UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF CHEMICAL AND BIOENGINEERING TECHNOLOGY

FINAL EXAMINATION
OCTOBER 2025 SEMESTER

COURSE CODE	:	CLD 10003
COURSE NAME	:	GENERAL CHEMISTRY
PROGRAMME NAME	:	DIPLOMA IN CHEMICAL ENGINEERING TECHNOLOGY (FOOD)
DATE	:	29 JANUARY 2026
TIME	:	2.00 PM – 5.00 PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please CAREFULLY read the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of TWO (2) sections, Section A and Section B.
4. Answer ALL questions in Section A and ONLY THREE (3) questions in Section B.
5. Please write your answers on the answer booklet provided.
6. Answer all questions in English language ONLY.
7. Reduction Potential table and Periodic Table are appended for your reference.

THERE ARE 13 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 25 marks)

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

1. The base unit for the length in metric system is _____.

   A. cm
   C. m
   B. in
   D. yd

2. Figure 1 shows an experiment to find the density of a liquid. Calculate the density of the liquid.

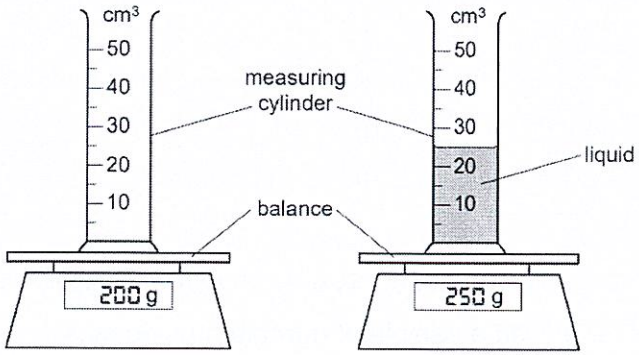


Figure 1

   A. 0.5 g/cm^3
   C. 2.0 g/cm^3
   B. 8.0 g/cm^3
   D. 10.0 g/cm^3

3. Express 0.000840 in scientific notation

   A. 8.40×10^{-3}
   C. 8.40×10^{4}
   B. 8.40×10^{-4}
   D. 0.84×10^{-3}

4. 65.0 °C is equivalent to

   A. 338.15 K
   C. 100.15 K
   B. 149.15 K
   D. 65.15 K

5. Identify the maximum number of molecules from the following substance.

   A. 1g CO_2
   C. 1g N_2
   B. 1g H_2
   D. 1g CH_4

6. The structure of an atom is shown in Figure 2 below.

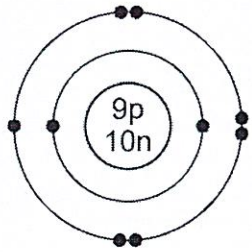


Figure 2

Choose the correct pair which shows the nucleon number and proton number of the atom.

	Nucleon number	Proton number
A.	9	10
B.	19	10
C.	10	9
D.	19	9

7. Europium, atomic number 63, is used in some television screens to highlight colours. A chemist analysed a sample of europium using mass spectrometry. The results are shown in Table 1 below. Choose the correct average atomic mass of europium.

Table 1:

Isotope	Relative isotopic mass	Relative Abundance (%)
Eu-151	151.0	47.77
Eu-153	153.0	52.23

A. 151.045 a.m.u
B. 153.045 a.m.u
C. 154.045 a.m.u
D. 152.045 a.m.u

8. The ground state electron configuration of Fe is _____.

A. $1s^2\ 2s^2\ 3s^2\ 3p^6\ 3d^6$
B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$
C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6$
D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4d^6$

9. Arrange the elements Cl, F, and S in order of increasing atomic radius.

A. S, Cl, F
B. F, S, Cl
C. Cl, F, S
D. F, Cl, S

10. In general, atomic radius _____ going left to right across a row in the periodic table.

A. decreases
C. increases
B. does not change
D. none of these answers is correct

11. A 100.0 g sample of a compound is made up of 35.9 g of aluminum (Al) and 64.1 g of sulfur (S). The empirical formula of the compound is _____.

A. Al_2S_3
C. AlS
B. Al_4S_6
D. Al_3S_2

12. Determine the number of moles of tungsten atoms in 4.8×10^{25} atoms of tungsten.

A. 1.3×10^{-1} moles
C. 1.3×10^{-2} moles
B. 8.0×10^{-1} moles
D. 80 moles

13. Caffeine is a naturally occurring central nervous system stimulant that widely recognized as the most consumed psychoactive substance in the world. Caffeine has the molecular formula $C_8H_{10}N_4O_2$. Choose the correct molar mass of caffeine.

