

INFORMATION IN THE TABLE BELOW AND IN THE TABLES ON PAGES 3-5 MAY BE USEFUL IN ANSWERING THE QUESTIONS IN THIS SECTION OF THE EXAMINATION.

<b>H</b>	1.0079
<b>Li</b>	3
<b>Be</b>	4
<b>B</b>	6.941
<b>C</b>	11
<b>N</b>	12
<b>Mg</b>	22.99
<b>Al</b>	24.30
<b>Si</b>	19
<b>P</b>	20
<b>Cl</b>	21
<b>S</b>	22
<b>Ar</b>	23
<b>F</b>	24
<b>Ca</b>	25
<b>Sc</b>	26
<b>Ti</b>	27
<b>V</b>	28
<b>Cr</b>	29
<b>Mn</b>	30
<b>Fe</b>	31
<b>Co</b>	32
<b>Ni</b>	33
<b>Cu</b>	34
<b>Zn</b>	35
<b>Ga</b>	36
<b>Ge</b>	37
<b>As</b>	38
<b>Se</b>	39
<b>Br</b>	40
<b>Kr</b>	41
<b>Rb</b>	42
<b>Sr</b>	43
<b>Y</b>	44
<b>Zr</b>	45
<b>Nb</b>	46
<b>Mo</b>	47
<b>Tc</b>	48
<b>Ru</b>	49
<b>Rh</b>	50
<b>Pd</b>	51
<b>Ag</b>	52
<b>Cd</b>	53
<b>In</b>	54
<b>Sn</b>	55
<b>Sb</b>	56
<b>Te</b>	57
<b>I</b>	58
<b>Xe</b>	59
<b>He</b>	60
<b>Dy</b>	61
<b>Tb</b>	62
<b>Gd</b>	63
<b>Eu</b>	64
<b>Sm</b>	65
<b>Pm</b>	66
<b>Pr</b>	67
<b>Ce</b>	68
<b>Lu</b>	69
<b>Er</b>	70
<b>Tm</b>	71
<b>Yb</b>	72
<b>Ho</b>	73
<b>Dy</b>	74
<b>Tb</b>	75
<b>Gd</b>	76
<b>Eu</b>	77
<b>Sm</b>	78
<b>Pm</b>	79
<b>Pr</b>	80
<b>Ce</b>	81
<b>Lu</b>	82
<b>Yb</b>	83
<b>Er</b>	84
<b>Tm</b>	85
<b>Ho</b>	86
<b>Dy</b>	87
<b>Tb</b>	88
<b>Gd</b>	89
<b>Eu</b>	90
<b>Sm</b>	91
<b>Pm</b>	92
<b>Pr</b>	93
<b>Lu</b>	94
<b>Yb</b>	95
<b>Er</b>	96
<b>Tm</b>	97
<b>Ho</b>	98
<b>Dy</b>	99
<b>Tb</b>	100
<b>Gd</b>	101
<b>Eu</b>	102
<b>Sm</b>	103
<b>Pm</b>	104
<b>Pr</b>	105
<b>Lu</b>	106
<b>Yb</b>	107
<b>Er</b>	108
<b>Tm</b>	109
<b>Ho</b>	110
<b>Dy</b>	111
<b>Tb</b>	112
<b>Gd</b>	113
<b>Eu</b>	114
<b>Sm</b>	115
<b>Pm</b>	116
<b>Pr</b>	117
<b>Lu</b>	118
<b>Yb</b>	119
<b>Er</b>	120
<b>Tm</b>	121
<b>Ho</b>	122
<b>Dy</b>	123
<b>Tb</b>	124
<b>Gd</b>	125
<b>Eu</b>	126
<b>Sm</b>	127
<b>Pm</b>	128
<b>Pr</b>	129
<b>Lu</b>	130
<b>Yb</b>	131
<b>Er</b>	132
<b>Tm</b>	133
<b>Ho</b>	134
