ภาคผนวก

ตารางที่ 1 หน่วยเอสไอและค่าคงที่ต่าง ๆ

Physical quantity	*Old unit*	*Value in SI units*
energy	calorie (thermochemical)	4·184 J (joule)
	*electronvolt—eV	$1{\cdot}602 \times 10^{-19}$ J
	*electronvolt per molecule	96·48 kJ mol^{-1}
	erg	10^{-7} J
	*wave number—cm^{-1}	$1{\cdot}986 \times 10^{-23}$ J
entropy (S)	eu = cal g^{-1} $°C^{-1}$	4184 J kg^{-1} K^{-1}
force	dyne	10^{-5} N (newton)
pressure (P)	atmosphere	$1{\cdot}013 \times 10^{5}$ Pa (pascal), or N m^{-2}
	torr = mmHg	133·3 Pa
dipole moment (μ)	debye—D	$3{\cdot}334 \times 10^{-30}$ C m
magnetic flux density (H)	*gauss—G	10^{-4} T (tesla)
frequency (ν)	cycle per second	1 Hz (hertz)
relative permittivity (ε)	dielectric constant	1
temperature (T)	*°C and °K	1 K (kelvin); 0 °C = 273·2 K

(* indicates permitted non-SI unit)

Multiples of the base units are illustrated by length

fraction	10^{9}	10^{6}	10^{3}	1	(10^{-2})	10^{-3}	10^{-6}	10^{-9}	(10^{-10})	10^{-12}
prefix	giga-	mega-	kilo-	metre	(centi-)	milli-	micro-	nano-	(*ångstrom)	pico-
unit	Gm	Mm	km	m	(cm)	mm	μm	nm	(*Å)	pm

The fundamental constants

Avogadro constant	L or N_A	$6{\cdot}022 \times 10^{23}$ mol^{-1}
Bohr magneton	μ_B	$9{\cdot}274 \times 10^{-24}$ J T^{-1}
Bohr radius	a_0	$5{\cdot}292 \times 10^{-11}$ m
Boltzmann constant	k	$1{\cdot}381 \times 10^{-23}$ J K^{-1}
charge of a proton (charge of an electron = $-e$)	e	$1{\cdot}602 \times 10^{-19}$ C
Faraday constant	F	$9{\cdot}649 \times 10^{4}$ C mol^{-1}
gas constant	R	8·314 J K^{-1} mol^{-1}
nuclear magneton	μ_N	$5{\cdot}051 \times 10^{-27}$ J T^{-1}
permeability of a vacuum	μ_0	$4\pi \times 10^{-7}$ H m^{-1} or N A^{-2}
permittivity of a vacuum	ε_0	$8{\cdot}854 \times 10^{-12}$ F m^{-1}
Planck constant	h	$6{\cdot}626 \times 10^{-34}$ J s
(Planck constant)/2π	$\hbar$	$1{\cdot}055 \times 10^{-34}$ J s
rest mass of electron	m_e	$9{\cdot}110 \times 10^{-31}$ kg
rest mass of proton	m_p	$1{\cdot}673 \times 10^{-27}$ kg
speed of light in a vacuum	c	$2{\cdot}998 \times 10^{8}$ m s^{-1}

$\ln 10 = 2{\cdot}303$ $\quad \ln x = 2{\cdot}303 \lg x$ $\quad \lg e = 0{\cdot}4343$ $\quad \pi = 3{\cdot}142$

$R \ln 10 = 19{\cdot}14$ J K^{-1} mol^{-1} $\quad RTF^{-1} \ln 10 = 59{\cdot}16$ mV at 298·2 K

