PHYSICAL SCIENCES

DATA AND FORMULAE FOR THE PHYSICAL SCIENCES PAPER I (PHYSICS)

DATA FOR THE PHYSICAL SCIENCES PAPER 2 (CHEMISTRY)

TABLE 1   PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Approximate magnitude of acceleration due to gravity	g	10 m·s^{-2}
Speed of light in a vacuum	c	$3{,}0 \times 10^8 \text{ m·s}^{-1}$
Gravitational Constant	G	$6{,}7 \times 10^{-11} \text{ N·m}^2\text{·kg}^{-2}$
Magnitude of charge on electron	e	$1{,}6 \times 10^{-19} \text{ C}$
Mass of an electron	m_e	$9.1 \times 10^{-31} \text{ kg}$
Permittivity of free space	ε_o	$8{,}9 \times 10^{-12} \text{ F·m}^{-1}$
Planck's constant	h	$6{,}6 \times 10^{-34} \text{ J·s}$
1 electron volt	1 eV	$1{,}6 \times 10^{-19} \text{ J}$

TABLE 2   FORMULAE

MOTION

$$v_f = v_i + a\Delta t \qquad v = u + a\Delta t \qquad \Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t \qquad s = \left(\frac{v + u}{2}\right)\Delta t$$

$$v_f{}^2 = v_i{}^2 + 2a\Delta x \qquad v^2 = u^2 + 2as \qquad \Delta x = v_i\Delta t + \tfrac{1}{2}a(\Delta t)^2 \qquad s = u\Delta t + \tfrac{1}{2}a(\Delta t)^2$$

FORCE

$$F = \frac{Gm_1 m_2}{r^2} \qquad\qquad F = \mu_s F_N \qquad\qquad F = \mu_k F_N$$

$$p = mv \qquad\qquad F_{net} = \frac{\Delta p}{\Delta t}$$

$$F_{net}\Delta t = m\Delta v \qquad\qquad F_{net} = ma \qquad\qquad F_g = mg$$

$$\tau = F_\perp r \qquad\qquad MA = \frac{F_L}{F_A}$$

WORK, ENERGY AND POWER

$$W = F\Delta x \quad \text{or} \quad W = Fs \qquad\qquad E_p = mgh$$

$$P = \frac{W}{t} \qquad\qquad Ek = \tfrac{1}{2}mv^2$$

$$P = Fv$$

WAVES, LIGHT AND SOUND

$$v = f\lambda$$

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

$$\sin\theta_n = \frac{n\lambda}{w}$$

$$f_o = \left(\frac{v}{v - v_s}\right)f_s \quad \text{or} \quad f_o = \left(\frac{v}{v + v_s}\right)f_s$$

$$E = hf$$

$$E = \frac{hc}{\lambda}$$

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

$$E = W_f + \tfrac{1}{2}mv^2$$

ELECTROSTATICS

$$F = \frac{kQ_1Q_2}{r^2} \qquad (k = 9 \times 10^9 \text{ N·m}^2\text{·C}^{-2})$$

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

$$E = \frac{F}{Q}$$

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

$$E = \frac{kQ}{r^2} \qquad (k = 9 \times 10^9 \text{ N·m}^2\text{·C}^{-2})$$

$$C = \frac{Q}{V}$$

$$C = \varepsilon_o \frac{A}{d}$$

ELECTROMAGNETISM

$$emf = -N\frac{\Delta\Phi}{\Delta t}$$

$$\Phi = BA$$

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

$$F = qvB$$

CURRENT ELECTRICITY

$$Q = I\Delta t$$

$$R = \frac{V}{I}$$

$$R = R_1 + R_2 + R_3 + \ldots$$

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$P = VI = I^2R = \frac{V^2}{R}$$

$$emf = I(R + r)$$

ALTERNATING CURRENT

$$I_{rms} = \frac{I_{max}}{\sqrt{2}} \qquad \text{and} \qquad V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$X_C = \frac{1}{2\pi fC} \qquad \text{and} \qquad V_{rms} = I_{rms}X_C$$

$$X_L = 2\pi f L \qquad \text{and} \qquad V_{rms} = I_{rms}X_L$$

TABLE 1   PHYSICAL CONSTANTS

Avogadro's constant	N_A or L	$6,02 \times 10^{23}$ mol^{-1}
Molar gas constant	R	$8,31$ J.K^{-1}·mol^{-1}
Standard pressure	p^θ	$1,013 \times 10^5$ Pa
Molar gas volume at STP	V_m	$22,4$ dm^3·mol^{-1}
Standard temperature	T^θ	273 K