<b>Dy</b>	135
<b>Tb</b>	136
<b>Gd</b>	137
<b>Eu</b>	138
<b>Sm</b>	139
<b>Pm</b>	140
<b>Pr</b>	141
<b>Lu</b>	142
<b>Yb</b>	143
<b>Er</b>	144
<b>Tm</b>	145
<b>Ho</b>	146
<b>Dy</b>	147
<b>Tb</b>	148
<b>Gd</b>	149
<b>Eu</b>	150
<b>Sm</b>	151
<b>Pm</b>	152
<b>Pr</b>	153
<b>Lu</b>	154
<b>Yb</b>	155
<b>Er</b>	156
<b>Tm</b>	157
<b>Ho</b>	158
<b>Dy</b>	159
<b>Tb</b>	160
<b>Gd</b>	161
<b>Eu</b>	162
<b>Sm</b>	163
<b>Pm</b>	164
<b>Pr</b>	165
<b>Lu</b>	166
<b>Yb</b>	167
<b>Er</b>	168
<b>Tm</b>	169
<b>Ho</b>	170
<b>Dy</b>	171
<b>Tb</b>	172
<b>Gd</b>	173
<b>Eu</b>	174
<b>Sm</b>	175
<b>Pm</b>	176
<b>Pr</b>	177
<b>Lu</b>	178
<b>Yb</b>	179
<b>Er</b>	180
<b>Tm</b>	181
<b>Ho</b>	182
<b>Dy</b>	183
<b>Tb</b>	184
<b>Gd</b>	185
<b>Eu</b>	186
<b>Sm</b>	187
<b>Pm</b>	188
<b>Pr</b>	189
<b>Lu</b>	190
<b>Yb</b>	191
<b>Er</b>	192
<b>Tm</b>	193
<b>Ho</b>	194
<b>Dy</b>	195
<b>Tb</b>	196
<b>Gd</b>	197
<b>Eu</b>	198
<b>Sm</b>	199
<b>Pm</b>	200
<b>Pr</b>	201
<b>Lu</b>	202
<b>Yb</b>	203
<b>Er</b>	204
<b>Tm</b>	205
<b>Ho</b>	206
<b>Dy</b>	207
<b>Tb</b>	208
<b>Gd</b>	209
<b>Eu</b>	210
<b>Sm</b>	211
<b>Pm</b>	212
<b>Pr</b>	213
<b>Lu</b>	214
<b>Yb</b>	215
<b>Er</b>	216
<b>Tm</b>	217
<b>Ho</b>	218
<b>Dy</b>	219
<b>Tb</b>	220
<b>Gd</b>	221
<b>Eu</b>	222
<b>Sm</b>	223
<b>Pm</b>	224
<b>Pr</b>	225
<b>Lu</b>	226
<b>Yb</b>	227
<b>Er</b>	228
<b>Tm</b>	229
<b>Ho</b>	230
<b>Dy</b>	231
<b>Tb</b>	232
<b>Gd</b>	233
<b>Eu</b>	234
<b>Sm</b>	235
<b>Pm</b>	236
<b>Pr</b>	237
<b>Lu</b>	238
<b>Yb</b>	239
<b>Er</b>	240
<b>Tm</b>	241
<b>Ho</b>	242
<b>Dy</b>	243
<b>Tb</b>	244
<b>Gd</b>	245
<b>Eu</b>	246
<b>Sm</b>	247
<b>Pm</b>	248
<b>Pr</b>	249
<b>Lu</b>	250
<b>Yb</b>	251
<b>Er</b>	252
<b>Tm</b>	253
<b>Ho</b>	254
<b>Dy</b>	255
<b>Tb</b>	256
<b>Gd</b>	257
<b>Eu</b>	258
<b>Sm</b>	259
<b>Pm</b>	260
<b>Pr</b>	261