A. 194.194 g/mol
C. 306.999 g/mol
B. 150.008 g/mol
D. 274.404 g/mol

14. Identify the correct Lewis dot structure for chlorine.

A. 
C. 
B. 
D. 

15. The tendency of atoms to acquire two electrons in their valence shell is _____.

A. octet rule
C. duplet rule
B. triplet rule
D. all of these

16. A covalent bond is formed when electrons are _____.

A. split
C. shared
B. transferred
D. destroyed

17. The fuel ethane, C_2H_6, burns in air to form carbon dioxide and water. Determine the missing coefficients for the skeleton equation below.

$$\_\_ C_2H_6 + \_\_ O_2 \rightarrow \_\_ CO_2 + \_\_ H_2O$$

A. 1,7,2,3
B. 2,7,2,3
C. 2,7,4,6
D. 2,14,4,6

18. Identify which of the following reactions represents a double displacement reaction.

A. $BaCl_{2(aq)} + Na_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq)}$
B. $2FeSO_{4(s)} \rightarrow Fe_2O_{3(s)} + SO_{2(g)} + SO_{3(g)}$
C. $2Pb(NO_3)_{2(g)} \rightarrow 2PbO_{(s)} + 4NO_{2(g)} + O_{2(g)}$
D. $Zn_{(s)} + 2AgNO_{3(aq)} \rightarrow Zn(NO_3)_{2(aq)} + 2Ag_{(s)}$

19. Calculate the molality of 34.5 g of sugar ($C_{12}H_{22}O_{11}$) dissolved in 215 g of water.

A. 0.469 m
B. 0.613 m
C. 0.603 m
D. 0.554 m

20. The following Figure 3 shows a galvanic cell,

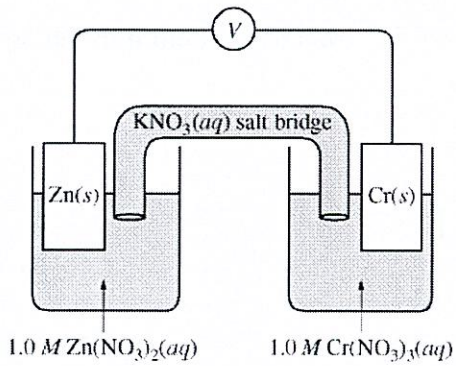


Figure 3

The reaction at anode is_____.

A. $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$
B. $Zn^{2+}_{(aq)} + 2e^- \rightarrow Zn_{(s)}$
C. $Cr^{3+}_{(aq)} + 3e^- \rightarrow Cr_{(s)}$
D. $Cr_{(s)} \rightarrow Cr^{3+}_{(aq)} + 3e^-$

21. Calculate the standard cell potential produced by a galvanic cell in Figure 4 below:

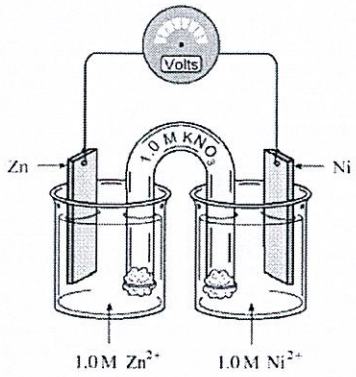


Figure 4

Given:

$Ni^{2+}_{(aq)} + 2e^- \rightarrow Ni_{(s)}$ $E°= -0.23$ V

$Zn^{2+}_{(aq)} + 2e^- \rightarrow Ag_{(s)}$ $E°= -0.76$ V

A. −0.53 V
B. −0.99 V
C. +0.53 V
D. +0.99 V

22. Calculate the concentration (in M) of hydroxide ions (OH^-) in a solution at 25.0 °C with pH = 4.282.

A. 9.718 M
B. 5.224×10^{-5} M
C. 1.914×10^{-10} M
D. 4.282 M

23. Identify the gas law represented by Figure 5 below.

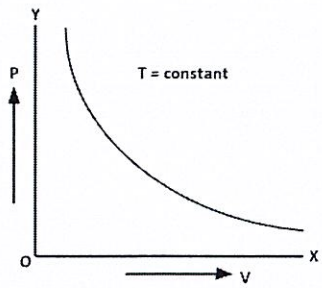


Figure 5

A. Boyle's Law
B. Dalton's Law
C. Charles's Law
D. Avogadro's Law

24. Choose the correct gas law represented in Figure 6.

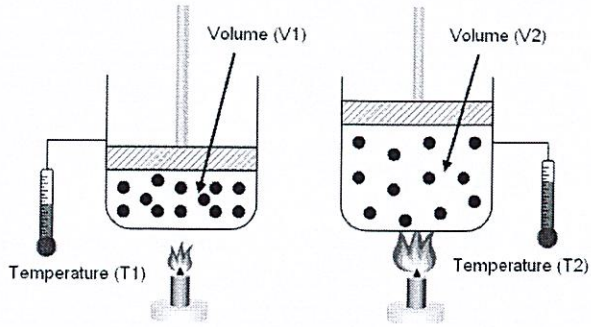


Figure 6

A. Boyle's Law
B. Dalton's Law
C. Charles's Law
D. Avogadro's Law

25. A mixture of He and Ne at a total pressure of 0.95 atm is found to contain 0.32 mol of He and 0.56 mol of Ne. The partial pressure of Ne is _____ atm.

A. 1.270
B. 0.604
C. 1.510
D. 0.345

SECTION B (Total: 75 marks)

INSTRUCTION: Answer THREE (3) questions ONLY.
Please use the answer booklet provided.

Question 1

(a) Some of the acid in acid rain is produced from the following reaction:

$$3NO_{2(g)} + H_2O_{(l)} \rightarrow NO_{(g)} + 2HNO_{3(aq)}$$

A falling raindrop (H_2O) with a mass of 0.05 g reacts with 0.010 g of NO_2 gas.

i. Determine the limiting reactant for this reaction.

(4 marks)

ii. Calculate the mass in gram of nitric acid (HNO_3) produced in the reaction.

(3 marks)

iii. If 0.006 g of HNO_3 is actually produced, calculate the percentage yield of HNO_3.

(3 marks)

(b) Consider the following chemical reaction:

$$Fe_{(s)} + O_{2(g)} \rightarrow Fe_2O_{3(s)}$$

i. Balance the chemical equation provided above.

(3 marks)

ii. In the lab, a reaction involving 624 g of O_2 occurred. Calculate the amount of Fe_2O_3 (moles) were produced.

(3 marks)

(c) Define octet rule.

(1 mark)

(d) Show all the steps in drawing a Lewis dot structure of the following compounds:

i. NF_3

(4 marks)

ii. K_2S

(4 marks)

Question 2

(a) Define

i. solute

ii. solvent

iii. solution

(3 marks)

(b) Calculate the concentration of the following solutions:

i. the molarity of a solution of 4.5 g KI in 50.0 mL H_2O.

(2 marks)

ii. the percent-by-mass (%w/w), when dissolving 7.6 g of sucrose in 83.4 g of water.

(2 marks)

iii. the percentage concentration (% w/v) of the salt solution, when 34.5 g sample of pure NaCl was placed in a 250 mL volumetric flask.

(2 marks)

(c) Solve these gas law problems:

[Hint: Please include the name of the gas law in your answer.]

i. A sample of 25 L of NH_3 gas at 10°C is heated at constant pressure until it fills a volume of 50 L. Calculate the new temperature in °C.

(3 marks)

ii. A 25.5 L balloon holding 3.5 moles of carbon dioxide leaks. It was found that 1.9 moles of carbon dioxide escaped before the balloon could be sealed. Calculate the new volume of the balloon.

(3 marks)

iii. Calculate the amount in moles of gas (air) are in the lungs of an adult with a lung capacity of 3.9 L. Assume that the lungs are at 1.00 atm pressure and at a body temperature of 40 °C.

(3 marks)

(d) A 1.5 L flask contains a mixture of non-reacting gaseous of 0.600 mol helium (He), 0.04 mol neon (Ne) and 0.05 mol argon (Ar). The total pressure of the gaseous is 3.5 atm. Calculate the partial pressure of the gaseous in the mixture.

(7 marks)

Question 3

(a) Define acids and bases according to the Arrhenius theory.

(2 marks)

(b) Identify the acid, base, conjugate acid and conjugate base from these equations:

i. $HClO_{4(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + ClO_4^-{}_{(aq)}$

(2 marks)

ii. $NH_{3(g)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-_{(aq)}$

(2 marks)

(c) Calculate the pH of the following solutions:

i. a solution of HBr has concentration of 4.5×10^{-3} M.

