Physics Review

- Translational kinematics with constant acceleration
  1. $v_{avg} = \dfrac{v_i + v_f}{2} = \Delta d/\Delta t$
  2. $\Delta v = a\Delta t$
  3. $\Delta v^2 = 2a\Delta d$
  4. $\Delta d = v_i\Delta t + \dfrac{1}{2}a(\Delta t)^2$
- Rotational kinematics with constant angular acceleration
  1. $\omega_{avg} = \dfrac{\omega_i + \omega_f}{2} = \Delta\theta/\Delta t$
  2. $\Delta\omega = \alpha\Delta t$
  3. $\Delta\omega^2 = 2\alpha\Delta\theta$
  4. $\Delta\theta = \omega_i\Delta t + \dfrac{1}{2}\alpha(\Delta t)^2$
- Linear Dynamics
  1. Second law of Newton: $F_{net} = ma$
  2. Gravitational force: $F_g = mg = \dfrac{Gm_1m_2}{r^2}$
  3. Spring force: $F_s = -k(\Delta x)$
  4. Magnitude of friction force: $F_f = \mu F_N$
- Linear Momentum
  1. Momentum: $P = mv$
  2. Impulse: $J = F_{avg}t$
  3. Impule Momentum: $J = \Delta P$
  4. Conservation of Momentum: $P_i = P_f$ if $F_{ext} = 0$
  5. Center of mass: $x_{cm} = \dfrac{\sum x_i m_i}{\sum m_i}$
- Rotational Dynamics
  1. Torque: $\tau = rF\sin(\Theta)$
  2. Angular momentum: $L = rPsin(\theta) = rmvsin(\theta)$
  3. $\tau = \Delta L/\Delta t$
  4. Conservation of angular momentum: $L_i = L_f$ if $\tau_{ext} = 0$
  5. Moment of Inertia: $I = \sum m_i r_i^2$
  6. Rotational kinetic energy: $KE_{rot} = \dfrac{1}{2}I\omega^2$
  7. $\tau = I\alpha$
  8. Uniform circular motion: $a_c = \dfrac{v_t^2}{r} = \omega^2 r$
  9. Angular velocity and tangential velocity: $v_t = r\omega$
  10. Angular acceleration and tangential acceleration: $a_t = r\alpha$

Physics Review

- Work and Energy
  1. Kinetic energy: $KE = \frac{1}{2}mv^2$
  2. Total mechanical energy: $TME = KE + PE$
  3. Gravitational potential energy: $PE_g = mgh = -\frac{GMm}{r}$
  4. Spring potential energy: $PE_s = \frac{1}{2}k(\Delta x)^2$
  5. Work: $W = Fdcos(\theta)$
  6. Power: $P = W/t = Fv$
  7. Work Energy: $\Delta W = \Delta TME$
  8. Conservation of Energy: $TME_i = TME_f$ if $F_{ext} = 0$
- Electricity
  1. Force between point charges: $F = \frac{q_1 q_2}{4\pi\epsilon_0 r^2}$
  2. Field: $E = \frac{F}{q}$
  3. Potential: $V_B - V_A = -W_{AB}/q_0$
  4. Potential due to point charge q: $V = \frac{q}{4\pi\epsilon_0 r}$
  5. Potential due to point charges q_i: $V = \frac{1}{4\pi\epsilon_0}\sum\frac{q_i}{r_i}$
  6. Capacitance: $C = Q/V = \frac{\epsilon_0 A}{d}$
  7. Potential energy of system of point charges: $U = \frac{1}{4\pi\epsilon_0}\sum_{i\neq j}\frac{q_i q_j}{r_{i,j}}$
  8. Potential energy stored in capacitor: $U_C = \frac{1}{2}QV = \frac{1}{2}CV^2$
  9. Field due to a point charge q: $E_{electric} = \frac{kq}{r^2}$
  10. Ohm Law: $V = IR$
  11. Power: $P = IV = I^2R = V^2/R$
  12. Parallel capacitors: $C_P = \sum C_i$
  13. Series capacitors: $\frac{1}{C_S} = \sum\frac{1}{C_i}$
  14. Parallel resistance: $\frac{1}{R_P} = \sum\frac{1}{R_i}$
  15. Series resistance: $R_S = \sum R_i$
- Magnetism
  1. Force on moving charge: $F_B = qvB\sin(\theta)$
  2. Force on current carrying wire: $F_B = BIl\sin(\theta)$
  3. Field induced by current in wire: $B = \frac{\mu_0 I}{2\pi r}$

