Study Guide

For Placement into Chemistry 20 (CHEM 181)

Academic Upgrading Placement Test | Version: 9 Jan 2025

Important Information

The Chemistry Placement test is a free assessment designed for Academic Upgrading placement purposes only. No section of the test may be used for admission to any SAIT program other than Academic Upgrading. The Chemistry Placement Test is not accepted for admission to any other institution.

- The passing mark required for eligibility to register in CHEM 181 (Chemistry 20) is 60%.
- We aim to put students' passing marks on our system within 2 business days of successful completion of the test.
- Students who have been accepted into the Academic Upgrading program can register for the course they are placed into once we have granted them permission based on their passing grades.
- Students who have already taken and passed SAIT's Academic Upgrading courses in Math and Physics ARE NOT required to take a placement test.

Chemistry Placement Study Guide

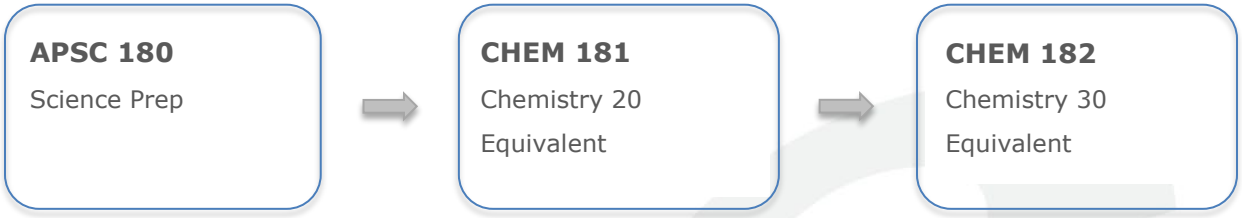
This study guide is designed to prepare students for the Academic Upgrading Chemistry Placement test for entry into CHEM 181 (Chemistry 20). Please use the following practice material from Science 10 to prepare for your online placement test to meet eligibility for CHEM 181. An answer key is included at the end of this guide.

This test is for placement into Chemistry 20 equivalency (CHEM 181):

- The study guide consists of 35 questions for practice. The actual test will consist of 20 questions. You may use the solubility table and periodic table of elements as provided at the end of the guide.
- **A data booklet including the periodic table will be provided.** Students will require a pen and paper for the calculation-based questions.
- Students should allow for 60 minutes to complete the test. An additional 30 minutes has been added to allow for accommodated time, for a total test time of 90 minutes.
- A passing mark of 60% or greater is required in this test for eligibility to register in CHEM 181.

- This test is to be written in the Testing Centre.
- You may choose to utilize a Science 10 Study Guide from the Calgary Public Library or bookstore for additional review.

SAIT Academic Upgrading Course Sequence



Multiple Choice

1. John Dalton proposed four ideas in his model of the atom. Which of the following is **not** part of his model?
   a) all matter is made of small indivisible particles
   b) atoms of different elements have different properties
   c) atoms are never created or destroyed during a chemical reaction
   d) all the atoms of an element are identical in properties such as size and mass

2. A certain chemical family is composed of elements that are soft, shiny, very reactive with water, and form ions with a charge of 1+. This family could be
   a) the halogens
   b) the noble gases
   c) the alkali metals
   d) the alkaline-earth metals

3. Which column in the periodic table contains elements with one electron in their valence energy level?
   a) first on the left
   b) first on the right
   c) second from the left
   d) second from the right

4. Which two particles are approximately equal in mass?
   a) proton and neutron
   b) proton and electron
   c) neutron and electron
   d) none of these

5. The magnesium ion, Mg^{+2}, has
   a) 10 electrons and 10 protons
   b) 10 electrons and 12 protons
   c) 12 electrons and 10 protons
   d) 12 electrons and 12 protons

6. An atom of fluorine has 9 protons, 10 neutrons, and 9 electrons. Its mass number is
   a) 9
   b) 10
   c) 18
   d) 19

7. What is the formula for sodium carbonate?
   a) $S_2CO_{3(s)}$
   b) $NaCO_{(s)}$
   c) $Na_2CO_{3(s)}$
   d) $Na_3CO_{3(s)}$

8. What is the formula for aluminum hydroxide?
   a) $AlOH_{3(s)}$
   b) $Al_3OH_{(s)}$
   c) $Al(OH)_{3(s)}$
   d) Al(III) $OH_{(s)}$

9. Which of the following is an ionic compound?
   a) $HCl_{(aq)}$
   b) $KCl_{(s)}$
   c) $ClO_{3(g)}$
   d) $NCl_{3(g)}$

10. Which of the following properties are characteristic of an ionic compound?

    I It is malleable.
    II It is solid at room temperature.
    III Its solution conducts electricity.

    a) I and II only
    b) I and III only
    c) II and III only
    d) I, II, and III

11. Which of the following are very soluble?

    I Na_2S
    II CuBr
    III $Sr(OH)_2$

    a) I and II only
    b) I and III only
    c) II and III only
    d) I, II, and III

