PHY 132 - Tables & Formulas

You may refer to this handout on quizzes & exams. Do not add additional information.

Things you should know from PHY 131 and other prerequisites. (If you don’t, learn them now.)
- Definitions of trig functions
- Pythagorean theorem
- Newton’s three laws
- Relationship between weight and mass
- Formula for kinetic energy
- Relationship between frequency and period
- Definition of pressure
- Ideal gas law

\[ F = \frac{G m_1 m_2}{r^2} \]

Sec. 1: Gravitational Force:

Coulomb’s law:
Magnitude: \( F = \frac{1}{4\pi \varepsilon_0} \frac{|q_1||q_2|}{r^2} \)
Direction: Likes repel, opposites attract.

Electric Field Vector: \( \vec{E} = \vec{F}/q \)  \( \text{Force per unit charge} \)
\( (\text{so, } \vec{E} = \frac{1}{4\pi \varepsilon_0} \frac{|q|}{r^2} \text{ for a point charge or sphere}) \)
Field lines show direction of the force on a positive test charge.

Superposition:
- Force: Vector sum of forces from all charges at other points.
- \( \vec{E} \): Vector sum of fields from all charges at other points.

Sec. 2: Memorize: Definition of potential (and potential difference).
Potential difference: \( \Delta V = V_B - V_A = -\int_A^B \vec{E} \cdot d\vec{s} = -\vec{E} \cdot \vec{s} \text{ if } \vec{E} \text{ constant} \)

- Between parallel plates: \( V = Ed \)
- Around a point charge (or sphere): \( V = \frac{1}{4\pi \varepsilon_0} \frac{q}{r} \)

Potential Energy:
- \( U_e = -\frac{G m_1 m_2}{r} \)  \( U_e = \frac{1}{4\pi \varepsilon_0} \frac{q_1 q_2}{r} \)

Potential energy of one charge: \( U = \Sigma U \) for every pair which includes that charge
Total \( U \) of a group of charges: \( \Sigma U \) for every pair of charges.
Potential at some point: \( V = \Sigma V \) from all charges at other points
Sec 3:

Electric Flux: \( \Phi_\ell = \int \vec{E} \cdot d\vec{A} \)
\[
= EA \cos \theta \text{ if } E \text{ & } \theta \text{ constant over } A
\]

Gauss's Law:
Net Flux through a closed surface = \((1/\varepsilon_0)(\text{total charge inside})\)
\(+\text{ if out, } -\text{ if in}\)

Charge per unit length: \( \lambda = Q/L \)
Charge per unit area: \( \sigma = Q/A \)
Charge per unit volume: \( \rho = Q/V \)

Sec 4: Memorize: Definition of current, definition of capacitance, and Ohm’s law.

Between parallel plates in a vacuum:
\[
E = \frac{V}{d} \quad \text{and} \quad E = \frac{Q}{\varepsilon_0 A}
\]
\[
C = \varepsilon_0 A/d
\]

Current density: Magnitude: \( J = I/A \)
Direction: direction positive charge is moving

If \( n \) = number of free charges per unit volume, \( q \) = charge of one of them, and \( v_d \) = their drift velocity,
\( J = nqv_d \)

Resistivity, \( \rho \): \( E = \rho J \), \( \rho = RA/l \)

Conductivity: \( \sigma = 1/\rho \)

<table>
<thead>
<tr>
<th>Series</th>
<th>Parallel</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{tot}} = V_1 + V_2 + V_3 + \ldots )</td>
<td>( V_{\text{tot}} = V_1 = V_2 = V_3 = \ldots )</td>
</tr>
<tr>
<td>( I_{\text{tot}} = I_1 = I_2 = I_3 = \ldots )</td>
<td>( I_{\text{tot}} = I_1 + I_2 + I_3 + \ldots )</td>
</tr>
<tr>
<td>( R_{\text{eq}} = R_1 + R_2 + R_3 + \ldots )</td>
<td>( 1/R_{\text{eq}} = 1/R_1 + 1/R_2 + \ldots )</td>
</tr>
<tr>
<td>( Q_{\text{tot}} = Q_1 = Q_2 = Q_3 = \ldots )</td>
<td>( Q_{\text{tot}} = Q_1 + Q_2 + Q_3 + \ldots )</td>
</tr>
<tr>
<td>( 1/C_{\text{eq}} = 1/C_1 + 1/C_2 + \ldots )</td>
<td>( C_{\text{eq}} = C_1 + C_2 + C_3 + \ldots )</td>
</tr>
</tbody>
</table>