<b>Lu</b>	262
<b>Yb</b>	263
<b>Er</b>	264
<b>Tm</b>	265
<b>Ho</b>	266
<b>Dy</b>	267
<b>Tb</b>	268
<b>Gd</b>	269
<b>Eu</b>	270
<b>Sm</b>	271
<b>Pm</b>	272
<b>Pr</b>	273
<b>Lu</b>	274
<b>Yb</b>	275
<b>Er</b>	276
<b>Tm</b>	277
<b>Ho</b>	278
<b>Dy</b>	279
<b>Tb</b>	280
<b>Gd</b>	281
<b>Eu</b>	282
<b>Sm</b>	283
<b>Pm</b>	284
<b>Pr</b>	285
<b>Lu</b>	286
<b>Yb</b>	287
<b>Er</b>	288
<b>Tm</b>	289
<b>Ho</b>	290
<b>Dy</b>	291
<b>Tb</b>	292
<b>Gd</b>	293
<b>Eu</b>	294
<b>Sm</b>	295
<b>Pm</b>	296
<b>Pr</b>	297
<b>Lu</b>	298
<b>Yb</b>	299
<b>Er</b>	300
<b>Tm</b>	301
<b>Ho</b>	302
<b>Dy</b>	303
<b>Tb</b>	304
<b>Gd</b>	305
<b>Eu</b>	306
<b>Sm</b>	307
<b>Pm</b>	308
<b>Pr</b>	309
<b>Lu</b>	310
<b>Yb</b>	311
<b>Er</b>	312
<b>Tm</b>	313
<b>Ho</b>	314
<b>Dy</b>	315
<b>Tb</b>	316
<b>Gd</b>	317
<b>Eu</b>	318
<b>Sm</b>	319
<b>Pm</b>	320
<b>Pr</b>	321
<b>Lu</b>	322
<b>Yb</b>	323
<b>Er</b>	324
<b>Tm</b>	325
<b>Ho</b>	326
<b>Dy</b>	327
<b>Tb</b>	328
<b>Gd</b>	329
<b>Eu</b>	330
<b>Sm</b>	331
<b>Pm</b>	332
<b>Pr</b>	333
<b>Lu</b>	334
<b>Yb</b>	335
<b>Er</b>	336
<b>Tm</b>	337
<b>Ho</b>	338
<b>Dy</b>	339
<b>Tb</b>	340
<b>Gd</b>	341
<b>Eu</b>	342
<b>Sm</b>	343
<b>Pm</b>	344
<b>Pr</b>	345
<b>Lu</b>	346
<b>Yb</b>	347
<b>Er</b>	348
<b>Tm</b>	349
<b>Ho</b>	350
<b>Dy</b>	351
<b>Tb</b>	352
<b>Gd</b>	353
<b>Eu</b>	354
<b>Sm</b>	355
<b>Pm</b>	356
<b>Pr</b>	357
<b>Lu</b>	358
<b>Yb</b>	359
<b>Er</b>	360
<b>Tm</b>	361
<b>Ho</b>	362
<b>Dy</b>	363
<b>Tb</b>	364
<b>Gd</b>	365
<b>Eu</b>	366
<b>Sm</b>	367
<b>Pm</b>	368
<b>Pr</b>	369
<b>Lu</b>	370
<b>Yb</b>	371
<b>Er</b>	372
<b>Tm</b>	373
<b>Ho</b>	374
<b>Dy</b>	375
<b>Tb</b>	376
<b>Gd</b>	377
<b>Eu</b>	378
<b>Sm</b>	379
<b>Pm</b>	380
<b>Pr</b>	381
<b>Lu</b>	382
<b>Yb</b>	383
<b>Er</b>	384
<b>Tm</b>	385
<b>Ho</b>	386
<b>Dy</b>	387
<b>Tb</b>	388
<b>Gd</b>	389
