

# Physics

## DATA SHEET

Charge on electron, $q_e$	$-1.602 \times 10^{-19} \text{ C}$
Mass of electron, $m_e$	$9.109 \times 10^{-31} \text{ kg}$
Mass of neutron, $m_n$	$1.675 \times 10^{-27} \text{ kg}$
Mass of proton, $m_p$	$1.673 \times 10^{-27} \text{ kg}$
Speed of sound in air	$340 \text{ m s}^{-1}$
Earth's gravitational acceleration, $g$	$9.8 \text{ m s}^{-2}$
Speed of light, $c$	$3.00 \times 10^8 \text{ m s}^{-1}$
Electric permittivity constant, $\epsilon_0$	$8.854 \times 10^{-12} \text{ A}^2 \text{ s}^4 \text{ kg}^{-1} \text{ m}^{-3}$
Magnetic permeability constant, $\mu_0$	$4\pi \times 10^{-7} \text{ N A}^{-2}$
Universal gravitational constant, $G$	$6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
Mass of Earth, $M_E$	$6.0 \times 10^{24} \text{ kg}$
Radius of Earth, $r_E$	$6.371 \times 10^6 \text{ m}$
Planck constant, $h$	$6.626 \times 10^{-34} \text{ J s}$
Rydberg constant, $R$ (hydrogen)	$1.097 \times 10^7 \text{ m}^{-1}$
Atomic mass unit, $u$	$1.661 \times 10^{-27} \text{ kg}$ $931.5 \text{ MeV}/c^2$
1 eV	$1.602 \times 10^{-19} \text{ J}$
Density of water, $\rho$	$1.00 \times 10^3 \text{ kg m}^{-3}$
Specific heat capacity of water	$4.18 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$
Wien's displacement constant, $b$	$2.898 \times 10^{-3} \text{ m K}$

## FORMULAE SHEET

### Motion, forces and gravity

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$\Delta U = mg\Delta h$$

$$P = \frac{\Delta E}{\Delta t}$$

$$\sum \frac{1}{2}mv_{\text{before}}^2 = \sum \frac{1}{2}mv_{\text{after}}^2$$

$$\Delta \vec{p} = \vec{F}_{\text{net}} \Delta t$$

$$\omega = \frac{\Delta \theta}{t}$$

$$\tau = r_{\perp} F = rF \sin \theta$$

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

$$U = -\frac{GMm}{r}$$

$$v = u + at$$

$$\vec{F}_{\text{net}} = m\vec{a}$$

$$W = F_{\parallel} s = Fs \cos \theta$$

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

$$P = F_{\parallel} v = Fv \cos \theta$$

$$\sum m\vec{v}_{\text{before}} = \sum m\vec{v}_{\text{after}}$$

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

$$F_c = \frac{mv^2}{r}$$

$$F = \frac{GMm}{r^2}$$

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

### Waves and thermodynamics

$$v = f\lambda$$

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

$$d \sin \theta = m\lambda$$

$$n_x = \frac{c}{v_x}$$

$$I = I_{\text{max}} \cos^2 \theta$$

$$Q = mc\Delta T$$

$$f_{\text{beat}} = |f_2 - f_1|$$

$$f' = f \frac{(v_{\text{wave}} + v_{\text{observer}})}{(v_{\text{wave}} - v_{\text{source}})}$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\sin \theta_c = \frac{n_2}{n_1}$$

$$I_1 r_1^2 = I_2 r_2^2$$

$$\frac{Q}{t} = \frac{kA\Delta T}{d}$$

# FORMULAE SHEET (continued)

## Electricity and magnetism

$$E = \frac{V}{d}$$

$$V = \frac{\Delta U}{q}$$

$$W = qV$$

$$W = qEd$$

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

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

$$\Phi = B_{\parallel} A = BA \cos \theta$$

$$\mathcal{E} = -N \frac{\Delta \Phi}{\Delta t}$$

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

$$\vec{F} = q\vec{E}$$

$$F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$$

$$I = \frac{q}{t}$$

$$V = IR$$

$$P = VI$$

$$F = qv_{\perp} B = qvB \sin \theta$$

$$F = Il_{\perp} B = lIB \sin \theta$$

$$\frac{F}{l} = \frac{\mu_0}{2\pi} \frac{I_1 I_2}{r}$$

$$\tau = nIA_{\perp} B = nIAB \sin \theta$$

$$V_p I_p = V_s I_s$$

## Quantum, special relativity and nuclear

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

$$K_{\max} = hf - \phi$$

$$\lambda_{\max} = \frac{b}{T}$$

$$E = mc^2$$

$$E = hf$$

$$\frac{1}{\lambda} = R \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$t = \frac{t_0}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

$$l = l_0 \sqrt{\left(1 - \frac{v^2}{c^2}\right)}$$

$$p_v = \frac{m_0 v}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

$$N_t = N_0 e^{-\lambda t}$$

$$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$$

PERIODIC TABLE OF THE ELEMENTS

1 H 1.008 Hydrogen		KEY										2 He 4.003 Helium			
3 Li 6.941 Lithium	4 Be 9.012 Beryllium		Atomic Number Symbol		79 Au 197.0 Gold		Standard Atomic Weight Name		5 B 10.81 Boron		6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	
	11 Na 22.99 Sodium		12 Mg 24.31 Magnesium						13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon	
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.38 Zinc				36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.61 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.96 Molybdenum	43 Tc Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids		72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	
87 Fr Francium	88 Ra Radium	Actinoids		104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium	114 Fl Flerovium	
														115 Mc Moscovium	
														116 Lv Livermorium	
														117 Ts Tennessee	
														118 Og Oganesson	

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.1 Ytterbium	71 Lu 175.0 Lutetium
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Actinoids

89 Ac Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium
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Standard atomic weights are abridged to four significant figures.  
Elements with no reported values in the table have no stable nuclides.

Information on elements with atomic numbers 113 and above is sourced from the International Union of Pure and Applied Chemistry Periodic Table of the Elements (November 2016 version).  
The International Union of Pure and Applied Chemistry Periodic Table of the Elements (February 2010 version) is the principal source of all other data. Some data may have been modified.