The Definitive Physics Definition List

Engineers of Dubious Quality

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1 Measurements

Express errors/uncertainties to 1 s.f. and write the measured value to the same decimal place as its error/uncertainty

Systematic Error	An error that occurs consistently more or consistently less than the actual reading.
Random Error	An error that occurs as a scattering (or spreading) of readings about the average or mean value of the measurements.
Precision	The ***reproducibility*** of a measurement. Repeated measurements which are very close to one another are precise measurements. Thus an experiment which has ***small random errors*** (i.e. small spread of readings) is said to have ***high precision***.
Accuracy	The ***agreement*** between the measured value and the true or accepted value of a quantity. An experiment which has ***small systematic errors*** is said to have ***high accuracy***. The ***average value*** is close to the true value.
Vector Quantity	A quantity that has a ***magnitude and direction***.
Scalar Quantity	A quantity that has a magnitude only.

2 Kinematics

We define a coordinate system with defined reference positive directions and we assume constant acceleration.

Displacement	$\mathbf{s}$	The distance travelled in a stated direction from a reference point.
Velocity	$\mathbf{v} = \dfrac{d\mathbf{s}}{dt}$	The rate of change of displacement with respect to time.
Speed	$v = \lvert\mathbf{v}\rvert = \left\lvert\dfrac{d\mathbf{s}}{dt}\right\rvert$	The rate of change of distance travelled with respect to time.
Acceleration	$\mathbf{a} = \dfrac{d\mathbf{v}}{dt} = \dfrac{d^2\mathbf{s}}{dt^2}$	The rate of change of velocity with respect to time.

3 Dynamics

3.1 Newton's Laws of Motion

1st Law	A body will continue in its ***state of rest***, or ***move*** at ***constant speed in a stright line*** unless an ***external resultant force*** acts on it.
→ Inertia	The resistance to change in the state of motion of an object
→ Mass	A property of that determines the objects inertia.
2nd Law	The ***rate of change of linear momentum*** of a body is ***directly proportional*** to the resultant force acting on it, and its direction is in the ***same direction*** as this resultant force. The ***force acting on an object*** is defined as the ***rate of change of linear momentum*** of an object. $$F \propto \frac{dp}{dt},\ F = ma \text{ (if constant mass)}$$
3rd Law	If body A exerts a force on body B, then body B will exert an ***equal and opposite*** force on body A. *Note:* Action-Reaction Pairs act on different bodies and are of the same nature.
Weight	The gravitational force acting on the object.
Weightlessness	There is no contact force acting on the object. *A body experiences apparent weightlessness when the resultant force acting on it is its weight, or it is undergoing freefall.*

3.2 Momentum

Linear Momentum	$\mathbf{p} = m\mathbf{v}$	The product of an object's mass and its velocity.
Impulse	$\mathbf{J} = \int_{t1}^{t2} \mathbf{F}\, dt = P_f - P_i$	The product of the average force acting on an object and the time interval that the force is being applied.
Principle of Conservation of Linear Momentum	The total momentum of the system is a constant when no external resultant force acts on it.	

4 Forces

Pressure due to Fluid	$\Delta P = h\rho g$	The force acting per unit area by the fluid on a body submerged at a depth in the fluid.
Upthrust	$U = m_f g = \rho V_{dis} g$	The ***net force exerted by a fluid*** on a body submerged in the fluid.
Principle of Floatation	$mg = U = \rho V_{dis} g$	This holds true for an object floating in equillibrium in a fluid.
Drag	$\mathbf{F_D} = k\mathbf{v}$ (Laminar Flow)	It is the force resisting an object ***moving relative to a fluid***. It always ***opposes*** motion, and its magnitude is ***dependent on the velocity*** of the object.
Moment of a force (Torque)	$\boldsymbol{\tau} = \mathbf{r} \times \mathbf{F}$	Moment of a force about a point (the pivot) is the ***product*** of the magnitude of the force and the ***perpendicular distance*** of the ***line of action*** of the force to the point.
Couple	A couple always consists of 2 parallel forces which are equal in magnitude and opposite in direction (their lines of action fo not coincide)	
Torque of a couple	The ***product*** of the ***magnitude of one of the forces*** of the couple and the ***perpendicular distance between the forces.***	
Center of gravity of a body	It is the point at which the weight of the body appears to act.	