Sec 5:

Electric Power: \( P = VI = I^2R = V^2/R \) \( \text{ (Recall, } P = W/t = \text{ (energy delivered)}/t) \)

EMF (Electromotive "force", in volts): \( E = \text{(energy form source)}/q \)

Loop rule: \( \Sigma \text{ potential changes around a closed loop} = 0 \)
\( \text{ (increase = pos, decrease = neg, where + side is higher V) } \)

Point rule: Total current into a point = total current out.
sec. 6:
Unit vector = $\cos \theta \hat{i} + \sin \theta \hat{j}$

(No other formulas are new.)

Sec. 7: Know how $\vec{B}$'s direction is defined.

Force on a moving charge: $\vec{F} = q(\vec{v} \times \vec{B})$

Charge circling in a B field: $|F_{\text{centripetal}}| = |F_{\text{magnetic}}|$ (F = $mv^2/r$)

Force on a wire: $\vec{F} = I(\vec{l} \times \vec{B})$

$\vec{l}$'s magnitude = wire's length, $\vec{l}$'s direction = direction of current

Lorentz force equation: $\vec{F} = q\vec{E} + q(\vec{v} \times \vec{B})$

Torque on current loop: $\vec{\tau} = \vec{\mu} \times \vec{B}$

where magnetic moment = $\vec{\mu} = I\vec{A}$

direction of $\vec{\mu}$ & $\vec{A}$:

Sec. 8:
Ampere's law: $\sum_{\text{closed loop}} (B \text{ on path})(\text{length of path})(\cos \theta) = \mu_0(\text{total current through loop})$

(If field or angle vary from point to point, $\oint B \cdot ds = \mu_0 I$ .)

Around a long straight wire: $B = \frac{\mu_0 I}{2\pi r}$

Inside a solenoid of length L:

$B = \frac{\mu_0 IN}{L}$

On axis of a flat coil, N turns:

$B = \frac{N\mu_0 I R^2}{2(R^2 + x^2)^{3/2}}$

In a toroidal coil of circumference $2\pi r$:

$B = \frac{\mu_0 IN}{2\pi r}$

Sec. 9:
Faraday's Law of Induction: $\mathcal{E} = -N\frac{d\Phi_B}{dt}$

Magnetic flux, $\Phi_B$: Replace E with B in $\Phi_E$ equation, sec. 3
Maxwell's Equations (If field or angle vary from point to point, replace $\sum$ with $\oint$):

Gauss: $\sum_{\text{closed surface}} (E \text{ on surface})(A \text{ of surface})(\cos \theta) = \frac{1}{\varepsilon_0}$ (charge in surface)

Gauss for Magnetism: $\sum_{\text{closed surface}} (B \text{ on surface})(A \text{ of surface})(\cos \theta) = 0$

Faraday: $\sum_{\text{closed loop}} (E \text{ on path})(\text{length of path})(\cos \theta) = -\frac{d}{dt}$ (magnetic flux through loop)

Ampere-Maxwell:

$\sum_{\text{closed loop}} (B \text{ on path})(\text{length of path})(\cos \theta) = \mu_0(\text{total current through loop}) + \mu_0\varepsilon_0 \frac{d}{dt}$ (electric flux through loop)

Sec. 10:

Lenz's Law: Direction of induced current is such that coil's own B field opposes the change in flux.

Dielectric constant: $\kappa = \frac{C}{C_0}$

$C_0 = \text{capacitance with nothing, } C = \text{capacitance with dielectric}$

Permittivity: $\varepsilon = \kappa\varepsilon_0$ ($\varepsilon$ replaces $\varepsilon_0$ in all equations when a material medium is present.)

Magnetic permeability: $\mu$ replaces $\mu_0$ in all equations when a material medium is present.)

