_A/(n_A + n_B)$

**Normality** – $N = M \times n$-factor; dilution $M_1V_1 = M_2V_2$

**Raoult's law** – $p_A = x_A p°_A$; relative lowering $(p° - p)/p° = x_{solute}$

**Colligative properties** – $\Delta T_b = iK_b m$; $\Delta T_f = iK_f m$; osmotic pressure $\pi = iCRT$

**Henry's law** – $p = K_H x$

## 02 Atomic structure

**Bohr energy** – $E_n = -13.6\ Z^2/n^2$ eV; radius $r_n = 0.529\ n^2/Z$ Å

**de Broglie** – $\lambda = h/mv$; Heisenberg $\Delta x \cdot \Delta p \geq h/4\pi$

**Quantum numbers** – $n$; $l$ from 0 to $n - 1$; $m_l$ from $-l$ to $+l$; $m_s = \pm ½$

**Capacity** – $2n^2$ electrons per shell; $2l + 1$ orbitals per subshell

**Nodes** – radial $n - l - 1$; angular $l$

**Filling order** – $(n + l)$ rule, then Pauli exclusion and Hund's rule

## 03 Gases

**Ideal gas** – $PV = nRT$, $R = 0.0821$ L atm mol$^{-1}$ K$^{-1}$ $= 8.314$ J mol$^{-1}$ K$^{-1}$

**Dalton** – $p_i = x_i p_{total}$

**Graham** – rate $\propto 1/\sqrt{M}$

**van der Waals** – $(P + an^2/V^2)(V - nb) = nRT$

**Compressibility** – $Z = PV/nRT$

**Molecular speeds** – $u_{rms} = \sqrt{(3RT/M)}$, $u_{avg} = \sqrt{(8RT/\pi M)}$, $u_{mp} = \sqrt{(2RT/M)}$

## 04 Thermodynamics

**First law** – $\Delta U = q + w$ ($w$ = work done on the system); $w = -P_{ext}\Delta V$

**Enthalpy** – $\Delta H = \Delta U + \Delta n_g RT$; Hess's law adds reaction enthalpies

**Gibbs energy** – $\Delta G = \Delta H - T\Delta S$; spontaneous when $\Delta G < 0$

**Link to equilibrium** – $\Delta G° = -RT \ln K = -2.303RT \log K$

**Link to cells** – $\Delta G° = -nFE°_{cell}$

## 05 Equilibrium

**$K_p$ and $K_c$** – $K_p = K_c(RT)^{\Delta n}$

**pH** – $pH = -\log[H^+]$; $pH + pOH = 14$ and $K_w = 10^{-14}$ at 25 °C

**Weak acid** – $[H^+] = \sqrt{(K_a C)}$, degree of dissociation $\alpha = \sqrt{(K_a/C)}$

**Buffer (Henderson)** – $pH = pK_a + \log([\text{salt}]/[\text{acid}])$

**Salt of weak acid and strong base** – $pH = 7 + ½(pK_a + \log C)$

**Solubility product** – $K_{sp} = s^2$ for AB; $4s^3$ for $AB_2$

## 06 Electrochemistry and kinetics

**Cell emf** – $E°_{cell} = E°_{cathode} - E°_{anode}$

**Nernst equation (298 K)** – $E = E° - (0.0591/n) \log Q$

**Faraday's law** – $m = (M/nF)It$, $F = 96{,}500$ C mol$^{-1}$

**Conductivity** – $\Lambda_m = \kappa \times 1000/M$ ($\kappa$ in S cm$^{-1}$); Kohlrausch $\Lambda°_m = \nu_+\lambda°_+ + \nu_-\lambda°_-$

**Zero order** – $t_{½} = [A]_0/2k$

**First order** – $k = (2.303/t)\log([A]_0/[A])$, $t_{½} = 0.693/k$

**Arrhenius** – $k = Ae^{-E_a/RT}$; $\log(k_2/k_1) = [E_a/2.303R](1/T_1 - 1/T_2)$

## 07 Periodic trends and bonding

**Atomic radius** – decreases across a period, increases down a group

**Ionisation enthalpy** – increases across a period; exceptions N > O, Be > B, Mg > Al

**Electronegativity** – fluorine is highest (4.0 on the Pauling scale); chlorine has the most negative electron gain enthalpy

