VCE Chemistry – Unit 2 (2012)
PRACTICE EXAMINATION

Reading time: 15 minutes
Writing time: 90 minutes

Your name: _____

Teacher's initials: ____

Instructions:

1. Section A (multiple choice) answers are to be written on the separate answer sheet provided. All answers to Section B are to be written on the examination paper.
2. If you run out of room, or need to start your answer again, you may use the back of a page. Clearly indicate where this occurs.
3. Write your answers clearly and neatly. Answers that cannot be read will be marked incorrect.
4. There are **81 marks—Section A (25) and Section B (58)—**available in this examination. This is little more than **one minute per mark** for each question.
5. You will not be permitted to leave the examination room until the scheduled completion of the exam.
6. Non-programmable scientific calculators permitted.

SECTION A

(Suggested time: 25 – 30 mins) ***(Total Marks = 25)***

- *This section contains 25 multiple choice questions.*
- *Choose the response that best answers the question and mark that response on the separate answer sheet provided.*
- *Each question has only **one** correct response.*
- *Marks are not deducted for incorrect answers.*

Question 1

What is the oxidation number of Mn in the compound MnO_3^-?

A. +2

B. +3

C. +5

D. +10

Question 2

Water contaminated with sulphuric acid was washed into a creek. How will this affect the pH of the water in the creek?

A. The pH of the water would increase because the concentration of the H_3O^+ ion would decrease.

B. The pH of the water would decrease because the concentration of the H_3O^+ ion would increase.

C. The pH of the water would decrease because the concentration of the OH^- ion would increase.

D. The pH of the water would not be affected.

Question 3

A sample of hydrogen gas occupies 2.24 L at 0 °C and 1 atm pressure. How many moles of oxygen are present in the sample?

A. 0.82 mol

B. 2.42 mol

C. 1.33 mol

D. 0.10 mol

/3

Question 4

What is the mass of 0.8 mol of calcium carbonate, $CaCO_3$?

A. 80.0 g

B. 119 g

C. 18.0 g

D. 183 g

Question 5

What is the **mass** of Na^+ ions in 0.25 L of 1.6 M Na_2SO_4?

A. 18.4 g

B. 0.16 g

C. 1.25 g

D. 11.5 g

Question 6

A 800 mL container was filled with helium gas at 200 °C. The pressure was measured and found to be 1.10 atm. The gas was then compressed to 160 mL at a temperature of 200 °C. What would be the pressure of the helium after compression?

A. 550 kpa

B. 2.73 kpa

C. 2.73 atm

D. 5.50 atm

Question 7

Consider the following chemical equations. Which equation has the species that becomes reduced underlined?

A. $2\underline{\mathbf{Al}}\ (s) + 6HCl\ (aq) \rightarrow 2AlCl_3\ (aq) + 3H_2\ (g)$

B. $CuCO_3\ (s) + \underline{\mathbf{H}}_2SO_4\ (aq) \rightarrow CuSO_4\ (aq) + H_2O(l) + CO_2(g)$

C. $\underline{\mathbf{Cu}}O\ (s) + 2HCl\ (aq) \rightarrow CuCl_2\ (aq) + H_2O\ (l)$

D. $\underline{\mathbf{Zn(}}NO_3)_2\ (aq) + Na(s) \rightarrow Zn\ (s) + Na_2SO_4\ (aq)$

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Question 8

Which of the following reactions would occur spontaneously?

A. $F_2(g) + 2H_2O(l) \rightarrow 2F^-(aq) + 4H^+(aq) + O_2(l)$

B. $2Br^-(aq) + 2Ag+ (aq) \rightarrow Br_2(l) + 2Ag(s)$

C. $I_2(aq) + 2Ag^+ (aq) \rightarrow 2I^- (aq) + 2Ag(s)$

D. $Pb^{2+}(aq) + H_2S(aq) \rightarrow PbS(s) + 2H^+(aq)$

Question 9

What is the pH of an aqueous solution of 0.0005 M H_2CO_3?