<b>Eu</b>	390
<b>Sm</b>	391
<b>Pm</b>	392
<b>Pr</b>	393
<b>Lu</b>	394
<b>Yb</b>	395
<b>Er</b>	396
<b>Tm</b>	397
<b>Ho</b>	398
<b>Dy</b>	399
<b>Tb</b>	400
<b>Gd</b>	401
<b>Eu</b>	402
<b>Sm</b>	403
<b>Pm</b>	404
<b>Pr</b>	405
<b>Lu</b>	406
<b>Yb</b>	407
<b>Er</b>	408
<b>Tm</b>	409
<b>Ho</b>	410
<b>Dy</b>	411
<b>Tb</b>	412
<b>Gd</b>	413
<b>Eu</b>	414
<b>Sm</b>	415
<b>Pm</b>	416
<b>Pr</b>	417
<b>Lu</b>	418
<b>Yb</b>	419
<b>Er</b>	420
<b>Tm</b>	421
<b>Ho</b>	422
<b>Dy</b>	423
<b>Tb</b>	424
<b>Gd</b>	425
<b>Eu</b>	426
<b>Sm</b>	427
<b>Pm</b>	428
<b>Pr</b>	429
<b>Lu</b>	430
<b>Yb</b>	431
<b>Er</b>	432
<b>Tm</b>	433
<b>Ho</b>	434
<b>Dy</b>	435
<b>Tb</b>	436
<b>Gd</b>	437
<b>Eu</b>	438
<b>Sm</b>	439
<b>Pm</b>	440
<b>Pr</b>	441
<b>Lu</b>	442
<b>Yb</b>	443
<b>Er</b>	444
<b>Tm</b>	445
<b>Ho</b>	446
<b>Dy</b>	447
<b>Tb</b>	448
<b>Gd</b>	449
<b>Eu</b>	450
<b>Sm</b>	451
<b>Pm</b>	452
<b>Pr</b>	453
<b>Lu</b>	454
<b>Yb</b>	455
<b>Er</b>	456
<b>Tm</b>	457
<b>Ho</b>	458
<b>Dy</b>	459
<b>Tb</b>	460
<b>Gd</b>	461
<b>Eu</b>	462
<b>Sm</b>	463
<b>Pm</b>	464
<b>Pr</b>	465
<b>Lu</b>	466
<b>Yb</b>	467
<b>Er</b>	468
<b>Tm</b>	469
<b>Ho</b>	470
<b>Dy</b>	471
<b>Tb</b>	472
<b>Gd</b>	473
<b>Eu</b>	474
<b>Sm</b>	475
<b>Pm</b>	476
<b>Pr</b>	477
<b>Lu</b>	478
<b>Yb</b>	479
<b>Er</b>	480
<b>Tm</b>	481
<b>Ho</b>	482
<b>Dy</b>	483
<b>Tb</b>	484
<b>Gd</b>	485
<b>Eu</b>	486
<b>Sm</b>	487
<b>Pm</b>	488
<b>Pr</b>	489
<b>Lu</b>	490
<b>Yb</b>	491
<b>Er</b>	492
<b>Tm</b>	493
<b>Ho</b>	494
<b>Dy</b>	495
<b>Tb</b>	496
<b>Gd</b>	497
<b>Eu</b>	498
<b>Sm</b>	499
<b>Pm</b>	500
<b>Pr</b>	501
<b>Lu</b>	502
<b>Yb</b>	503
<b>Er</b>	504
<b>Tm</b>	505
<b>Ho</b>	506
<b>Dy</b>	507
<b>Tb</b>	508
<b>Gd</b>	509
<b>Eu</b>	510
<b>Sm</b>	511
<b>Pm</b>	512
<b>Pr</b>	513
<b>Lu</b>	514
<b>Yb</b>	515
<b>Er</b>	516
<	

