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# MCAT® Physics Equations

## Work, Energy, and Power

Work $= W = Fd\cos\theta$

Kinetic Energy $= KE = \frac{1}{2}mv^2$

Work Energy Theorem $= W_{net} = \Delta KE$

Power $= P = \frac{W}{t} = Fv$

Gravitational Potential Energy $= PE_{grav} = mgh$

Total Mechanical Energy $= E = KE + PE$

## Gravity

$F_{grav} = mg$

$g = G\frac{M}{r^2}$

$F_{grav} = G\frac{Mm}{r^2}$

$g_{earth} \simeq 10\,\frac{m}{s^2}$

## Circular Motion

Centripetal Acceleration $= v_0 + at$

Centripetal Force $= F_c = ma_c = m\frac{v^2}{r}$

## Projectile Motion

Horizontal Component

$x = v_{x0}t$

$v_x = v_{x0}$

$a_x = 0$

Vertical Component

$y = v_{y0}t - \frac{1}{2}gt^2$

$v_y = v_{x0} - gt$

$a_y = -g$

## Kinematics

Constant Acceleration

$v = v_0 + at$

$d = v_0t + \frac{1}{2}at^2$

## Friction

$F_{static} \leq \mu_s F_N$

$F_{kinetic} = \mu_k F_N$

## Torque

$\tau = rF\sin\theta$

## Magnetism

Magnetic Force $= F_M = qvB\sin\theta$

## Thermodynamics

First Law $= \Delta E = Q - W$

Work $= P\Delta V$

Heat Capacity $= Q = C\Delta T$

Specific Heat Capacity $= Q = mc\Delta T$

## Fluids

Density $= \rho = \frac{mass}{volume} = \frac{m}{v}$

Specific Gravity $= SG = \frac{\rho}{\rho_{water}}$

Pressure $= P = \frac{F}{A}$

Gauge Pressure $= P_{gauge} = P - P_{atm}$

Archimedes' Principle $= F_{bouyant} = F_{fluid}V_{submerged}g$

Pascal's Law $= \frac{F_1}{A_1} = \frac{F_2}{A_2}$

Continuity Equation $= A_1v_1 = A_2v_2$

Flow Rate $= Q = Av$

## Inclined Plane

$\theta$ = angle of incline

$F_{g\ parallel} = mg\sin\theta$

$F_{g\ perpendicular} = mg\cos\theta$

## Circuits and Electrostatics

Ohms Law $= V = IR$

Power $= P = IV = I^2R = \frac{V^2}{R}$

Series Resistors $= R_{Total} = R_1 + R_2 + \ldots R_n$

Parallel Resistorsv $= \frac{1}{R_{Total}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots \frac{1}{R_n}$

Current $= I = \frac{Q}{t}$

Resistance $= R = \rho\frac{L}{A}$

Coulomb's Law $= F_E = \frac{kQ_1Q_2}{r^2}$

Electric Field (Point Charge) $= E = \frac{kQ}{r^2}$

Force by an Electric Field $= F = qE$

## Lights and Optics

$E_{photon} = hf = \frac{hc}{\lambda}$

$c = 3 \times 10^8 \frac{m}{s}$

Index of Refraction $= n = \frac{c}{v}$

Shell's Law $= n_1\sin\theta_1 = n_2\sin\theta_2$

Lens Equation $= \frac{1}{o} + \frac{1}{i} = \frac{1}{f}$

Magnification $= m = \frac{i}{o}$

Lens Power $= P = \frac{1}{f}$

## Capacitors

Capacitance $= C = \frac{Q}{V}$

Capacitance $= \varepsilon_0\frac{A}{d}$

Compacitor Electric Field $= E = \frac{V}{d}$

Potential Energy $= PE_C = \frac{1}{2}QV$

Series Capacitors $= C_{Total} = C_1 + C_2 + \ldots C_n$

Parallel Capacitors $= \frac{1}{C_{Total}} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots \frac{1}{C_n}$

## Waves and Oscillations

$f = \frac{1}{T}$

where $f$ is frequency and $T$ is period

Velocity $= v = \lambda f$

Hooke's Law $= F_s = -kx$

Harmonics for Open Pipes $= f_n = \frac{nv}{2L}$

Harmonics for Closed Pipes $= f_n = \frac{n_{odd}v}{4L}$

## Sound

Velocity $= v = \sqrt{\frac{B}{\rho}}$

Intensity $= I = \frac{\text{power}}{\text{area}}$

Intensity in Decibels $= \beta = 10\log\frac{I}{I_0}$

Doppler Effect $= f_D = \frac{v \pm v_D}{v \pm v_s} f_s$

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# MCAT® Chemistry Equations

## Stoichiometry

$$\text{Moles} = \frac{mass\ (g)}{molecular\ weight\ (MW)}$$

$$\text{Mole Fraction} = X_a = \frac{moles\ of\ a}{total\ moles}$$

$$\text{Molarity} = M = \frac{moles}{L}$$

$$\text{Molarity} = M = \frac{moles}{kg}$$

$$\text{Dilution Equation} = M_1V_1 = M_2V_2$$

## Gases

Standard Temperature and Pressure (STP)

$T = 0\ ^{\circ}C = 273\ K;$
$P = 1\ atm = 760\ torr = 760\ mmHg$

$$\text{Ideal Gas Law} = PV = nRT$$

$$\text{Dalton's Law of Partial Pressures} = P_{Total} = P_1 + P_2 + \ ...\ P_n$$

$$\text{Graham's Law of Effusion} = \frac{v^1}{v^2} = \sqrt{\frac{MW_2}{MW_1}}$$

## Thermodynamics

$$T_K = T_{^{\circ}C} + 273$$

$$q = mc\Delta T$$

$$q = n\Delta H_{fusion/vaporization}$$

$$\Delta H^{\circ}_{rxn} = \Sigma n\Delta H^{\circ}_{f,products} - \Sigma n\Delta H^{\circ}_{f,reactants}$$

Gibbs Free Energy

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta G^{\circ} = -RTlnK$$

## Atomic Chemistry

Formal Charge

$FC = \#\ valence\ electrons - \#\ bonds - \#\ lone\ pair\ electrons$

## Electrochemistry

$$F = 96{,}000\ \frac{c}{mole^-}$$

$$\Delta G = -nFE_{cell}$$

## Equilillbrium

For the balanced reation

$$aA + bB \leftrightarrow cC + dD$$

$$\text{Equilibrium Constant} = K_{eq} = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

Products and reactants at equilibrium

$$\text{Reaction Quotient} = Q = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

## Acids and Bases

$$pH = -log\,[H^+]$$

$$pOH = -log\,[OH^-]$$

$$pH + pOH = 14$$

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$pK_a = -logK_a$$

$$K_b = \frac{[OH^-][HB^+]}{[B]}$$

$$pK_b = -logK_b$$

$$K_aK_b = K_w = 1 \times 10^{-14}$$

$$K_w = [H^+][OH^-] = 1 \times 10^{-14}\ \text{at}\ 25\ ^{\circ}C$$

Henderson-Hasselbach Equation

$$pH = pK_a + log\ \frac{[A^-]}{[HA]}$$

## Kinetics

$$\text{Rate Law} = \text{Rate} = k[A]^a[B]^b$$

$$\text{Arrhenius Equation} = k = Ae^{\frac{-E_a}{RT}}$$