A. 3.0

B. 3.3

C. 4.0

D. It is impossible to calculate without knowing the percentage ionisation.

Question 10

What are the products produced when a dilute solution of nitric acid (HNO_3) reacts with solid calcium oxide?

A. Salt (calcium nitrate) and water

B. Salt (sodium chloride) and water

C. Carbon dioxide, water and a salt

D. An aqueous solution of sodium chloride and water

Question 11

$H_2SO_4(aq) + H_2O(l) \rightarrow H_3O^+(aq) + HSO_4^-(aq)$

Consider the reaction above. Which of the following are conjugate acid/base pairs?

A. H_3O^+ / HSO_4^-

B. H_2SO_4/H_2O

C. H_3O^+ /H_2O

D. H_3O^+, H_2SO_4

/4

Question 12

What would be the molar concentration of sodium ions in an aqueous solution prepared by dissolving 0.110 mol sodium phosphate, Na_3PO_4, in 500 mL of distilled water?

A. 0.055 M

B. 0.22 M

C. 0.165 M

D. 0.66 M

Question 13

A 0.010 M solution of acid has a pH of 2. Which of the following is likely to be true?

A. $[H_3O^+]$ = 0.01 M and it is a concentrated solution of a weak acid.

B. $[H_3O^+]$ = 0.01 M and it is a dilute solution of a strong acid

C. $[H_3O^+]$ = 2.00 M and it is a concentrated solution of a weak acid

D. $[H_3O^+]$ = 0.02 M and it is a dilute solution of a weak acid

Question 14

Under STP, 1 mol of an ideal gas occupies a volume of 22.4 L. Which of the following comments is true if the pressure is kept constant?

A. At 12.5 °C the volume will be 11.2 L

B. At 5.5 °C the volume will be 1.2 L

C. At –135.4 °C the volume will be 11.3 L

D. At 323 °C the volume will be 1.2 L

Question 15

The combustion of pentane, C_5H_{12}, can be described by the **<u>unbalanced</u>** chemical equation below,

$$C_5H_{12}\ (g) + O_2\ (g) \rightarrow CO_2\ (g) + H_2O\ (l)$$

If 14.40 g of pentane is reacted, how many moles of carbon dioxide are produced?

A. 8.00

B. 44.0

C. 51.5

D. 1.00

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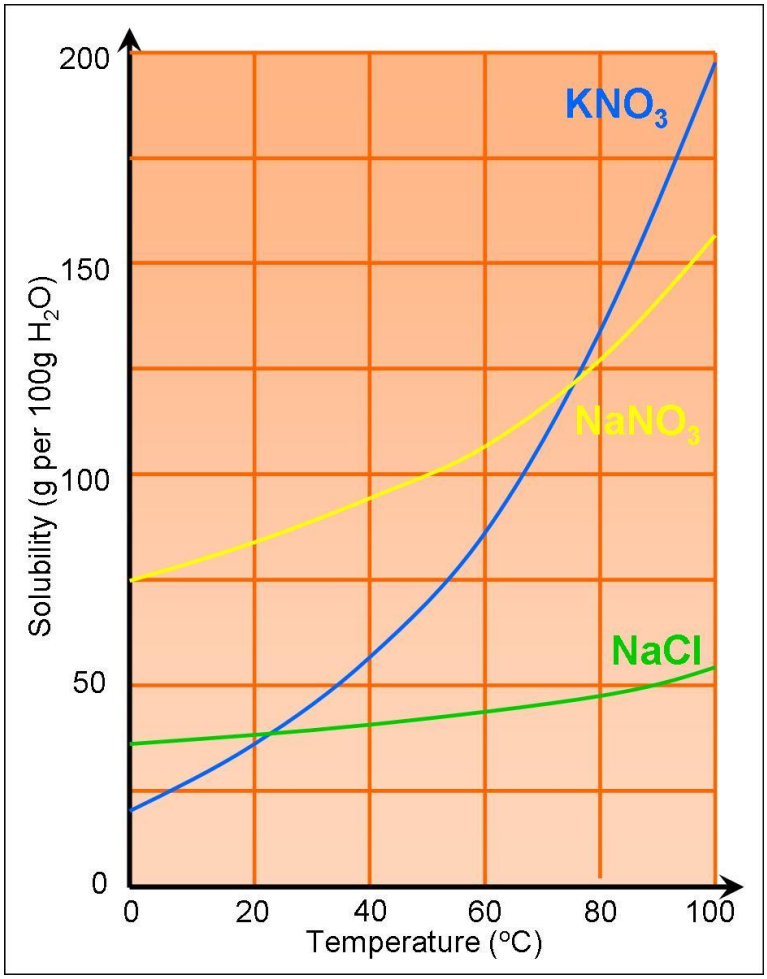
Questions 16—18 refer to the following solubility