(2 marks)

ii. a NaOH solution with a concentration of 0.000841 M.

(2 marks)

iii. a certain solution has pOH of 9.3.

(2 marks)

(d) An aqueous solution that has 28 g of aniline ($C_6H_5NH_2$) in 1500 mL water is presented in this equation:

$$C_6H_5NH_{2(aq)} + H_2O_{(l)} \rightleftharpoons C_6H_5NH_3^+{}_{(aq)} + OH^-_{(aq)}$$

Given: K_b of aniline = 3.80×10^{-10}

i. Write an expression of dissociation constant, K_b.

(2 marks)

ii. Calculate the pK_b.

(2 marks)

iii. Calculate the pH of aniline.
[Hint: Construct an ICE table]

(6 marks)

iv. Calculate the percentage of dissociation of aniline.

(3 marks)

Question 4

(a) Define oxidation and reduction based on oxidation number.

(2 marks)

(b) Consider the following reaction below, identify:

$$Ce^{4+}_{(aq)} + Fe^{2+}_{(aq)} \rightarrow Ce^{3+}_{(aq)} + Fe^{3+}_{(aq)}$$

i. substance oxidized

(1 mark)

ii. substance reduced

(1 mark)

iii. oxidizing agent

(1 mark)

iv. reducing agent

(1 mark)

(c) Figure 7 depicts the setup of an electrochemical cell:

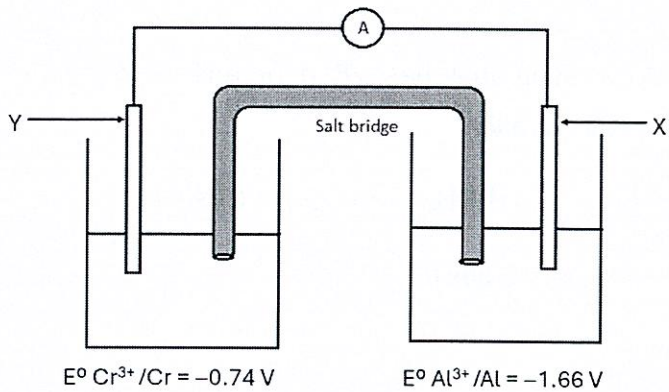


Figure 7

i. Write the half-reaction occurring at electrode X.

(2 marks)

ii. Write the half-reaction occurring at electrode Y.

(2 marks)

iii. Write the cell notation.

(2 marks)

(d) State the oxidation number of each of the elements which is underlined. Show your calculation.

i. $H_2\underline{P}O_4^{2-}$

(2 marks)

ii. $K\underline{Mn}O_4$

(2 marks)

(e) Figure 8 shows an electrochemical cell constructed from two half-cells:

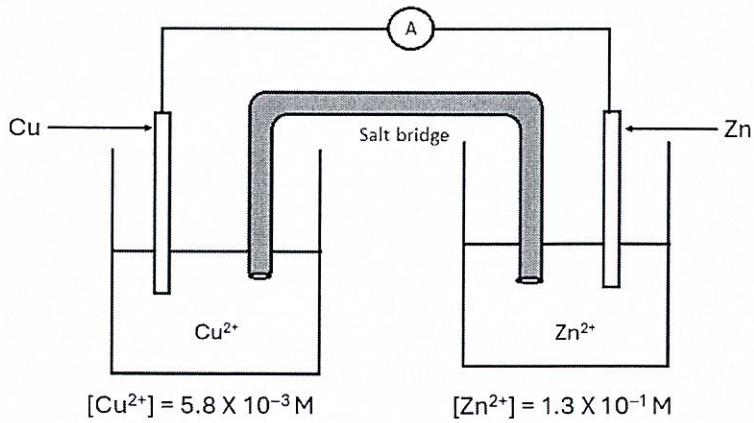


Figure 8

i. Calculate the overall cell potential (E_{cell}) at the specific concentrations given.

(7 marks)

ii. Predict the spontaneity of the redox reaction. Justify your answer.