12. Which of the following is a general property of bases?
    a) taste sour
    b) turn litmus red
    c) conduct electricity
    d) react with Mg to produce hydrogen bubbles

13. Which of the following is an acid?
    a) $CH_{4(g)}$
    b) $K_3PO_{4(aq)}$
    c) $H_3PO_{4(aq)}$
    d) $NaOH_{(aq)}$

14. Consider the following reaction:
    ____ $NaOH_{(aq)}$ + ____ $Al(NO_3)_{3(aq)}$ → ____ $Al(OH)_{3(s)}$ + ____ $NaNO_{3(aq)}$
    The coefficient for $Al(NO_3)_3$ when the above equation is balanced is
    a) 1
    b) 2
    c) 3
    d) 4

15. The following reaction takes place when gasoline reacts with air:
    $2\ C_6H_{14(l)} + 19\ O_{2(g)} \rightarrow 12\ CO_{2(g)} + 14\ H_2O_{(g)}$ (*insert earth-shattering kaboom! noise here.)*
    This reaction is
    a) single replacement reaction
    b) double replacement reaction
    c) hydrocarbon combustion reaction
    d) decomposition reaction

Section II. Skills

Name or give the formula for each compound in questions 24 to 33. (1 mark each)

16. $CaBr_{2(s)}$ _____
17. $Au_3PO_{4(s)}$ _____
18. $N_2O_{4(g)}$ _____
19. $NH_{3(s)}$ _____
20. $H_2SO_{4(aq)}$ _____
21. lead(IV) sulfide _____
22. methane _____

23. sulfur trioxide _____

24. hydrochloric acid _____

25. iron(II) nitride _____

Section III. Written Response

Balance the equations in questions 31, 32, and 33.

26. _____ $Na_{(s)}$ + _____ $O_{2(g)}$ → _____ $Na_2O_{(s)}$

27. . _____ $C_8H_{16(l)}$ + _____ $O_{2(g)}$ → _____ $CO_{2(g)}$ + _____ $H_2O_{(g)}$

28. _____ $NH_{3(g)}$ + _____ $O_{2(g)}$ → _____ $NO_{(g)}$ + _____ $H_2O_{(l)}$

Predict the formulas of the products for each reaction below and WRITE them in the spaces provided, but do NOT balance the equations. Also, state the FULL name of the reaction type for each reaction.

	Products	**Reaction Type**
29. $Na_{(s)} + Br_{2(l)}$ →		
30. $CH_{4(g)} + O_{2(g)}$ →		
31. $Al_{(s)} + CuCl_{2(aq)}$ →		
32. $NaI_{(aq)} + Pb(NO_3)_{2(aq)}$ →		

Write balanced formula equations for the reactions in questions 33 and 34.

33. Aqueous ammonium sulfide and aqueous lead(II) nitrate are mixed together. They react to yield aqueous ammonium nitrate and solid lead(II) sulfide.

34. Copper metal is placed in a solution of silver nitrate. This produces aqueous copper(II) nitrate and silver metal.

35. The element nitrogen has two common isotopes: nitrogen-14 and nitrogen-16.
    a) State how these two types of atoms are similar.

    b) State how these two types of atoms are different.

Chemistry Answers

Section I. Multiple Choice

1. c
2. c
3. a
4. a
5. b
6. d
7. c
8. c
9. b
10. c
11. b
12. c
13. c
14. a
15. c

Section II. Skills

16. calcium bromide
17. gold(III) phosphate
18. dinitrogen tetroxide
19. ammonia
20. sulfuric acid
21. $PbS_{2(s)}$
22. $CH_{4(g)}$
23. $SO_{3(g)}$
24. $HCl_{(aq)}$
25. $Fe_3N_{2(s)}$

Section III. Response

26. 4, 1, 2
27. 1, 12, 8, 8
28. 4, 5, 4, 6
29. $NaBr_{(s)}$ formation
30. $CO_{2(g)} + H_2O_{(g)}$ hydrocarbon combustion
31. $AlCl_{3(aq)} + Cu_{(s)}$ single replacement
32. $NaNO_{3(aq)} + PbI_{2(s)}$ double replacement
33. $(NH_4)_2S_{(aq)} + Pb(NO_3)_{2(aq)} \rightarrow 2\ NH_4NO_{3(aq)} + PbS_{(s)}$
34. $Cu_{(s)} + 2\ AgNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + 2\ Ag_{(s)}$
35. a) Both atoms have the same number of protons or atomic number.
    b) One has 7 neutrons and the other has 8 neutrons. Their mass numbers are different.