**Bond order (MOT)** – $(N_b - N_a)/2$; $O_2$ has bond order 2 and is paramagnetic; $N_2$ has bond order 3

**Hybridisation** – 2 sp linear; 3 $sp^2$ trigonal planar; 4 $sp^3$ tetrahedral; 5 $sp^3d$ trigonal bipyramidal; 6 $sp^3d^2$ octahedral

**Shapes** – $H_2O$ bent 104.5°; $NH_3$ pyramidal 107°; $SF_4$ see-saw; $ClF_3$ T-shaped; $XeF_2$ linear; $XeF_4$ square planar

**Formal charge** – valence electrons – non-bonding electrons – ½ bonding electrons

## 08 Coordination compounds

**Crystal field (octahedral)** – $t_{2g}$ $-0.4\Delta_o$, $e_g$ $+0.6\Delta_o$

**Spectrochemical series** – $I^- < Br^- < Cl^- < F^- < OH^- < H_2O < NH_3 < en < CN^- < CO$

**Magnetic moment (spin only)** – $\mu = \sqrt{[n(n+2)]}$ BM, n = unpaired electrons

## 09 Named reactions

**Aldol** – aldehydes or ketones with α-H in dilute alkali give β-hydroxy carbonyl compounds

**Cannizzaro** – aldehydes without α-H in concentrated alkali give an alcohol and a carboxylate

**Wurtz** – 2R–X + 2Na in dry ether give R–R

**Friedel–Crafts** – alkylation or acylation of benzene with $AlCl_3$

**Reimer–Tiemann** – phenol + $CHCl_3$ + NaOH give salicylaldehyde

**Kolbe** – sodium phenoxide + $CO_2$ give salicylic acid

**Hell–Volhard–Zelinsky** – carboxylic acid + $X_2$/red P gives the α-halo acid

**Hoffmann bromamide** – amide + $Br_2$/NaOH gives an amine with one carbon fewer

**Sandmeyer** – diazonium salt + CuX gives an aryl halide

**Gabriel phthalimide** – a route to pure primary amines

**Clemmensen and Wolff–Kishner** – reduce C=O to $CH_2$ (Zn-Hg/HCl; $NH_2NH_2$/KOH)

**Rosenmund** – acid chloride + $H_2$/Pd-$BaSO_4$ gives an aldehyde

**Etard** – toluene + $CrO_2Cl_2$ gives benzaldehyde

**Williamson** – $RO^-Na^+$ + R'X gives the ether R–O–R'

## 10 Organic rules of thumb

**Markovnikov** – H adds to the carbon with more hydrogens; HBr with peroxide adds anti-Markovnikov

**Substitution** – $S_N1$ favours 3° > 2° > 1° and racemises; $S_N2$ favours 1° > 2° > 3° with inversion

**Carbocation stability** – 3° > 2° > 1° > methyl

**Acidity** – carboxylic acids > phenols > water > alcohols; electron-withdrawing groups raise acidity

## 11 Laboratory tests

**Tollens' reagent** – silver mirror with aldehydes

**Fehling's solution** – red precipitate with aliphatic aldehydes

**Iodoform test** – $CH_3CO-$ or $CH_3CH(OH)-$ groups give yellow $CHI_3$

**Lucas test** – tertiary alcohols turn cloudy at once

**Carbylamine test** – primary amines give a foul-smelling isocyanide

**Neutral $FeCl_3$** – violet colour with phenols

**2,4-DNP** – orange precipitate with aldehydes and ketones

**Hinsberg's reagent** – tells primary, secondary and tertiary amines apart

### How to use these notes

1. Learn named reactions as reagent → product pairs, then test yourself by covering one side.
2. For trends, remember the exceptions: they are what the questions ask about.
3. NCERT lines are the source for most inorganic questions; read the relevant chapter after this sheet.

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FORMULA SHEET · CLASS 11 AND 12

# Physics Formula Sheet for JEE and NEET

The formulas that carry most of the marks in JEE Main, JEE Advanced and NEET physics, grouped the way the NCERT books teach them. Print it, stick it above your desk, and test yourself on one section a day.