ตารางที่ 2 ศักย์ไฟฟ้าอิเล็กโตรดมาตรฐาน ที่ 25°C

Electrode	E°	Half Cell Reaction
$Li^+ \mid Li$	−3.045	$Li^+ + e = Li$
$K^+ \mid K$	−2.925	$K^+ + e = K$
$Na^+ \mid Na$	−2.714	$Na^+ + e = Na$
$Mg^{2+} \mid Mg$	−2.37	$\frac{1}{2}Mg^{2+} + e = \frac{1}{2}Mg$
$Th^{4+} \mid Th$	−1.90	$\frac{1}{4}Th^{4+} + e = \frac{1}{4}Th$
$Al^{3+} \mid Al$	−1.66	$\frac{1}{3}Al^{3+} + e = \frac{1}{3}Al$
$Zn^{2+} \mid Zn$	−0.763	$\frac{1}{2}Zn^{2+} + e = \frac{1}{2}Zn$
$Fe^{2+} \mid Fe$	−0.440	$\frac{1}{2}Fe^{2+} + e = \frac{1}{2}Fe$
$Cr^{3+}, Cr^{2+} \mid Pt$ [b,c]	−0.41	$Cr^{3+} + e = Cr^{2+}$
$Cd^{2+} \mid Cd$	−0.403	$\frac{1}{2}Cd^{2+} + e = \frac{1}{2}Cd$
$Br^- \mid PbBr_2(s) \mid Pb$	−0.280	$\frac{1}{2}PbBr_2 + e = \frac{1}{2}Pb + Br^-$
$Ni^{2+} \mid Ni$	−0.250	$\frac{1}{2}Ni^{2+} + e = \frac{1}{2}Ni$
$I^- \mid AgI(s) \mid Ag$	−0.151	$AgI + e = Ag + I^-$
$Sn^{2+} \mid Sn$	−0.140	$\frac{1}{2}Sn^{2+} + e = \frac{1}{2}Sn$
$Pb^{2+} \mid Pb$	−0.126	$\frac{1}{2}Pb^{2+} + e = \frac{1}{2}Pb$
$D^+ \mid D_2 \mid Pt$	−0.0034	$D^+ + e = \frac{1}{2}D_2$
$H^+ \mid H_2 \mid Pt$	0.0000	$H^+ + e = \frac{1}{2}H_2$
$Ti^{4+}, Ti^{3+} \mid Pt$	0.04	$Ti^{4+} + e = Ti^{3+}$
$Br^- \mid AgBr(s) \mid Ag$	0.0711	$AgBr + e = Ag + Br^-$
$Sn^{4+}, Sn^{2+} \mid Pt$	0.15	$\frac{1}{2}Sn^{4+} + e = \frac{1}{2}Sn^{2+}$
$Cu^{2+}, Cu^+ \mid Pt$	0.153	$Cu^{2+} + e = Cu^+$
$Cl^- \mid AgCl(s) \mid Ag$	0.2224	$AgCl + e = Ag + Cl^-$
Cl^- (1N)$\mid Hg_2Cl_2(s) \mid Hg$ [d]	0.2800	$\frac{1}{2}Hg_2Cl_2 + e = Hg + Cl^-$
$Cu^{2+} \mid Cu$	0.337	$\frac{1}{2}Cu^{2+} + e = \frac{1}{2}Cu$
$OH^- \mid O_2 \mid Pt$	0.401	$\frac{1}{4}O_2 + \frac{1}{2}H_2O + e = OH^-$
$H^+ \mid C_2H_4(g), C_2H_6(g) \mid Pt$	0.52	$H^+ + \frac{1}{2}C_2H_4(g) + e = \frac{1}{2}C_2H_6(g)$
$Cu^+ \mid Cu$	0.521	$Cu^+ + e = Cu$
$I^- \mid I_2(s) \mid Pt$	0.5355	$\frac{1}{2}I_2 + e = I^-$
$H^+ \mid$ quinhydrone$(s) \mid Pt$	0.6996	$\frac{1}{2}C_6H_4O_2 + H^+ + e = \frac{1}{2}C_6H_6O_2$
$Fe^{3+}, Fe^{2+} \mid Pt$	0.771	$Fe^{3+} + e = Fe^{2+}$
$Hg_2^{2+} \mid Hg$	0.789	$\frac{1}{2}Hg_2^{2+} + e = Hg$
$Ag^+ \mid Ag$	0.7991	$Ag^+ + e = Ag$
$Hg^{2+}, Hg_2^{2+} \mid Pt$	0.920	$Hg^{2+} + e = \frac{1}{2}Hg_2^{2+}$
$Br^- \mid Br_2(l) \mid Pt$	1.0652	$\frac{1}{2}Br_2(l) + e = Br^-$
$Cl^- \mid Cl_2(g) \mid Pt$	1.3595	$\frac{1}{2}Cl_2(g) + e = Cl^-$
$Pb^{2+} \mid PbO_2 \mid Pb$	1.455	$\frac{1}{2}PbO_2 + 2H^+ + e = \frac{1}{2}Pb^{2+} + H_2O$
$Au^{3+} \mid Au$	1.50	$\frac{1}{3}Au^{3+} + e = \frac{1}{3}Au$
$F^- \mid F_2(g) \mid Pt$	2.87	$\frac{1}{2}F_2(g) + e = F^-$
$HF(aq) \mid F_2(g) \mid Pt$	3.06	$H^+ + \frac{1}{2}F_2(g) + e = HF(aq)$

ตารางที่ 3 อินติกรอลบางอย่างที่มีประโยชน์

1. $\int x^n e^{ax} dx = e^{ax} \sum_{r=0}^{n} (-1)^r \frac{n! x^{n-r}}{(n-r)! a^{r+1}}$

2. $\int x^n \sin(ax) dx = -\frac{x^n \cos(ax)}{a} + \frac{n}{a} \int x^{n-1} \cos(ax) dx$

3. $\int x^n \cos(ax) dx = \frac{x^n \sin(ax)}{a} - \frac{n}{a} \int x^{n-1} \sin(ax) dx$

4. $\int \sin^n(ax) dx = -\frac{\sin^{n-1}(ax)\cos(ax)}{na} + \frac{(n-1)}{n} \int \sin^{n-2}(ax) dx$

5. $\int \cos^n(ax) dx = \frac{\cos^{n-1}(ax)\sin(ax)}{na} + \frac{(n-1)}{n} \int \cos^{n-2}(ax) dx$

6. $\int_b^\infty x^n e^{-ax} dx = \frac{n! e^{-ab}}{a^{n+1}} \left[1 + ab + \frac{(ab)^2}{2!} + \cdots + \frac{(ab)^n}{n!} \right]$

7. $\int_o^\infty x^n e^{-ax} dx = \frac{n!}{a^{n+1}} \quad (a > 0, \quad n = 1, 2, \cdots)$

8. $\int_o^\infty x^{2n+1} e^{-ax^2} dx = \frac{n!}{2a^{n+1}} \quad (a > 0)$

9. $\int_o^\infty x^{2n} e^{-ax^2} dx = \frac{1 \cdot 3 \cdot 5 \cdots (2n-1)}{2^{n+1} a^n} \sqrt{\frac{\pi}{a}}$

10. $\int_{-\varepsilon}^{+\varepsilon} \delta(x) dx = 1; \qquad \int_o^a \delta(x) dx = \begin{cases} +1/2, & a > 0 \\ -1/2, & a < 0 \end{cases}$