Self inductance, L:

$\mathcal{E} = -L \frac{dI}{dt}$

$\mathcal{E} = \text{induced emf}$

Mutual inductance, M:

$\mathcal{E}' = -M \frac{dI_2}{dt}$

Sec. 11:

LR circuits:

Time constant: $\tau = L/R = \text{time to get about 63\% (1-1/e) of the way to the final value.}$

Current decay: $I = I_0 e^{-t/\tau}$

Current building up: $I = (\mathcal{E}/R)(1 - e^{-t/\tau})$

RC circuits:

Time constant: $\tau = RC$

Discharging: $q = Q_0 e^{-t/\tau}$

Charging up: $q = C \mathcal{E}(1 - e^{-t/\tau})$

Find current from $I = dq/dt$, capacitor's voltage using $C = q/v$. (When discharging, $Q_0/C = V_0$.)

Energy stored in a capacitor: $U = \frac{1}{2} CV^2 = Q^2/(2C)$

Energy per unit volume in an E field: $u = \frac{1}{2} \varepsilon E^2$

Energy stored in an inductor: $U = \frac{1}{2} LI^2$

Energy per unit volume in a B field: $u = B^2/(2\mu)$
LC Circuits: \( q = Q_{\text{max}} \cos (\omega t + \phi) \)  
\[ \omega = \frac{1}{\sqrt{LC}} \]  
where \( \omega = 2\pi f \)

Find current from \( I = dq/dt \), and voltage using \( C = q/v \). (\( Q_{\text{max}}/C = V_{\text{max}} \)).

**LC circuits total energy:** \( U = \frac{1}{2} CV^2 + \frac{1}{2} LI^2 \)

Sec. 12:

General forms: \( i = I_{\text{max}} \sin (\omega t) \) \( v = V_{\text{max}} \sin (\omega t + \phi) \) \( \omega = 2\pi f \), \( \phi = \) phase angle

RMS current & voltage: \( I_{\text{RMS}} = \frac{I_{\text{max}}}{\sqrt{2}} \) \( V_{\text{RMS}} = \frac{V_{\text{max}}}{\sqrt{2}} \)

Resistor: \( V = IR \) (That is, \( V_{\text{RMS}} = IR_{\text{RMS}} \) and \( V_{\text{max}} = i_{\text{max}}R \)), \( v \) & \( i \) in phase.

Capacitor: \( V = IX_c \), capacitive reactance = \( X_c = 1/(\omega C) \), ELI ICE

Inductor: \( V = IX_L \), inductive reactance = \( X_L = \omega L \)

Circuit as a whole: \( V = IZ \), impedance \( Z = \sqrt{R^2 + (X_L - X_C)^2} \)

Sec. 13: From Phy 131: Heat flow when temperature changes: \( Q = mc \Delta T \)

Heat flow when state changes: \( Q = mL_f \) or \( Q = mL_v \)

Work done on a gas: \( W = -\int_{V_i}^{V_f} P \, dV = -(\text{Area under } P-V \text{ graph}) = -P \Delta V \) if \( P \) is constant

First Law of Thermo.: \( \Delta E_{\text{int}} = Q + W \)  
\( W = \text{Work Done on System.} \)

\( \Delta E_{\text{int}} = \text{Increase in Internal Energy} \) \( Q = \text{Heat Added} \)

Molar Heat Capacity: \( Q = nC\Delta T \)

For any Ideal Gas: \( \Delta E_{\text{int}} = nC_v \Delta T \), \( C_p - C_v = R \), \[ \gamma = \frac{C_p}{C_v} \]

\( C_p = \) constant pressure heat capacity, \( C_v = \) constant volume heat capacity
For a Monatomic Ideal Gas: \[ C_v = \frac{3}{2} R, \quad C_p = \frac{5}{2} R \]

Isobaric Process = No Pressure Change

Adiabatic (No Heat Flow) Process: \[ P V^{\gamma} = \text{constant} \quad \text{or} \quad TV^{\gamma - 1} = \text{constant} \]

Isothermal (No Temp. Change) Process: \[ \text{work} = (nRT) \ln\left( \frac{V_f}{V_i} \right) \]

**SEC. 14:** Know 2\textsuperscript{nd} law of Thermodynamics in terms of entropy and in terms of heat.

Work Done In A Cycle = Area Enclosed On P-V Diagram.

\[ Q_{in} = W + Q_{out} \]

Efficiency: \[ e = \frac{W}{Q_{in}} \]

Efficiency of Carnot Cycle: \[ e = 1 - \frac{T_{OUT}}{T_{IN}} \]

Change in Entropy for a Reversible Process: \[ \Delta S = \int_{i}^{f} \frac{dQ}{T} \]