Question 16

What minimum temperature is required to dissolve 60 g of sodium nitrate in 50 g of water?

A. 90 ºC
B. 75 ºC
C. 40 ºC
D. 20 ºC

Question 17

How much extra mass of potassium nitrate could be dissolved in 25 g of water at 60 ºC if 15g of the compound is already dissolved?

A. 10.5 g
B. 30.8 g
C. 40.0 g
D. 6.9 g

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Question 18

How many grams of solid potassium nitrate are required to form a saturated solution, at 60 °C, if 80 g of water is used?

A. 170 g

B. 70 g

C. 5.0 g

D. 54.0 g

Question 19

Which one of the following statements is true for a weak acid solution?

A. $[H_3O^+] > [OH^-]$

B. $[H_3O^+] < [OH^-]$

C. $[H_3O^+] = [OH^-]$

D. $[H_3O^+] = 0$

Question 20

Which of the statements below **best** describes a redox reaction?

A. Oxidation and reduction reactions occur simultaneously.

B. Oxidation reactions occur before the reduction reactions.

C. Electrons are transferred from the reductant to the oxidant.

D. Protons are transferred from the reductant to the oxidant.

Question 21

Consider the reaction given by the equation below. What mass of NaOH is formed if 15.6 g of $Al(OH)_3$ reacts completely?

$$Al(OH)_3 + 3\ NaNO_3 \text{ --> } Al(NO_3)_3 + 3NaOH$$

A. 24 g

B. 53 g

C. 89 g

D. 32 g

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Question 22

What is the temperature of a 3.2 g sample of oxygen gas contained in 1.06 L at 104.30 kPa ?

A. 133 ^{o}C

B. 133 K

C. -140 ^{o}C

D. -140 K

Question 23

A 250 mL of aqueous 2.00 M HCL is placed in a beaker and diluted by adding 950 mL of water. What is the final concentration of the HCL in this diluted solution?

A. 0.53 M

B. 0.14 M

C. 0.42 M

D. 1.1 M

Question 24

The reaction between magnesium and phosphoric acid can be described by the chemical equation,

$$3Mg\ (s) + 2H_3PO_4\ (aq) \rightarrow Mg_3(PO_4)_2\ (aq) + 3H_2\ (g)$$

What volume of hydrogen gas at SLC would be liberated when 29.39 g of phosphoric acid reacts with excess magnesium?

A. (0.45 X 24.5) L

B. (0.35 X 24.5) L

C. (0.30X 22.4) L

D. (0.15 X 24.5) L

Question 25

Which of the below statements is true about gases?

A. At a constant temperature, all gas molecules have the same kinetic energy.

B. At a constant temperature, pressure remains constant independent of volume.

C. At a constant volume, an increase in temperature decreases pressure.

D. At a constant pressure, increasing temperature causes an increase in volume.

/4

SECTION B

- *Suggested time: 60 – 65 minutes* ***(Total marks 53)***
- *All questions must be answered in this section.*
- *For full marks, all workings out must be shown and they should be logically presented. Legibility may be taken into account and poor legibility may be penalised.*

Question 1

A 04.304 g sample of a hydrocarbon gas occupied a volume of 0.158 L at 154.1 kPa and 27.0 °C.