JEE | NEET | CBSE 12

## 01 Units and errors

**Force** – $[M\ L\ T^{-2}]$

**Work, energy** – $[M\ L^2\ T^{-2}]$

**Power** – $[M\ L^2\ T^{-3}]$

**Pressure, stress** – $[M\ L^{-1}\ T^{-2}]$

**Gravitational constant G** – $[M^{-1}\ L^3\ T^{-2}]$

**Planck's constant h** – $[M\ L^2\ T^{-1}]$

**Error in $x = a^p b^q / c^r$** – $\Delta x/x = p(\Delta a/a) + q(\Delta b/b) + r(\Delta c/c)$

## 02 Kinematics

**Equations of motion** – $v = u + at$, $s = ut + \tfrac{1}{2}at^2$, $v^2 = u^2 + 2as$

**Distance in the nth second** – $s_n = u + a(n - \tfrac{1}{2})$

**Projectile** – $T = 2u\sin\theta/g$, $H = u^2\sin^2\theta/2g$, $R = u^2\sin 2\theta/g$ (maximum at 45°)

**Relative velocity** – $v_{AB} = v_A - v_B$

**Uniform circular motion** – $a_c = v^2/r = \omega^2 r$, $v = \omega r$

## 03 Laws of motion and friction

**Newton's second law** – $F = dp/dt = ma$

**Impulse** – $J = F\Delta t = \Delta p$

**Friction** – $f_s \le \mu_s N$, $f_k = \mu_k N$, angle of repose: $\tan\theta = \mu_s$

**Banked road (no friction)** – $\tan\theta = v^2/rg$

**Level curve, maximum speed** – $v = \sqrt{(\mu rg)}$

## 04 Work, energy and power

**Work** – $W = F\cdot s = Fs\cos\theta$

**Kinetic energy** – $K = \tfrac{1}{2}mv^2 = p^2/2m$

**Potential energy** – $mgh$ (near Earth), $\tfrac{1}{2}kx^2$ (spring)

**Work–energy theorem** – $W_{net} = \Delta K$

**Power** – $P = dW/dt = F\cdot v$

**Elastic collision (1D)** – $v_1 = [(m_1 - m_2)u_1 + 2m_2u_2]/(m_1 + m_2)$

**Coefficient of restitution** – $e = (v_2 - v_1)/(u_1 - u_2)$

## 05 Rotational motion

**Torque** – $\tau = r \times F = I\alpha$

**Angular momentum** – $L = I\omega = r \times p$

**Rotational kinetic energy** – $\tfrac{1}{2}I\omega^2$

**Parallel axis** – $I = I_{cm} + Md^2$

**Perpendicular axis (lamina)** – $I_z = I_x + I_y$

**Moments of inertia** – ring $MR^2$; disc $\tfrac{1}{2}MR^2$; solid sphere $(2/5)MR^2$; hollow sphere $(2/3)MR^2$; rod about centre $ML^2/12$, about end $ML^2/3$