Ideal Gas, Reversible Process: \[ \Delta S = nC_v \ln\left( \frac{T_f}{T_i} \right) + nR \ln\left( \frac{V_f}{V_i} \right) \]
Geometric Formulas:
(r = radius, h = height)

Circumference of a circle or sphere .......... \(2\pi r\)
Area of circle. .................................. \(\pi r^2\)
Area of a circular cylinder (excluding ends) .... \(2\pi rh\)
Area of a sphere ................................. \(4\pi r^2\)
Volume of a circular cylinder ................. \(\pi r^2 h\)
Volume of a sphere .............................. \((4/3)\pi r^3\)

Quadratic Formula: If \(ax^2 + bx + c = 0\) then \(x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}\)

Logarithms:
def.: if \(x = b^y\) then \(\log_b(x) = y\)
common log: \(\log = \log_{10}\)  natural log: \(\ln = \log_e\) where \(e = 2.71828\)
Properties (for log of any base):
\(\log(xy) = \log x + \log y\)  \(\log(x/y) = \log x - \log y\)
\(\log(x^a) = a \log x\)  \(\log_b(b^x) = x\)

Short Table of Integrals:
\[\int x^n \, dx = \frac{x^{n+1}}{n+1} + c \quad \text{if } n \neq -1\]
\[\int \sin(ax) \, dx = -\frac{1}{a} \cos ax + c\]
\[\int \frac{dx}{x} = \ln x + c\]
\[\int \cos(ax) \, dx = \frac{1}{a} \sin(ax) + c\]
\[\int e^{ax} \, dx = \frac{1}{a} e^{ax} + c\]
\[\int \sec^2(ax) \, dx = \frac{1}{a} \tan(ax) + c\]
\[\int \sin^2(ax) \, dx = \frac{x}{2} - \frac{\sin(2ax)}{4a} + c\]
\[\int \cos^2(ax) \, dx = \frac{x}{2} + \frac{\sin(2ax)}{4a} + c\]
\[\int \sin(ax)\cos(ax) \, dx = \frac{\sin^2(ax)}{2a} + c\]
Partial Derivatives:

Differentiate with respect to one variable, treating the others as constants.

example: \( z = x + x^2 y^3 \)

\[
\frac{\partial z}{\partial x} = 1 + (2x)y^3 \quad \frac{\partial z}{\partial y} = 0 + x^2(3y^2)
\]

Vector Multiplication:

\[
\hat{A} \cdot \hat{B} = A_x B_x + A_y B_y + A_z B_z
\]

\[
\hat{A} \times \hat{B} = A_x B_x + A_y B_y + A_z B_z
\]

Determinants:

\[
\begin{vmatrix}
    a_1 & a_2 & a_3 \\
    b_1 & b_2 & b_3 \\
    c_1 & c_2 & c_3 \\
\end{vmatrix} = a_1 \begin{vmatrix}
    b_2 & b_3 \\
    c_2 & c_3 \\
\end{vmatrix} - a_2 \begin{vmatrix}
    b_1 & b_3 \\
    c_1 & c_3 \\
\end{vmatrix} + a_3 \begin{vmatrix}
    b_1 & b_2 \\
    c_1 & c_2 \\
\end{vmatrix}
\]

\[
\begin{vmatrix}
    a & b \\
    c & d \\
\end{vmatrix} = ad - cb
\]

<table>
<thead>
<tr>
<th>Material</th>
<th>Dielectric Constant, k</th>
<th>Dielectric Strength (V/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacuum</td>
<td>1.000000</td>
<td>-</td>
</tr>
<tr>
<td>Air</td>
<td>1.00059</td>
<td>3 x 10^6</td>
</tr>
<tr>
<td>Bakelite</td>
<td>4.9</td>
<td>24 x 10^6</td>
</tr>
<tr>
<td>Fused quartz</td>
<td>3.78</td>
<td>8 x 10^6</td>
</tr>
<tr>
<td>Pyrex glass</td>
<td>5.6</td>
<td>14 x 10^6</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>2.56</td>
<td>24 x 10^6</td>
</tr>
<tr>
<td>Teflon</td>
<td>2.1</td>
<td>60 x 10^6</td>
</tr>
<tr>
<td>Neoprene rubber</td>
<td>6.7</td>
<td>12 x 10^6</td>
</tr>
<tr>
<td>Nylon</td>
<td>3.4</td>
<td>14 x 10^6</td>
</tr>
<tr>
<td>Paper</td>
<td>3.7</td>
<td>16 x 10^6</td>
</tr>
<tr>
<td>Strontium titanate</td>
<td>233</td>
<td>8 x 10^6</td>
</tr>
<tr>
<td>Water</td>
<td>80</td>
<td>-</td>
</tr>
<tr>
<td>Silicone oil</td>
<td>2.5</td>
<td>15 x 10^6</td>
</tr>
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</table>
Molar Heat Capacities of gasses:

<table>
<thead>
<tr>
<th>Monatomic:</th>
<th>Diatomic:</th>
<th>Polyatomic:</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_p (J/mol-K)</td>
<td>C_v (J/mol-K)</td>
<td>γ</td>
</tr>
<tr>
<td>C_p (J/mol-K)</td>
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<td>γ</td>
</tr>
<tr>
<td>C_p (J/mol-K)</td>
<td>C_v (J/mol-K)</td>
<td>γ</td>
</tr>
<tr>
<td>He 20.8</td>
<td>12.5</td>
<td>1.67</td>
</tr>
<tr>
<td>H_2 28.7</td>
<td>20.4</td>
<td>1.41</td>
</tr>
<tr>
<td>CO_2 36.9</td>
<td>28.5</td>
<td>1.30</td>
</tr>
<tr>
<td>Ar 20.8</td>
<td>12.5</td>
<td>1.67</td>
</tr>
<tr>
<td>N_2 29.1</td>
<td>20.8</td>
<td>1.40</td>
</tr>
<tr>
<td>SO_2 40.4</td>
<td>31.4</td>
<td>1.29</td>
</tr>
<tr>
<td>Ne 20.8</td>
<td>12.7</td>
<td>1.64</td>
</tr>
<tr>
<td>O_2 29.2</td>
<td>20.9</td>
<td>1.40</td>
</tr>
<tr>
<td>H_2O 35.4</td>
<td>27.0</td>
<td>1.30</td>
</tr>
<tr>
<td>Kr 20.8</td>
<td>12.3</td>
<td>1.69</td>
</tr>
<tr>
<td>CO 29.2</td>
<td>20.9</td>
<td>1.40</td>
</tr>
<tr>
<td>CH_4 35.5</td>
<td>27.1</td>
<td>1.31</td>
</tr>
<tr>
<td>Cl_2 34.7</td>
<td>25.7</td>
<td>1.35</td>
</tr>
</tbody>
</table>

Some physical constants:

Elementary charge: \( e = 1.602 \times 10^{-19} \text{C} \)

Permittivity of free space: \( \varepsilon_0 = 8.854 \times 10^{-12} \text{C}^2/\text{N}\cdot\text{m}^2 \)

\[
\frac{1}{4\pi\varepsilon_0} = 8.988 \times 10^9 \text{N}\cdot\text{m}^2/\text{C}^2
\]

Gravitational constant: \( G = 6.672 \times 10^{-11} \text{N}\cdot\text{m}^2/\text{kg}^2 \)

Speed of light in a vacuum: \( c = 2.998 \times 10^8 \text{m/s} \)

Electron mass: \( m_e = 9.110 \times 10^{-31} \text{kg} \)

Proton mass: \( m_p = 1.673 \times 10^{-27} \text{kg} \)

Permeability of free space: \( \mu_0 = 4\pi \times 10^{-7} \text{N/A}^2 \)

Universal Gas Constant: \( R = 8.314 \text{J/mole-K} \)

SI prefixes:

<table>
<thead>
<tr>
<th>Power:</th>
<th>Prefix:</th>
<th>Abbreviation:</th>
<th>Power:</th>
<th>Prefix:</th>
<th>Abbreviation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10^{-24})</td>
<td>yocto</td>
<td>y</td>
<td>(10^1)</td>
<td>deka</td>
<td>da</td>
</tr>
<tr>
<td>(10^{-21})</td>
<td>zepto</td>
<td>z</td>
<td>(10^2)</td>
<td>hecto</td>
<td>h</td>
</tr>
<tr>
<td>(10^{-18})</td>
<td>atto</td>
<td>a</td>
<td>(10^3)</td>
<td>kilo</td>
<td>k</td>
</tr>
<tr>
<td>(10^{-15})</td>
<td>femto</td>
<td>f</td>
<td>(10^6)</td>
<td>mega</td>
<td>M</td>
</tr>
<tr>
<td>(10^{-12})</td>
<td>pico</td>
<td>p</td>
<td>(10^9)</td>
<td>giga</td>
<td>G</td>
</tr>
<tr>
<td>(10^{-9})</td>
<td>nano</td>
<td>n</td>
<td>(10^{12})</td>
<td>tera</td>
<td>T</td>
</tr>
<tr>
<td>(10^{-6})</td>
<td>micro</td>
<td>µ</td>
<td>(10^{15})</td>
<td>peta</td>
<td>P</td>
</tr>
<tr>
<td>(10^{-3})</td>
<td>milli</td>
<td>m</td>
<td>(10^{18})</td>
<td>exa</td>
<td>E</td>
</tr>
<tr>
<td>(10^{-2})</td>
<td>centi</td>
<td>c</td>
<td>(10^{21})</td>
<td>zetta</td>
<td>Z</td>
</tr>
<tr>
<td>(10^{-1})</td>
<td>deci</td>
<td>d</td>
<td>(10^{24})</td>
<td>yotta</td>
<td>Y</td>
</tr>
</tbody>
</table>
Fundamental Units:

<table>
<thead>
<tr>
<th>Standard SI Unit and Abbreviation</th>
<th>Conversion Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>LENGTH</td>
<td>meter = m</td>
</tr>
<tr>
<td></td>
<td>1 m = 3.28 ft, 1 mile = 1609 m = 5280 ft</td>
</tr>
<tr>
<td></td>
<td>1 Angstrom = 10^{-10} m, 1 inch = 2.54 cm</td>
</tr>
<tr>
<td>TIME</td>
<td>second = s</td>
</tr>
<tr>
<td></td>
<td>1 hour = 3600 s, 1 day = 86,400 s</td>
</tr>
<tr>
<td></td>
<td>1 year = 3.16 x 10^7 s</td>
</tr>
<tr>
<td>MASS</td>
<td>kilogram = kg</td>
</tr>
<tr>
<td></td>
<td>1 kg = 0.0685 slug, weighs 2.21 lb in standard gravity</td>
</tr>
<tr>
<td></td>
<td>1 unified mass unit = 1 u = 1.66 x 10^{-27} kg</td>
</tr>
<tr>
<td>CURRENT</td>
<td>ampere = C/s = A</td>
</tr>
<tr>
<td>TEMPERATURE</td>
<td>kelvin = k</td>
</tr>
<tr>
<td></td>
<td>T (in kelvins) = T (in Celsius) + 273.15</td>
</tr>
</tbody>
</table>

Derived Units

| VOLUME                            | m^3               |
|                                   | 1 Liter = 10^{-3} m^3 = 10^{-3} cm^3 |
| SPEED                             | m/s               |
|                                   | 1 mi/hr = 0.447 m/s = 1.47 ft/sec |
| FORCE                             | newton = N        |
|                                   | 1 N = 0.225 pound |
| ENERGY & WORK                    | joule = J         |
|                                   | 1 calorie = 4.186 J 1 J = 0.738 ft lb |
|                                   | 1 electronvolt = 1.602 x 10^{-19} J, 1 BTU = 252 cal |
| POWER                             | watt = W          |
|                                   | 1 horsepower = 746 W = 550 ft-lb/sec |
| ANGLE                             | radian = rad      |
|                                   | 1 revolution = 360° = 2π rad |
| FREQUENCY                        | hertz = Hz        |
|                                   | 1 Hz = 60 rev/min = 1 cycle/sec |
| IMPULSE & MOMENTUM               | kg·m/s = N·S      |
| PRESSURE                          | pascal = N/m²     |
|                                   | 1 atmosphere = 1.013 x 10^5 Pa = 14.7 lb/in² |
| CHARGE                            | coulomb = C       |
| ELECTRIC FIELD                   | N/C = V/m         |
| POTENTIAL                         | volt = V          |
| CAPACITANCE                       | farad = F         |
| RESISTANCE                        | ohm = Ω           |
| REACTANCE & IMPEDANCE            |                   |
| ELECTRIC FLUX                     | N·m²/C = V·m      |
| MAGNETIC FLUX                     | weber = Wb        |
| MAGNETIC FIELD                   | Wb/m² = tesla = T |
|                                   | 1 T = 10^4 gauss  |
| INDUCTANCE                        | henry = H         |