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# Honors Physics
## Equation Sheet

## Fall Semester

### Constant Motion

$$\Delta d = v_c t$$

### Changing Motion

$$\Delta d = v_{avg} t$$

$$v_f = v_i + at$$

$$\Delta d = v_i t + \frac{1}{2} a t^2$$

$$v_f^2 = v_i^2 + 2a\Delta d$$

### Newton's Laws

$$\Sigma F = F_{net} = ma$$

$$F_g = mg \text{ (weight)}$$

$$F_{friction} \le \mu F_N$$

$$F_{spring} = -kx$$

### 2D Motion

$$v_x = v\cos\theta$$

$$v_y = v\sin\theta$$

### UCM and Gravity

(Uniform Circular Motion)

$$F_g = \frac{Gm_1m_2}{r^2} \text{ or } \frac{Gm_1m_2}{d^2}$$

$$\tau = rF\sin\theta$$

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

$$v = \frac{2\pi r}{T}$$

$$a_c = \frac{v^2}{r}$$

### Work and Energy

$$W = F\Delta d\cos\theta$$

$$W_{net} = \Delta KE$$

$$W = \Delta E$$

$$PE_{gravity} = mgh$$

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

$$PE_i + KE_i = PE_f + KE_f$$

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

$$PE_{spring} = \frac{1}{2}kx^2$$

$$Q = mc\Delta T$$

$$F = \frac{9}{5}C + 32$$

$$K = 273.15 + C$$

## Spring Semester

### Impulse & Momentum

$$p = mv$$

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

$$J = F_{net}\Delta t = \Delta p = m\Delta v$$

### Mechanical Waves

$$v = \lambda f$$

$$\lambda_n = \frac{2L}{n} \text{ or } \lambda_n = \frac{4L}{n}$$

$$f_n = nf_1$$

### Electromagnetic Waves

$$c = \lambda f$$

$$n = \frac{c}{v}$$

$$n_i\sin\theta_i = n_r\sin\theta_r$$

$$M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$f = \frac{R}{2}$$

### Electrostatics

$$Q = Ne$$

$$F_E = \frac{kq_1q_2}{r^2} \text{ or } \frac{kq_1q_2}{d^2}$$

$$E = \frac{F_E}{q}$$

$$E = \frac{kQ}{r^2}$$

$$V = \frac{W}{q}$$

### Circuits

$$V = iR$$

$$P = iV = i^2R = \frac{V^2}{R}$$

$$i = \frac{Q}{t}$$

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

$$R_{series} = R_i + R_2 + \ldots$$

$$\frac{1}{R_{parallel}} = \frac{1}{R_i} + \frac{1}{R_2} + \ldots$$

### Magnetism

$$F_B = qvB\sin\theta$$

$$F_B = BiL\sin\theta$$

*$F_B$ = palm; B = fingers*
*i or v = thumb*
*× = Into; ● = out of*
*right hand is positive*

$$B = \frac{\mu_o i}{2\pi r}$$

$$\frac{V_P}{V_S} = \frac{i_S}{i_P}$$

### Modern

$$E = Pt$$

$$E = hf$$

$$W = hf_t$$

$$KE = E - W$$

$$KE = hf - hf_t$$

$$E_n = \frac{E_1}{n^2} \text{ (Hydrogen ONLY)}$$

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

$$E = mc^2$$

**Working Equation** - Algebraically manipulate your equation(s) solving for the unknown variable. The working equation may only have variables identified in the given.