**Rolling without slipping** – $v = \omega R$, $K = \tfrac{1}{2}mv^2(1 + k^2/R^2)$

**Rolling down an incline** – $a = g\sin\theta/(1 + k^2/R^2)$

## 06 Gravitation

**Newton's law** – $F = Gm_1m_2/r^2$

**Surface gravity** – $g = GM/R^2$

**At height h ($h \ll R$)** – $g' \approx g(1 - 2h/R)$

**At depth d** – $g' = g(1 - d/R)$

**Orbital speed** – $v_o = \sqrt{(GM/r)}$

**Escape speed** – $v_e = \sqrt{(2GM/R)} = \sqrt{(2gR)} \approx 11.2$ km/s for Earth

**Kepler's third law** – $T^2 = 4\pi^2 r^3/GM$

**Potential energy** – $U = -GMm/r$

## 07 Solids and fluids

**Young's modulus** – $Y = (F/A)/(\Delta L/L)$

**Pressure at depth** – $P = P_0 + \rho gh$

**Buoyant force** – $F_B = \rho_{fluid} Vg$

**Continuity** – $A_1v_1 = A_2v_2$

**Bernoulli** – $P + \tfrac{1}{2}\rho v^2 + \rho gh = \text{constant}$

**Stokes' law** – $F = 6\pi\eta rv$

**Terminal velocity** – $v_t = 2r^2(\rho - \sigma)g/9\eta$

**Excess pressure** – drop $2T/r$, soap bubble $4T/r$

**Capillary rise** – $h = 2T\cos\theta/\rho gr$

## 08 Heat and thermodynamics

**Thermal expansion** – $\Delta L = \alpha L\Delta T$, $\beta = 2\alpha$, $\gamma = 3\alpha$

**Heat** – $Q = mc\Delta T$, $Q = mL$ (change of state)

**First law** – $\Delta U = Q - W$ ($W$ = work done by the gas)

**Isothermal work** – $W = nRT\ln(V_2/V_1)$

**Adiabatic** – $PV^\gamma = \text{constant}$, $W = (P_1V_1 - P_2V_2)/(\gamma - 1)$

**Specific heats** – $C_p - C_v = R$, $\gamma = C_p/C_v$ (monatomic 5/3, diatomic 7/5)

**Efficiency** – $\eta = W/Q_1$; Carnot $\eta = 1 - T_2/T_1$

**Refrigerator** – $COP = T_2/(T_1 - T_2)$

**Kinetic theory** – $P = \tfrac{1}{3}\rho v_{rms}^2$, $v_{rms} = \sqrt{(3RT/M)}$, average KE per molecule $= (3/2)kT$

**Radiation** – Stefan $E = \sigma eT^4$; Wien $\lambda_m T = b \approx 2.9 \times 10^{-3}$ m K

**Newton's law of cooling** – $dT/dt = -k(T - T_0)$

## 09 Oscillations and waves

**SHM** – $x = A\sin(\omega t + \varphi)$, $v = \omega\sqrt{(A^2 - x^2)}$, $a = -\omega^2 x$

**Time period** – spring $T = 2\pi\sqrt{(m/k)}$; simple pendulum $T = 2\pi\sqrt{(L/g)}$

**Energy in SHM** – $E = \tfrac{1}{2}kA^2$

**Wave speed** – $v = f\lambda$; on a string $v = \sqrt{(T/\mu)}$; sound in a gas $v = \sqrt{(\gamma RT/M)}$

**Open pipe or string** – $f_n = nv/2L$

**Closed pipe** – $f_n = (2n - 1)v/4L$ (odd harmonics only)

**Beats** – $f_{beat} = |f_1 - f_2|$

**Doppler effect** – $f' = f(v \pm v_o)/(v \mp v_s)$ (upper signs: moving towards each other)

## 10 Electrostatics

**Coulomb's law** – $F = kq_1q_2/r^2$, $k = 1/4\pi\varepsilon_0 \approx 9 \times 10^9$ N m$^2$ C$^{-2}$

**Point charge** – $E = kq/r^2$, $V = kq/r$

**Dipole** – axial $E = 2kp/r^3$, equatorial $E = kp/r^3$, torque $\tau = p \times E$

**Gauss's law** – $\Phi = q_{enc}/\varepsilon_0$

**Line charge** – $E = \lambda/2\pi\varepsilon_0 r$

**Infinite sheet** – $E = \sigma/2\varepsilon_0$

**Capacitance** – $C = Q/V$; parallel plates $C = K\varepsilon_0 A/d$

**Energy stored** – $U = \tfrac{1}{2}CV^2 = Q^2/2C$

**Combinations** – series $1/C = \Sigma 1/C_i$; parallel $C = \Sigma C_i$

## 11 Current electricity

**Current** – $I = dq/dt = nAev_d$

**Ohm's law** – $V = IR$, $R = \rho L/A$

**Temperature** – $R_T = R_0(1 + \alpha\Delta T)$

**Combinations** – series $R = \Sigma R_i$; parallel $1/R = \Sigma 1/R_i$

**Power** – $P = VI = I^2R = V^2/R$

**Cell** – $V = E - Ir$; maximum power to the load when $R = r$

**Kirchhoff** – $\Sigma I = 0$ at a junction; $\Sigma V = 0$ round a loop

**Wheatstone bridge (balanced)** – $P/Q = R/S$

## 12 Magnetism and induction

**Force on a charge** – $F = q(v \times B)$; radius $r = mv/qB$; period $T = 2\pi m/qB$

**Force on a wire** – $F = IL \times B$

**Biot–Savart** – $dB = (\mu_0/4\pi)\, I\, dl \times \hat{r}/r^2$

**Long straight wire** – $B = \mu_0 I/2\pi r$

**Centre of a loop** – $B = \mu_0 I/2R$

**Solenoid** – $B = \mu_0 nI$

**Parallel wires, force per length** – $\mu_0 I_1 I_2/2\pi d$

**Faraday's law** – $\varepsilon = -d\Phi/dt$; motional emf $\varepsilon = Blv$

**Inductance** – $U = \tfrac{1}{2}LI^2$; solenoid $L = \mu_0 n^2 Al$

**Growth in an LR circuit** – $I = I_0(1 - e^{-t/\tau})$, $\tau = L/R$; RC circuit $\tau = RC$

## 13 Alternating current

**RMS value** – $V_{rms} = V_0/\sqrt{2}$

**Reactance** – $X_L = \omega L$, $X_C = 1/\omega C$

**Impedance** – $Z = \sqrt{(R^2 + (X_L - X_C)^2)}$

**Resonance** – $f_0 = 1/(2\pi\sqrt{(LC)})$, $Q = \omega_0 L/R$

**Power** – $P = V_{rms} I_{rms}\cos\varphi$

**Ideal transformer** – $V_s/V_p = N_s/N_p = I_p/I_s$

## 14 Optics

**Mirror** – $1/v + 1/u = 1/f$, $f = R/2$, $m = -v/u$

**Lens** – $1/v - 1/u = 1/f$, $m = v/u$, $P = 1/f$ (dioptres, f in metres)

**Lens maker's formula** – $1/f = (\mu - 1)(1/R_1 - 1/R_2)$

**Lenses in contact** – $1/F = 1/f_1 + 1/f_2$

**Snell's law** – $n_1 \sin i = n_2 \sin r$; critical angle $\sin C = 1/\mu$

**Prism** – $\mu = \sin[(A + \delta_m)/2]/\sin(A/2)$; thin prism $\delta = (\mu - 1)A$

**Young's double slit** – fringe width $\beta = \lambda D/d$

**Single slit, first minimum** – $a \sin\theta = \lambda$

**Polarisation** – Malus $I = I_0 \cos^2\theta$; Brewster $\tan i_p = \mu$

**Instruments** – telescope $m = f_o/f_e$; compound microscope $m \approx (L/f_o)(D/f_e)$

## 15 Modern physics

**Photon** – $E = hf = hc/\lambda$, $hc \approx 1240$ eV nm

**Photoelectric effect** – $K_{max} = hf - \varphi = eV_0$

**de Broglie** – $\lambda = h/p = h/\sqrt{(2mK)}$; electron through V volts: $\lambda \approx 1.227/\sqrt{V}$ nm

**Bohr model** – $r_n = 0.529\, n^2/Z$ Å, $E_n = -13.6\, Z^2/n^2$ eV

**Spectral lines** – $1/\lambda = RZ^2(1/n_1^2 - 1/n_2^2)$, $R \approx 1.097 \times 10^7\ m^{-1}$

**Radioactive decay** – $N = N_0 e^{-\lambda t}$, $T_{½} = 0.693/\lambda$, mean life $\tau = 1/\lambda$

**Mass–energy** – $E = mc^2$; 1 u = 931.5 MeV

**Nuclear radius** – $R = R_0 A^{1/3}$

**Diodes** – a p-n junction conducts in forward bias above its barrier (about 0.7 V for silicon); a Zener diode in reverse breakdown regulates voltage

**Logic and rectifiers** – NAND and NOR are universal gates; full-wave output frequency = 2 × input

## 16 Constants worth knowing

| | |
|---|---|
| $g = 9.8\ m\ s^{-2}$ | $G = 6.67 \times 10^{-11}\ N\ m^2\ kg^{-2}$ |
| $c = 3 \times 10^8\ m\ s^{-1}$ | $h = 6.63 \times 10^{-34}\ J\ s$ |
| $e = 1.6 \times 10^{-19}\ C$ | $m_e = 9.1 \times 10^{-31}\ kg$ |
| $N_A = 6.022 \times 10^{23}\ mol^{-1}$ | $R = 8.314\ J\ mol^{-1}\ K^{-1}$ |
| $k_B = 1.38 \times 10^{-23}\ J\ K^{-1}$ | $\varepsilon_0 = 8.85 \times 10^{-12}\ F\ m^{-1}$ |
| $\mu_0 = 4\pi \times 10^{-7}\ T\ m\ A^{-1}$ | $\sigma = 5.67 \times 10^{-8}\ W\ m^{-2}\ K^{-4}$ |
| $1\ eV = 1.6 \times 10^{-19}\ J$ | |

### How to use this sheet

1. Cover the right-hand side of each line and say the formula out loud before you look.
2. Write the units next to every answer: it catches half of all slips.
3. Pair each formula with one solved question from your NCERT book or a previous paper.

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