(a) Given that the substance was a gas at the above temperature and pressure, calculate the moles of hydrocarbon gas present in the 4.304 g sample. *(3 marks)*

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(b) In $g.mol^{-1}$, calculate the molar mass of the hydrocarbon. *(1 mark)*

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(c) What temperature, in Celsius, is required for 0.374 g of the above gas to occupy a volume of 2.26 L at a pressure of 1.5 atm? *(3 marks)*

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(d) Briefly explain the equation $P_1 V_1 = P_2 V_2$. *(1 mark)*

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Question 2

Octane(C_8H_{18}) is an ingredient of car fuel. It is mixed with oxygen and then burnt to produce carbon dioxide and water vapour.

(a) Write a balanced chemical equation for the combustion of octane. *(3 marks)*

(b) What mass of carbon dioxide is produced if 30.0 g of octane is mixed with 30.0 g of oxygen gas.? *(3 marks)*

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Question 3

(a) Balance the following half-equations and identify each as either an oxidation or a reduction reaction. *(2 marks)*

(i) $H_2O_2(aq) \rightarrow H_2O(l)$ .....

(ii) $Cl_2(g) \rightarrow Cl^-(aq)$ .....

(b) Assign oxidation numbers to the underlined element in each of the following molecules or ions. *(3 marks)*

(i) $\underline{\mathbf{Cr}}_2O_7^{-2}$ .....

(ii) $C\underline{\mathbf{H}}_4$ .....

(iii) $\underline{\mathbf{Mn}}O_7^-$ .....

/11

(c) Consider the following redox reaction.

$$Cr_2O_7^{-2}(aq) + Cu(s) \rightarrow Cr^{3+}(aq) + Cu^{2+}(s) + H_2O(l)$$

Write balanced half-equations for

(i) the reduction process *(1 mark)*

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(ii) the oxidation process *(1 mark)*

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(iii) From these half-equations write the balanced overall equation, *(2 mark)*

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d) determine which chemical species is the reductant. *(1 mark)*

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Question 4

A solution of aqueous calcium hydroxide ($Ca(OH)_2$)was made by dissolving 0.02 mol of the alkali in water at 25 ^oC. This resulted in a 370 mL solution.

(a) Write a balanced **ionic equation** to show that calcium hydroxide is a strong base. *(1 mark)*

(b) Calculate the molar concentration, in $mol.L^{-1}$, of the solution? *(2 marks)*

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(c) Calculate the $[H_3O^+]$ in the sodium hydroxide solution in $mol.L^{-1}$. *(2 marks)*

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(d) Calculate the pH of the resultant solution. *(1 mark)*

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Question 5

Complete (a) to (c) below using the Brønsted-Lowry theory of acids and bases.

(a) i) Phosphoric acid, H_3PO_4, is a **strong acid**. Write appropriate, balanced chemical equations to show complete and successive ionisation of this acid in water. *(3 marks)*

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a) .....

b) .....

c) .....

ii) Indicate which reaction, from the ones above, is least likely to proceed to the right and give an explanation?

(2 marks)

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(b) In water, the carbonate ion, CO_3^{2-}, is a **weak base**. Write an appropriate, balanced chemical equation for the behaviour of this base in aqueous solution. *(1 mark)*

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(c) The hydrogen sulfate ion, HSO_4^-, is **amphiprotic**. Give two balanced chemical equations that demonstrate the amphiprotic nature of this ion. *(2 marks)*

a) .....

b) .....