4. Magnetic flux through area: $\phi_m = BA\cos(\theta)$
5. Faraday law: $\mathcal{E} = -\dfrac{\Delta\phi_m}{\Delta t}$
6. Induced emf in loop moving in magnetic field: $\mathcal{E} = Blv$

- Oscillations
  1. Period and frequency: $T = 1/f$
  2. Spring frequency: $f = \dfrac{1}{2\pi}\sqrt{k/m}$
  3. Pendulum frequency: $f = \dfrac{1}{2\pi}\sqrt{g/L}$
  4. Doppler effect: $f_{received} = \dfrac{v + v_{receiver}}{v - v_{sender}} f_{sent}$
     - v_r and v_s are positive (negative) if approaching (receding)
  5. Wave velocity, ν, in string with tension T and linear mass density μ: $\nu = \sqrt{\frac{T}{\mu}}$
  6. Wavelength (λ_n) of n^{th} harmonic of standing waves in medium of length L
     (a) Open-closed: $\lambda_n = \frac{4L}{2n-1}$
     (b) Open-open and closed-closed: $\lambda_n = \frac{2L}{n}$
  7. Double slit experiment with distance d between slits
     (a) Constructive interference: $d\sin(\theta_n) = n\lambda$
     (b) Destructive interference: $d\sin(\theta_n) = (n + 1/2)\lambda$

- Mirrors and Lenses
  1. Lens/Mirror equation: $\dfrac{1}{s_o} + \dfrac{1}{s_i} = \dfrac{1}{f}$
     - s_o=position of object, always positive
     - s_i=position of image, positive for real images, negative for virtual images
     - f=focal length, positive for concave mirrors and convex lenses, negative for convex mirrors and concave lenses
  2. Magnification: $m = -\dfrac{s_i}{s_0} = \dfrac{h_i}{h_o}$
     - h_o = height of object, always positive
     - h_i = height of image, positive for upright images, negative for inverted images

- Thermodynamics
  1. Specific heat: $Q = mc\Delta T$
  2. Conservation of energy: $Q_{lost} = Q_{gained}$
  3. Latent heat of phase change: $Q = mL$
  4. Linear expansion: $\Delta L = \alpha L_0 \Delta T$
  5. Ideal Gas Law: $PV = nRT$ where $R = 8.31 J/(moleK)$
  6. Ideal Gas Law: $PV = Nk_BT$ where $k_B = 1.4 \times 10^{-23} J/K$
  7. $KE_{avg} = \dfrac{3}{2}k_BT$ where $k_B = 1.4 \times 10^{-23} J/K$

8. Root mean square velocity: $v_{rms} = \sqrt{\dfrac{3RT}{M}}$ where M is the mass of 1 mole of the gas
9. Root mean square velocity: $v_{rms} = \sqrt{\dfrac{3k_BT}{\mu}}$ where μ is the mass of 1 molecule of the gas
10. First law: $\Delta U = \Delta Q - W_{\text{done by gas}} = \Delta Q + W_{\text{done on gas}}$
11. Second law: Heat always flows from hot to cold unless work is done or entropy of the universe increases
12. Efficiency of engine: $\mathcal{E} = \left|\dfrac{W_{out}}{Q_{in}}\right|$
13. Efficiency of Carnot Engine: $\mathcal{E} = 1 - T_C/T_H$

- Special Relativity

1. Relative velocity: $v_2 = \dfrac{u + v_1}{1 + (uv_1/c^2)}$
2. Time dilation: $\Delta T_2 = \dfrac{\Delta T_1}{\sqrt{1-(v/c)^2}}$
3. Length contraction: $L_2 = L_1 \quad \sqrt{1-(v/c)^2}$
4. Rest energy: $E_{rest} = mc^2$
5. Kinetic energy: $E_{kinetic} = (\sqrt{1-(v/c)^2} - 1) \quad mc^2$
6. Total energy: $E_{total} = \sqrt{1-(v/c)^2} \quad mc^2$

- Modern Physics

1. Energy of light: $E = hf = Pc$ where h is the Planck constant
2. Momentum of light: $P = h/\lambda$
3. DeBroglie wavelength of particle with mass: $P = mv = h/\lambda$
4. Work function ϕ: $KE_{max} = hf - \phi$