| Name | Variable | Unit |
|---|---|---|
| Acceleration | a | $m/s^2$ |
| Acceleration due to Gravity | g | $m/s^2$ |
| Average Velocity | $v_{avg}$ | m/s |
| Average Speed | $v_{avg}$ | m/s |
| Charge | q or Q | C, coulomb |
| Constant Velocity | $v_c$ | m/s |
| Current | i or I | A, ampere |
| de Broglie Wavelength | $\lambda$ | m, meter |
| Displacement | $\Delta$d or d | m, meter |
| Distance | $\Delta$d or d | m, meter |
| Electric Field | E | N/C |
| Electrostatic Force | $F_E$ | N |
| Elementary Charge | e | C, coulomb |
| Energy | E | J, joule |
| Focal Length | f | m, meter |
| Force | F | N, newton |
| Frequency | f | 1/s or Hz, hertz |
| Frictional Force | $F_f$ | N, newton |
| Gravitational Force | $F_g$ | N, newton |
| Image Distance | $d_i$ | m, meter |
| Impulse | J | Ns |
| Instantaneous speed | v | m/s |
| Magnetic Field | B | T, tesla |
| Magnetic Force | $F_B$ | N |
| Mass | m | kg, kilogram |
| Momentum | p | kgm/s |
| Net Force | $F_{net}$ or $\Sigma F$ | N, newton |
| Normal Force | $F_N$ | N, newton |
| Number | N | no unit |
| Kinetic Energy | KE | J, joule |
| Object Distance | $d_o$ | m, meter |
| Period | T | s, second |
| Pitch | f | 1/s or Hz, hertz |
| Potential Difference | V | V, volt |
| Potential Energy | | |
| Gravitational | $PE_g$ | J, joule |
| Elastic | $PE_E$ | J, joule |
| Power | P | W, watt |
| Radius | r | m, meter |
| Resistance | R | $\Omega$, ohm |
| Speed | v | m/s |
| Spring Constant | k | N/m |
| Summation of Forces | $F_{net}$ or $\Sigma F$ | N, newton |
| Tangential Velocity/Speed | $v_T$ | m/s |
| Tension Force | $F_T$ | N, newton |
| Time | t | s, second |
| Velocity | v | m/s |
| Velocity (constant) | $v_c$ | m/s |
| Velocity (average) | $v_{avg}$ | m/s |
| Volts | V | V, volt |
| Voltage | V | V, volt |
| Wavelength | $\lambda$ | m, meter |
| Wave Speed | v | m/s |
| Weight | $F_g$ | N, newton |
| Work | W | J, joule |
| Work Function | W | J, joule |

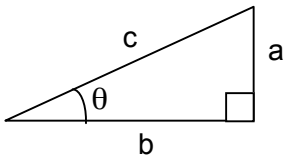
## Right Triangle Trigonometry

$$a^2 + b^2 = c^2$$

$$\sin\theta = \frac{a}{c} = \frac{opp}{hyp}$$

$$\cos\theta = \frac{b}{c} = \frac{adj}{hyp}$$

$$\tan\theta = \frac{a}{b} = \frac{opp}{adj}$$




## Trigonometric Values

| θ | sin θ | cos θ | tan θ |
|---|---|---|---|
| 0° | 0 | 1 | 0 |
| 30° | $1/2$ | $\sqrt{3}/2$ | $\sqrt{3}/3$ |
| 37° | $3/5$ | $4/5$ | $3/4$ |
| 45° | $\sqrt{2}/2$ | $\sqrt{2}/2$ | 1 |
| 53° | $4/5$ | $3/5$ | $4/3$ |
| 60° | $\sqrt{3}/2$ | $1/2$ | $\sqrt{3}$ |
| 90° | 1 | 0 | Inf. |

## Ratio

**A to B is** $\frac{A}{B}$ **OR A:B is** $\frac{A}{B}$

## Constants and Conversion Factors

Acceleration due to gravity ... $g = 9.8\ m/s^2$
Universal gravitational constant ... $G = 6.67 \times 10^{-11}\ Nm^2/kg^2$
Mass of the Earth ... $5.97 \times 10^{24}$ kg
Radius of the Earth ... $6.37 \times 10^{6}$ m
Mass of the Moon ... $7.36 \times 10^{22}$ kg
Radius of the Moon ... $1.74 \times 10^{6}$ m
Mass of the Sun ... $1.99 \times 10^{30}$ kg
Distance between:
- Earth and Sun $1.5 \times 10^{11}$ m
- Earth and Moon $3.82 \times 10^{8}$ m

Index of refraction of air ... n = 1
Speed of sound in air ... v = 343 m/s
Speed of light in a vacuum ... $c = 3.00 \times 10^{8}$ m/s
Ludicrous speed ... $v > 3.00 \times 10^{8}$ m/s
Elementary charge ... $e = 1.60 \times 10^{-19}$ C
Coulomb's law constant ... $k = 9.0 \times 10^{9}\ Nm^2/C^2$
Vacuum permeability ... $\mu_o = 4\pi \times 10^{-7}$ Tm/A
Planck's constant ... $h = 4.14 \times 10^{-15}$ eVs
$h = 6.63 \times 10^{-34}$ Js
eV to Joule conversion ... $1\ eV = 1.6 \times 10^{-19}$ J
Proton mass ... $m_p = 1.67 \times 10^{-27}$ kg
Neutron mass ... $m_n = 1.67 \times 10^{-27}$ kg
Electron mass ... $m_e = 9.11 \times 10^{-31}$ kg
Avogadro's number ... $N_o = 6.02 \times 10^{23}\ mol^{-1}$