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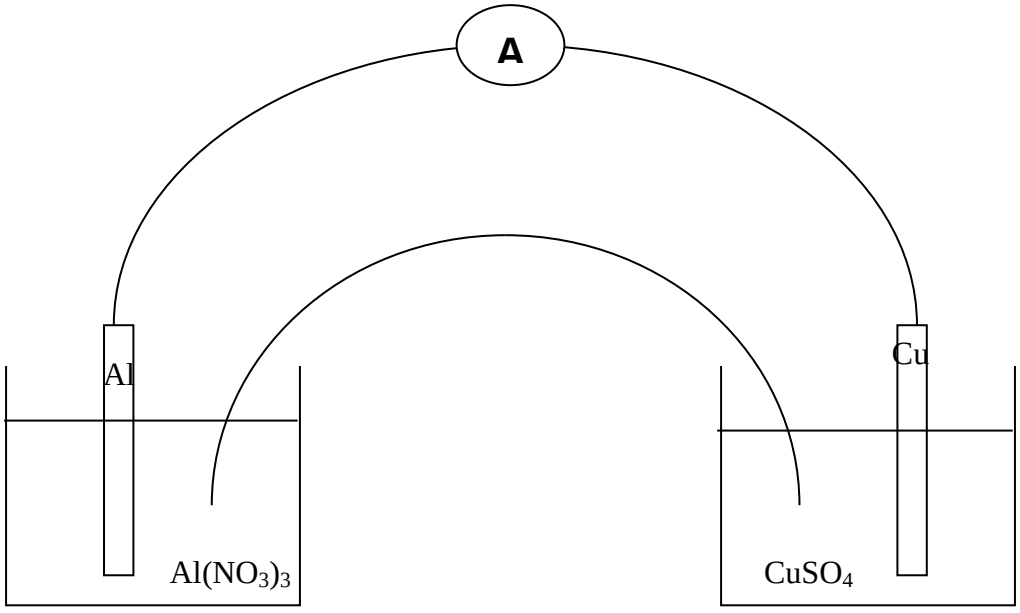
Question 6

a) On the below diagram of an electrochemical cell clearly indicate the
- anode and its polarity
- cathode and its polarity
- direction of electron flow
- direction of negative ion flow
- direction of positive ion flow
- the electrode gaining mass
- the electrode losing mass



(7marks)

(b)

Reduction half-equation	
Oxidation half-equation	
Overall Equation	

(3 marks)

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Question 7

A student mixed 20.0 mL of 0.010 M sodium carbonate (Na_2CO_3), with 60.0 mL of 0.010 M hydrochloric acid, HCl. The mixture was allowed to react completely.

(a) Write a balanced equation for the reaction between calcium hydroxide and nitric acid. *(2 marks)*

(b) Calculate the number of moles of Na_2CO_3 in the 20.0 mL sample. *(1 mark)*

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(c) Calculate the number of moles of HCl in the 60 mL sample. *(1 mark)*

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(d) At the completion of the reaction, which reactant is in excess and by how much in grams? *(2 marks)*

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Question 8

A pure sample of a gas has a density of $2.00gL^{-}$ at 25.0 °C and 1.05 atm pressure.

a) Calculate its molar mass in g/mol *(3marks)*

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b) A student is told that it is a dioxide. Which is the most likely gas? *(1 mark)*.

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Data Sheet

Physical constants

$F = 96\,500\ \text{C mol}^{-1}$

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

1 atm = 101 325 Pa = 760 mmHg

0°C = 273 K

Molar volume at STP = $22.4\ \text{L mol}^{-1}$

Avogadro constant = $6.02 \times 10^{23}\ \text{mol}^{-1}$

Ideal gas equati

$pV = nRT$

The electrochemical series

	$E°$ in volt
$F_2(g) + 2e^- \rightarrow 2F^-(aq)$	+2.87
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(l)$	+1.77
$Au^+(aq) + e^- \rightarrow Au(s)$	+1.68
$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$	+1.36
$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(1)$	+1.23
$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$	+1.09
$Ag^+(aq) + e^- \rightarrow Ag(s)$	+0.80
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	+0.77
$I_2(s) + 2e^- \rightarrow 2I^-(aq)$	+0.54
$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$	+0.40
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	+0.34
$S(s) + 2H^+(aq) + 2e^- \rightarrow H_2S(g)$	+0.14
$2H^+(aq) + 2e^- \rightarrow H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$	–0.13
$Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$	–0.14
$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$	–0.23
$Co^{2+}(aq) + 2e^- \rightarrow Co(s)$	–0.28
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	–0.44
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	–0.76
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	–0.83
$Mn^{2+}(aq) + 2e^- \rightarrow Mn(s)$	–1.03
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	–1.67
$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	–2.34
$Na^+(aq) + e^- \rightarrow Na(s)$	–2.71
$Ca^{2+}(aq) + 2e^- \rightarrow Ca(s)$	–2.87
$K^+(aq) + e^- \rightarrow K(s)$	–2.93
$Li^+(aq) + e^- \rightarrow Li(s)$	–3.02