## STANDARD REDUCTION POTENTIALS IN AQUEOUS SOLUTION AT 25 °C

Half-reaction		<i>E</i> (V)
$\text{F}_2(g) + 2 e^-$	$\rightarrow$	2.87
$\text{Co}^{3+} + e^-$	$\rightarrow$	1.82
$\text{Au}^{3+} + 3 e^-$	$\rightarrow$	1.50
$\text{Cl}_2(g) + 2 e^-$	$\rightarrow$	1.36
$\text{O}_2(g) + 4 \text{H}^+ + 4 e^-$	$\rightarrow$	1.23
$\text{Br}_2(l) + 2 e^-$	$\rightarrow$	1.07
$2 \text{Hg}^{2+} + 2 e^-$	$\rightarrow$	0.92
$\text{Hg}^{2+} + 2 e^-$	$\rightarrow$	0.85
$\text{Ag}^+ + e^-$	$\rightarrow$	0.80
$\text{Hg}_2^{2+} + 2 e^-$	$\rightarrow$	0.79
$\text{Fe}^{3+} + e^-$	$\rightarrow$	0.77
$\text{I}_2(s) + 2 e^-$	$\rightarrow$	0.53
$\text{Cu}^+ + e^-$	$\rightarrow$	0.52
$\text{Cu}^{2+} + 2 e^-$	$\rightarrow$	0.34
$\text{Cu}^{2+} + e^-$	$\rightarrow$	0.15
$\text{Sn}^{4+} + 2 e^-$	$\rightarrow$	0.15
$\text{S}(s) + 2 \text{H}^+ + 2 e^-$	$\rightarrow$	0.14
$2 \text{H}^+ + 2 e^-$	$\rightarrow$	0.00
$\text{Pb}^{2+} + 2 e^-$	$\rightarrow$	-0.13
$\text{Sn}^{2+} + 2 e^-$	$\rightarrow$	-0.14
$\text{Ni}^{2+} + 2 e^-$	$\rightarrow$	-0.25
$\text{Co}^{2+} + 2 e^-$	$\rightarrow$	-0.28
$\text{Cd}^{2+} + 2 e^-$	$\rightarrow$	-0.40
$\text{Cr}^{3+} + e^-$	$\rightarrow$	-0.41
$\text{Fe}^{2+} + 2 e^-$	$\rightarrow$	-0.44
$\text{Cr}^{3+} + 3 e^-$	$\rightarrow$	-0.74
$\text{Zn}^{2+} + 2 e^-$	$\rightarrow$	-0.76
$2 \text{H}_2\text{O}(l) + 2 e^-$	$\rightarrow$	-0.83
$\text{Mn}^{2+} + 2 e^-$	$\rightarrow$	-1.18
$\text{Al}^{3+} + 3 e^-$	$\rightarrow$	-1.66
$\text{Be}^{2+} + 2 e^-$	$\rightarrow$	-1.70
$\text{Mg}^{2+} + 2 e^-$	$\rightarrow$	-2.37
$\text{Na}^+ + e^-$	$\rightarrow$	-2.71
$\text{Ca}^{2+} + 2 e^-$	$\rightarrow$	-2.87
$\text{Sr}^{2+} + 2 e^-$	$\rightarrow$	-2.89
$\text{Ba}^{2+} + 2 e^-$	$\rightarrow$	-2.90
$\text{Rb}^+ + e^-$	$\rightarrow$	-2.92
$\text{K}^+ + e^-$	$\rightarrow$	-2.92
$\text{Cs}^+ + e^-$	$\rightarrow$	-2.92
$\text{Li}^+ + e^-$	$\rightarrow$	-3.05

GO ON TO THE NEXT PAGE.

## ADVANCED PLACEMENT CHEMISTRY EQUATIONS AND CONSTANTS

### ATOMIC STRUCTURE

$$E = h\nu \quad c = \lambda\nu$$

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

$$E_n = \frac{-2.178 \times 10^{-18}}{n^2} \text{ joule}$$

### EQUILIBRIUM

$$K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}$$

$$K_b = \frac{[\text{OH}^-][\text{HB}^+]}{[\text{B}]}$$

$$K_w = [\text{OH}^-][\text{H}^+] = 1.0 \times 10^{-14} \text{ @ } 25^\circ\text{C}$$

$$= K_a \times K_b$$

$$\text{pH} = -\log [\text{H}^+], \text{pOH} = -\log [\text{OH}^-]$$

$$14 = \text{pH} + \text{pOH}$$

$$\text{pH} = \text{p}K_a + \log \frac{[\text{A}^-]}{[\text{HA}]}$$

$$\text{pOH} = \text{p}K_b + \log \frac{[\text{HB}^+]}{[\text{B}]}$$

$$\text{p}K_a = -\log K_a, \text{p}K_b = -\log K_b$$

$$K_p = K_c(RT)^{\Delta n},$$

where  $\Delta n$  = moles product gas – moles reactant gas

### THERMOCHEMISTRY/KINETICS

$$\Delta S^\circ = \sum S^\circ \text{ products} - \sum S^\circ \text{ reactants}$$

$$\Delta H^\circ = \sum \Delta H_f^\circ \text{ products} - \sum \Delta H_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$= -RT \ln K = -2.303 RT \log K$$

$$= -n \mathcal{F} E^\circ$$

$$\Delta G = \Delta G^\circ + RT \ln Q = \Delta G^\circ + 2.303 RT \log Q$$

$$q = mc\Delta T$$

$$C_p = \frac{\Delta H}{\Delta T}$$

$$\ln[\text{A}]_t - \ln[\text{A}]_0 = -kt$$

$$\frac{1}{[\text{A}]_t} - \frac{1}{[\text{A}]_0} = kt$$

$$\ln k = \frac{-E_a}{R} \left( \frac{1}{T} \right) + \ln A$$

$E$ = energy	$v$ = velocity
$\nu$ = frequency	$n$ = principal quantum number
$\lambda$ = wavelength	$m$ = mass
$p$ = momentum	

$$\text{Speed of light, } c = 3.0 \times 10^8 \text{ m s}^{-1}$$

$$\text{Planck's constant, } h = 6.63 \times 10^{-34} \text{ J s}$$

$$\text{Boltzmann's constant, } k = 1.38 \times 10^{-23} \text{ J K}^{-1}$$

$$\text{Avogadro's number} = 6.022 \times 10^{23} \text{ mol}^{-1}$$

$$\text{Electron charge, } e = -1.602 \times 10^{-19} \text{ coulomb}$$

$$1 \text{ electron volt per atom} = 96.5 \text{ kJ mol}^{-1}$$

### Equilibrium Constants

$K_a$  (weak acid)