(2 marks)

END OF EXAMINATION PAPER

APPENDIX

R constant value:

Units	Numerical Value
L-atm/mol-K	0.08206
J/mol-K*	8.314
cal/mol-K	1.987
m^3-Pa/mol-K*	8.314
L-torr/mol-K	62.36

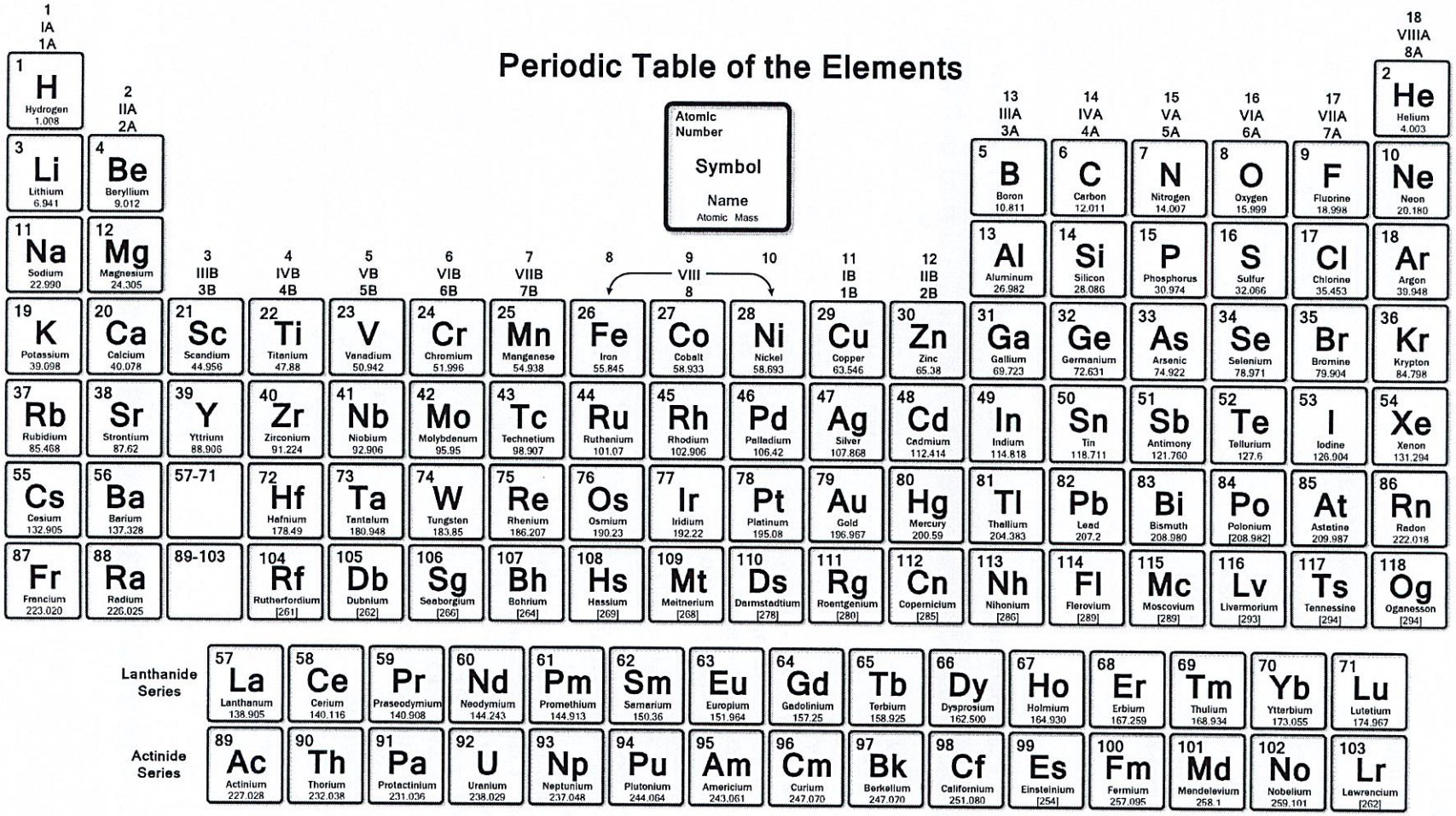
*SI unit

Nernst Equation:

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0592}{n} \log_{10} Q$$

TABLE 18.1 | Standard Reduction Potentials at 25°C (298 K) for Many Common Half-Reactions