Periodic Table

	Main groups 1A[a] 1		Transition metals										Main groups 3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
	1		3B 3	4B 4	5B 5	6B 6	7B 7	8B 8	8B 9	8B 10	1B 11	2B 12						2
1	**H** 1.00794	2A 2																**He** 4.00260
2	3 **Li** 6.941	4 **Be** 9.01218											5 **B** 10.811	6 **C** 12.0107	7 **N** 14.0067	8 **O** 15.9994	9 **F** 18.9984	10 **Ne** 20.1797
3	11 **Na** 22.9898	12 **Mg** 24.3050											13 **Al** 26.9815	14 **Si** 28.0855	15 **P** 30.9738	16 **S** 32.065	17 **Cl** 35.453	18 **Ar** 39.948
4	19 **K** 39.0983	20 **Ca** 40.078	21 **Sc** 44.9559	22 **Ti** 47.867	23 **V** 50.9415	24 **Cr** 51.9961	25 **Mn** 54.9380	26 **Fe** 55.845	27 **Co** 58.9332	28 **Ni** 58.6934	29 **Cu** 63.546	30 **Zn** 65.39	31 **Ga** 69.723	32 **Ge** 72.64	33 **As** 74.9216	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.80
5	37 **Rb** 85.4678	38 **Sr** 87.62	39 **Y** 88.9059	40 **Zr** 91.224	41 **Nb** 92.9064	42 **Mo** 95.94	43 **Tc** [98]	44 **Ru** 101.07	45 **Rh** 102.9055	46 **Pd** 106.42	47 **Ag** 107.8682	48 **Cd** 112.411	49 **In** 114.818	50 **Sn** 118.710	51 **Sb** 121.760	52 **Te** 127.60	53 **I** 126.9045	54 **Xe** 131.293
6	55 **Cs** 132.9055	56 **Ba** 137.327	71 **Lu** 174.967	72 **Hf** 178.49	73 **Ta** 180.9479	74 **W** 183.84	75 **Re** 186.207	76 **Os** 190.23	77 **Ir** 192.217	78 **Pt** 195.078	79 **Au** 196.9666	80 **Hg** 200.59	81 **Tl** 204.3833	82 **Pb** 207.2	83 **Bi** 208.9804	84 **Po** [208.98]	85 **At** [209.99]	86 **Rn** [222.02]
7	87 **Fr** [223.02]	88 **Ra** [226.03]	103 **Lr** [262.11]	104 **Rf** [261.11]	105 **Db** [262.11]	106 **Sg** [266.12]	107 **Bh** [264.12]	108 **Hs** [269.13]	109 **Mt** [268.14]	110 **Ds** [271.15]	111 **Rg** [272.15]	112 **Cn** [277]	113 [284]	114 [289]	115 [288]	116 [292]		

Lanthanide series	57 **La** 138.9055	58 **Ce** 140.116	59 **Pr** 140.9077	60 **Nd** 144.24	61 **Pm** [145]	62 **Sm** 150.36	63 **Eu** 151.964	64 **Gd** 157.25	65 **Tb** 158.9253	66 **Dy** 162.50	67 **Ho** 164.9303	68 **Er** 167.259	69 **Tm** 168.9342	70 **Yb** 173.04
Actinide series	89 **Ac** [227.03]	90 **Th** 232.0381	91 **Pa** 231.0359	92 **U** 238.0289	93 **Np** [237.05]	94 **Pu** [244.06]	95 **Am** [243.06]	96 **Cm** [247.07]	97 **Bk** [247.07]	98 **Cf** [251.08]	99 **Es** [252.08]	100 **Fm** [257.10]	101 **Md** [258.10]	102 **No** [259.10]

[a]The labels on top (1A, 2A, etc.) are common American usage. The labels below these (1, 2, etc.) are those recommended by the International Union of Pure and Applied Chemistry (IUPAC).