4.1 Equilibrium of Forces

For a rigid body to be in static equilibrium, 2 conditions must be satisfied:

1. **Translational equilibrium**
The **net external** force acting on the body is zero.

$$\sum F = 0$$

2. **Rotational Equilibrium**
The **net torque** on the body about **ANY** **point** is zero.

$$\sum \tau = 0$$

For a 3-forces system in static equilibrium, the 3 forces for *a closed vector triangle.* For 3 forces acting on an *extended body* in static equilibrium, the lines of action of the 3 forces *must intersect at a common point* unless the 3 forces are parallel.

5 Work, Energy, and Power

6 Circular Motion

7 Gravitation

8 Oscillations

9 Waves

10 Superposition

11 Thermal Physics

Temperature	T	The average kinetic energy the molecules in a system possess.
Heat	Q	Transfer of thermal energy from regions of higher to lower temperature.
Thermal Equilibrium		2 objects in thermal contact with no net exchange of heat.
Kelvin Scale		Absolute temperature scale independent of thermometric properties.
Absolute Zero	0K	All molecules possess minimal internal energy.
Specific Heat Capacity	C	Amount of thermal energy per unit substance to increase the temperature of the unit substance by one unit of temperature.
Specific latent heat of fusion	L_f	Amount of **thermal energy per unit mass** to convert the substance from solid to liquid without any change in temperature.
Specific latent heat of vaporisation	L_v	Amount of **thermal energy per unit mass** to convert the substance from liquid to gas without any change in temperature.
Internal Energy	U	Sum of microscopic random kinetic energy and microscopic potential energy of molecules in system. For ideal gases: $$U = \frac{3}{2}\, nRT$$

11.1 Laws of Thermodynamics

0^{th}	If two systems are in thermal equilibrium with a third system, they are in thermal equilibrium with each other.
1^{st}	Increase in internal energy of system is sum of heat absorbed by system and work done on system. $$\Delta U = Q + W_{on}$$

We need not know the 3^{rd} and 4^{th} laws.

11.2 PV Graphs

We assume, for the following, that the arrow points towards the positive-V direction.

Isobaric	Constant Pressure	$W_{on} < 0\,,\ \Delta U > 0$
Isochoric	Constant Volume	$W_{on} = 0\,,\ \Delta U > 0$
Isothermal	Constant Temperature	$W_{on} < 0\,,\ \Delta U = 0$
Adiabatic	Thermally Insulated	$W_{on} < 0\,,\ Q = 0$
Cyclic	Start and end at the same state	$\Delta U = 0$

12 Electric Fields

Electric Field	$E = \dfrac{Q}{4\pi\varepsilon_0 r^2}$	Electric force per unit charge acting on small positive test charge at that point
Coulomb's Law	$F_E = \dfrac{\lvert Q_1\rvert\lvert Q_2\rvert}{4\pi\varepsilon_0 r^2}$	Magnitude of the electric force between 2 point charges is directly proportional to the product of the magnitude of their charges and inversely proportional to square of their distance $$F_E = qE$$
Electric Potential	$V = \dfrac{Q}{4\pi\varepsilon_0 r}$	**Work done per unit charge** by external force to bring small positive test charge from infinity to that point in an electric field without change in kinetic energy
Electric Potential Energy	$U = \dfrac{Q_1 Q_2}{4\pi\varepsilon_0 r}$	**Work done** by external force to bring small positive test charge from infinity to that point in an electric field without change in kinetic energy $$U = qV$$

13 Current of Electricity

14 DC Circuits

15 EM and EMI

16 Alternating Current

17 Quantum Physics

18 Lasers and Semiconductors

19 Nuclear Physics