Half-Reaction	$\mathscr{E}^\circ$ (V)	Half-Reaction	$\mathscr{E}^\circ$ (V)
$F_2 + 2e^- \rightarrow 2F^-$	2.87	$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$	0.40
$Ag^{2+} + e^- \rightarrow Ag^+$	1.99	$Cu^{2+} + 2e^- \rightarrow Cu$	0.34
$Co^{3+} + e^- \rightarrow Co^{2+}$	1.82	$Hg_2Cl_2 + 2e^- \rightarrow 2Hg + 2Cl^-$	0.27
$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$	1.78	$AgCl + e^- \rightarrow Ag + Cl^-$	0.22
$Ce^{4+} + e^- \rightarrow Ce^{3+}$	1.70	$SO_4^{2-} + 4H^+ + 2e^- \rightarrow H_2SO_3 + H_2O$	0.20
$PbO_2 + 4H^+ + SO_4^{2-} + 2e^- \rightarrow PbSO_4 + 2H_2O$	1.69	$Cu^{2+} + e^- \rightarrow Cu^+$	0.16
$MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_2 + 2H_2O$	1.68	$2H^+ + 2e^- \rightarrow H_2$	0.00
$2e^- + 2H^+ + IO_4^- \rightarrow IO_3^- + H_2O$	1.60		
$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$	1.51	$Fe^{3+} + 3e^- \rightarrow Fe$	−0.036
$Au^{3+} + 3e^- \rightarrow Au$	1.50	$Pb^{2+} + 2e^- \rightarrow Pb$	−0.13
$PbO_2 + 4H^+ + 2e^- \rightarrow Pb^{2+} + 2H_2O$	1.46	$Sn^{2+} + 2e^- \rightarrow Sn$	−0.14
$Cl_2 + 2e^- \rightarrow 2Cl^-$	1.36	$Ni^{2+} + 2e^- \rightarrow Ni$	−0.23
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$	1.33	$PbSO_4 + 2e^- \rightarrow Pb + SO_4^{2-}$	−0.35
$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$	1.23	$Cd^{2+} + 2e^- \rightarrow Cd$	−0.40
$MnO_2 + 4H^+ + 2e^- \rightarrow Mn^{2+} + 2H_2O$	1.21	$Fe^{2+} + 2e^- \rightarrow Fe$	−0.44
$IO_3^- + 6H^+ + 5e^- \rightarrow \frac{1}{2}I_2 + 3H_2O$	1.20	$Cr^{3+} + e^- \rightarrow Cr^{2+}$	−0.50
$Br_2 + 2e^- \rightarrow 2Br^-$	1.09	$Cr^{3+} + 3e^- \rightarrow Cr$	−0.73
$VO_2^+ + 2H^+ + e^- \rightarrow VO^{2+} + H_2O$	1.00	$Zn^{2+} + 2e^- \rightarrow Zn$	−0.76
$AuCl_4^- + 3e^- \rightarrow Au + 4Cl^-$	0.99	$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$	−0.83
$NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O$	0.96	$Mn^{2+} + 2e^- \rightarrow Mn$	−1.18
$ClO_2 + e^- \rightarrow ClO_2^-$	0.954	$Al^{3+} + 3e^- \rightarrow Al$	−1.66
$2Hg^{2+} + 2e^- \rightarrow Hg_2^{2+}$	0.91	$H_2 + 2e^- \rightarrow 2H^-$	−2.23
$Ag^+ + e^- \rightarrow Ag$	0.80	$Mg^{2+} + 2e^- \rightarrow Mg$	−2.37
$Hg_2^{2+} + 2e^- \rightarrow 2Hg$	0.80	$La^{3+} + 3e^- \rightarrow La$	−2.37
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	0.77	$Na^+ + e^- \rightarrow Na$	−2.71
$O_2 + 2H^+ + 2e^- \rightarrow H_2O_2$	0.68	$Ca^{2+} + 2e^- \rightarrow Ca$	−2.76
$MnO_4^- + e^- \rightarrow MnO_4^{2-}$	0.56	$Ba^{2+} + 2e^- \rightarrow Ba$	−2.90
$I_2 + 2e^- \rightarrow 2I^-$	0.54	$K^+ + e^- \rightarrow K$	−2.92
$Cu^+ + e^- \rightarrow Cu$	0.52	$Li^+ + e^- \rightarrow Li$	−3.05