TABLE 2   FORMULAE

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$$

$$pV = nRT$$

$$n = \frac{m}{M}$$

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

$$c = \frac{m}{MV}$$

$$\frac{n_A}{n_B} = \frac{c_A V_A}{c_B V_B}$$

$$K_w = [H^+][OH^-] = 10^{-14} \quad \text{at 298 K}$$

$$pH = -\log[H^+]$$

$$E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$$

$$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$$

TABLE 3   PERIODIC TABLE

Key

Atomic number (Z) — $\begin{array}{l} 1 \quad 2.1 \\ \textbf{H} \\ 1 \end{array}$ — Electronegativity

Relative atomic mass

	I	II											III	IV	V	VI	VII	0
1	1 2.1 **H** 1																	2 **He** 4
2	3 1.0 **Li** 7	4 1.5 **Be** 9											5 2.0 **B** 10.8	6 2.5 **C** 12	7 3.0 **N** 14	8 3.5 **O** 16	9 4.0 **F** 19	10 **Ne** 20
3	11 0.9 **Na** 23	12 1.2 **Mg** 24.3											13 1.5 **Aℓ** 27	14 1.8 **Si** 28	15 2.1 **P** 31	16 2.5 **S** 32	17 3.0 **Cℓ** 35.5	18 **Ar** 40
4	19 0.8 **K** 39	20 1.0 **Ca** 40	21 1.3 **Sc** 45	22 1.5 **Ti** 48	23 1.6 **V** 51	24 1.6 **Cr** 52	25 1.5 **Mn** 55	26 1.8 **Fe** 56	27 1.8 **Co** 59	28 1.8 **Ni** 59	29 1.9 **Cu** 63.5	30 1.6 **Zn** 65.4	31 1.6 **Ga** 70	32 1.8 **Ge** 72.6	33 2.0 **As** 75	34 2.4 **Se** 79	35 2.8 **Br** 80	36 **Kr** 84
5	37 0.8 **Rb** 85.5	38 1.0 **Sr** 88	39 1.2 **Y** 89	40 1.4 **Zr** 91	41 1.6 **Nb** 93	42 1.8 **Mo** 96	43 1.9 **Tc** 99	44 2.2 **Ru** 101	45 2.2 **Rh** 103	46 2.2 **Pd** 106	47 1.9 **Ag** 108	48 1.7 **Cd** 112	49 1.7 **In** 115	50 1.8 **Sn** 119	51 1.9 **Sb** 121	52 2.1 **Te** 128	53 2.5 **I** 127	54 **Xe** 131
6	55 **Cs** 133	56 **Ba** 137.3		72 **Hf** 178.5	73 **Ta** 181	74 **W** 184	75 **Re** 186	76 **Os** 190	77 **Ir** 192	78 **Pt** 195	79 **Au** 197	80 **Hg** 200.6	81 **Tℓ** 204.4	82 **Pb** 207	83 **Bi** 209	84 **Po** -	85 **At** -	86 **Rn** -
7	87 **Fr**	88 **Ra**																

57 **La**	58 **Ce**	59 **Pr**	60 **Nd**	61 **Pm**	62 **Sm**	63 **Eu**	64 **Gd**	65 **Tb**	66 **Dy**	67 **Ho**	68 **Er**	69 **Tm**	70 **Yb**	71 **Lu**
89 **Ac**	90 **Th**	91 **Pa**	92 **U**	93 **Np**	94 **Pu**	95 **Am**	96 **Cm**	97 **Bk**	98 **Cf**	99 **Es**	100 **Fm**	101 **Md**	102 **No**	103 **Lw**

TABLE 4   STANDARD ELECTRODE POTENTIALS

Half –reaction			E°/ volt
$Li^+ + e^-$	$\rightleftharpoons$	Li	-3.05
$K^+ + e^-$	$\rightleftharpoons$	K	-2.93
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	-2.92
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	-2.90
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	-2.89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	-2.87
$Na^+ + e^-$	$\rightleftharpoons$	Na	-2.71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	-2.37
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	-1.66
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	-1.18
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	-0.83
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	-0.76
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	-0.74
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	-0.44
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	-0.40
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	-0.28
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	-0.25
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	-0.14
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	-0.13
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	-0.04
$2H^+ + 2e^-$	$\rightleftharpoons$	$H_2(g)$	0.00
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+0.14
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+0.15
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+0.16
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+0.17
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+0.34
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+0.40
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+0.45
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+0.54
$O_2(g) + 2H^+ + e^-$	$\rightleftharpoons$	H_2O_2	+0.68
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+0.77
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	Hg	+0.79
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+0.80
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+0.80
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+0.96
$Br_2 + 2e^-$	$\rightleftharpoons$	$2Br^-$	+1.09
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+1.20
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+1.21
$O_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+1.23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+1.33
$C\ell_2 + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+1.36
$Au^{3+} + 3e^-$	$\rightleftharpoons$	Au	+1.42
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+1.51
$H_2O_2 + 2H^+ + e^-$	$\rightleftharpoons$	$2H_2O$	+1.77
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+2.87

Increasing oxidising ability ↓

Increasing reducing ability ↑