$K_b$  (weak base)

$K_w$  (water)

$K_p$  (gas pressure)

$K_c$  (molar concentrations)

$S^\circ$  = standard entropy

$H^\circ$  = standard enthalpy

$G^\circ$  = standard free energy

$E^\circ$  = standard reduction potential

$T$  = temperature

$n$  = moles

$m$  = mass

$q$  = heat

$c$  = specific heat capacity

$C_p$  = molar heat capacity at constant pressure

$E_a$  = activation energy

$k$  = rate constant

$A$  = frequency factor

Faraday's constant,  $\mathcal{F} = 96,500$  coulombs per mole of electrons

Gas constant,  $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$

$= 0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1}$

$= 8.31 \text{ volt coulomb mol}^{-1} \text{ K}^{-1}$

## GASES, LIQUIDS, AND SOLUTIONS

$$PV = nRT$$

$$\left( P + \frac{n^2 a}{V^2} \right) (V - nb) = nRT$$

$$P_A = P_{\text{total}} \times X_A, \text{ where } X_A = \frac{\text{moles A}}{\text{total moles}}$$

$$P_{\text{total}} = P_A + P_B + P_C + \dots$$

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

$$K = {}^\circ\text{C} + 273$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$D = \frac{m}{V}$$

$$u_{\text{rms}} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M}}$$

$$KE \text{ per molecule} = \frac{1}{2} mv^2$$

$$KE \text{ per mole} = \frac{3}{2} RT$$

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

molarity,  $M$  = moles solute per liter solution

molality = moles solute per kilogram solvent

$$\Delta T_f = iK_f \times \text{molality}$$

$$\Delta T_b = iK_b \times \text{molality}$$

$$\pi = iMRT$$

$$A = abc$$

$P$  = pressure

$V$  = volume

$T$  = temperature

$n$  = number of moles

$D$  = density

$m$  = mass

$v$  = velocity

$u_{\text{rms}}$  = root-mean-square speed

$KE$  = kinetic energy

$r$  = rate of effusion

$M$  = molar mass

$\pi$  = osmotic pressure

$i$  = van't Hoff factor

$K_f$  = molal freezing-point depression constant

$K_b$  = molal boiling-point elevation constant

$A$  = absorbance

$a$  = molar absorptivity

$b$  = path length

$c$  = concentration

$Q$  = reaction quotient

$I$  = current (amperes)

$q$  = charge (coulombs)

$t$  = time (seconds)

$E^\circ$  = standard reduction potential

$K$  = equilibrium constant

## OXIDATION-REDUCTION; ELECTROCHEMISTRY

$$Q = \frac{[C]^c [D]^d}{[A]^a [B]^b}, \text{ where } a A + b B \rightarrow c C + d D$$

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

$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{RT}{nF} \ln Q = E_{\text{cell}}^\circ - \frac{0.0592}{n} \log Q @ 25^\circ\text{C}$$

$$\log K = \frac{nE^\circ}{0.0592}$$

Gas constant,  $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$

$= 0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1}$

$= 8.31 \text{ volt coulomb mol}^{-1} \text{ K}^{-1}$

Boltzmann's constant,  $k = 1.38 \times 10^{-23} \text{ J K}^{-1}$

$K_f$  for  $\text{H}_2\text{O} = 1.86 \text{ K kg mol}^{-1}$

$K_b$  for  $\text{H}_2\text{O} = 0.512 \text{ K kg mol}^{-1}$

1 atm = 760 mm Hg  
= 760 torr

STP =  $0.000^\circ\text{C}$  and  $1.000 \text{ atm}$

Faraday's constant,  $F = 96,500 \text{ coulombs per mole}$   
of electrons