Periodic Table of the Elements
Atomic Number
Symbol
Name
Atomic Mass
1 IA 1A
2 IIA 2A
3 IIIB 3B
4 IVB 4B
5 VB 5B
6 VIB 6B
7 VIIB 7B
8
9 VIII 8
10
11 IB 1B
12 IIB 2B
13 IIIA 3A
14 IVA 4A
15 VA 5A
16 VIA 6A
17 VIIA 7A
18 VIIIA 8A
1 H Hydrogen 1.008
2 He Helium 4.003
3 Li Lithium 6.941
4 Be Beryllium 9.012
5 B Boron 10.811
6 C Carbon 12.011
7 N Nitrogen 14.007
8 O Oxygen 15.999
9 F Fluorine 18.998
10 Ne Neon 20.180
11 Na Sodium 22.990
12 Mg Magnesium 24.305
13 Al Aluminum 26.982
14 Si Silicon 28.086
15 P Phosphorus 30.974
16 S Sulfur 32.066
17 Cl Chlorine 35.453
18 Ar Argon 39.948
19 K Potassium 39.098
20 Ca Calcium 40.078
21 Sc Scandium 44.956
22 Ti Titanium 47.88
23 V Vanadium 50.942
24 Cr Chromium 51.996
25 Mn Manganese 54.938
26 Fe Iron 55.845
27 Co Cobalt 58.933
28 Ni Nickel 58.693
29 Cu Copper 63.546
30 Zn Zinc 65.38
31 Ga Gallium 69.723
32 Ge Germanium 72.631
33 As Arsenic 74.922
34 Se Selenium 78.971
35 Br Bromine 79.904
36 Kr Krypton 84.798
37 Rb Rubidium 85.468
38 Sr Strontium 87.62
39 Y Yttrium 88.906
40 Zr Zirconium 91.224
41 Nb Niobium 92.906
42 Mo Molybdenum 95.95
43 Tc Technetium 98.907
44 Ru Ruthenium 101.07
45 Rh Rhodium 102.906
46 Pd Palladium 106.42
47 Ag Silver 107.868
48 Cd Cadmium 112.414
49 In Indium 114.818
50 Sn Tin 118.711
51 Sb Antimony 121.760
52 Te Tellurium 127.6
53 I Iodine 126.904
54 Xe Xenon 131.294
55 Cs Cesium 132.905
56 Ba Barium 137.328
57-71
72 Hf Hafnium 178.49
73 Ta Tantalum 180.948
74 W Tungsten 183.85
75 Re Rhenium 186.207
76 Os Osmium 190.23
77 Ir Iridium 192.22
78 Pt Platinum 195.08
79 Au Gold 196.967
80 Hg Mercury 200.59
81 Tl Thallium 204.383
82 Pb Lead 207.2
83 Bi Bismuth 208.980
84 Po Polonium [208.982]
85 At Astatine 209.987
86 Rn Radon 222.018
87 Fr Francium 223.020
88 Ra Radium 226.025
89-103
104 Rf Rutherfordium [261]
105 Db Dubnium [262]
106 Sg Seaborgium [266]
107 Bh Bohrium [264]
108 Hs Hassium [269]
109 Mt Meitnerium [268]
110 Ds Darmstadtium [278]
111 Rg Roentgenium [280]
112 Cn Copernicium [285]
113 Nh Nihonium [286]
114 Fl Flerovium [289]
115 Mc Moscovium [289]
116 Lv Livermorium [293]
117 Ts Tennessine [294]
118 Og Oganesson [294]
Lanthanide Series
57 La Lanthanum 138.905
58 Ce Cerium 140.116
59 Pr Praseodymium 140.908
60 Nd Neodymium 144.243
61 Pm Promethium 144.913
62 Sm Samarium 150.36
63 Eu Europium 151.964
64 Gd Gadolinium 157.25
65 Tb Terbium 158.925
66 Dy Dysprosium 162.500
67 Ho Holmium 164.930
68 Er Erbium 167.259
69 Tm Thulium 168.934
70 Yb Ytterbium 173.055
71 Lu Lutetium 174.967
Actinide Series
89 Ac Actinium 227.028
90 Th Thorium 232.038
91 Pa Protactinium 231.036
92 U Uranium 238.029
93 Np Neptunium 237.048
94 Pu Plutonium 244.064
95 Am Americium 243.061
96 Cm Curium 247.070
97 Bk Berkelium 247.070
98 Cf Californium 251.080
99 Es Einsteinium [254]
100 Fm Fermium 257.095
101 Md Mendelevium 258.1
102 No Nobelium 259.101
103 Lr Lawrencium [262]