Chemistry 11 Placement
Test Data Booklet

Solubility of Some Common Ionic Compounds in Water at 25°C								
Ion	**Group1 NH_4^+ H_3O^+,H^+**	**ClO_3^- NO_3^- ClO_4^-**	**CH_3COO^-**	**Cl^- Br^- I^-**	**SO_4^{2-}**	**S^{2-}**	**OH^-**	**PO_4^{3-} SO_3^{2-} CO_3^{2-}**
Solubility greater than or equal to 0.1 mol/L (very soluble)	all	all	most	most	most	Group1 Group2 NH_4^+	Group1 NH_4^+ Sr^{2+} Ba^{2+} Tl^+	Group1 NH_4^+
Solubility less than 0.1 mol/L (slightly soluble)	none	none	Ag^+ Hg^+	Ag^+ Pb^{2+} Hg^+ Cu^+ Tl^+	Ca^{2+} Sr^{2+} Ba^{2+} Ra^{2+} Pb^{2+} Ag^+	most	most	most

1	2	3	4	5	6	7	8	9

Table of Common Polyatomic Ions

acetate (ethanoate)	CH_3COO^-	chromate	CrO_4^{2-}	phosphate	PO_4^{3-}
ammonium	NH_4^+	dichromate	$Cr_2O_7^{2-}$	hydrogen phosphate	HPO_4^{2-}
benzoate	$C_6H_5COO^-$	cyanide	CN^-	dihydrogen phosphate	$H_2PO_4^-$
borate	BO_3^{3-}	hydroxide	OH^-	silicate	SiO_3^{2-}
carbide	C_2^{2-}	iodate	IO_3^-	sulfate	SO_4^{2-}
carbonate	CO_3^{2-}	nitrate	NO_3^-	hydrogen sulfate	HSO_4^-
hydrogen carbonate	HCO_3^-	nitrite	NO_2^-	sulfite	SO_3^{2-}
perchlorate	ClO_4^-	oxalate	$OOCCOO^{2-}$	hydrogen sulfite	HSO_3^-
chlorate	ClO_3^-	hydrogen oxalate	$HOOCCOO^-$	hydrogen sulfide	HS^-
chlorite	ClO_2^-	permanganate	MnO_4^-	thiocyanate	SCN^-
hypochlorite	OCl^- or ClO^-	peroxide	O_2^{2-}	thiosulfate	$S_2O_3^{2-}$
		persulfide	S_2^{2-}		

1 1.01 1+,1− 2.2 H hydrogen								
3 6.94 1+ 1.0 Li lithium	4 9.01 2+ 1.6 Be beryllium							
11 22.99 1+ 0.9 Na sodium	12 24.31 2+ 1.3 Mg magnesium							
19 39.10 1+ 0.8 K potassium	20 40.08 2+ 1.0 Ca calcium	21 44.96 3+ 1.4 Sc scandium	22 47.87 4+, 3+ 1.5 Ti titanium	23 50.94 5+, 4+ 1.6 V vanadium	24 52.00 3+, 2+ 1.7 Cr chromium	25 54.94 2+, 4+ 1.6 Mn manganese	26 55.85 3+, 2+ 1.8 Fe iron	27 58.93 2+, 3+ 1.9 Co cobalt
37 85.47 1+ 0.8 Rb rubidium	38 87.62 2+ 1.0 Sr strontium	39 88.91 3+ 1.2 Y yttrium	40 91.22 4+ 1.3 Zr zirconium	41 92.91 5+, 3+ 1.6 Nb niobium	42 95.94 6+ 2.2 Mo molybdenum	43 (98) 7+ 2.1 Tc technetium	44 101.07 3+ 2.2 Ru ruthenium	45 102.91 3+ 2.3 Rh rhodium
55 132.91 1+ 0.8 Cs cesium	56 137.33 2+ 0.9 Ba barium	57 138.91 3+ 1.1 La lanthanum	72 178.49 4+ 1.3 Hf hafnium	73 180.95 5+ 1.5 Ta tantalum	74 183.84 6+ 1.7 W tungsten	75 186.21 7+ 1.9 Re rhenium	76 190.23 4+ 2.2 Os osmium	77 192.22 4+ 2.2 Ir iridium
87 (223) 1+ 0.7 Fr francium	88 (226) 2+ 0.9 Ra radium	89 (227) 3+ 1.1 Ac actinium	104 (261) 4+ Rf rutherfordium	105 (262) Db dubnium	106 (266) Sg seaborgium	107 (264) Bh bohrium	108 (277) Hs hassium	109 (268) Mt meitnerium

lanthanide and actinide series begin

58 140.12 3+ 1.1 Ce cerium	59 140.91 3+ 1.1 Pr praseodymium	60 144.24 3+ 1.1 Nd neodymium	61 (145) 3+ — Pm promethium	62 150.36 3+, 2+ 1.2 Sm samarium
90 232.04 4+ 1.3 Th thorium	91 231.04 5+, 4+ 1.5 Pa protactinium	92 238.03 6+, 4+ 1.7 U uranium	93 (237) 5+ 1.3 Np neptunium	94 (244) 4+, 6+ 1.3 Pu plutonium

References

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Speight, James G. 2005. *Lange's Handbook of Chemistry*. 16th ed. New York: McGraw-Hill, Inc.

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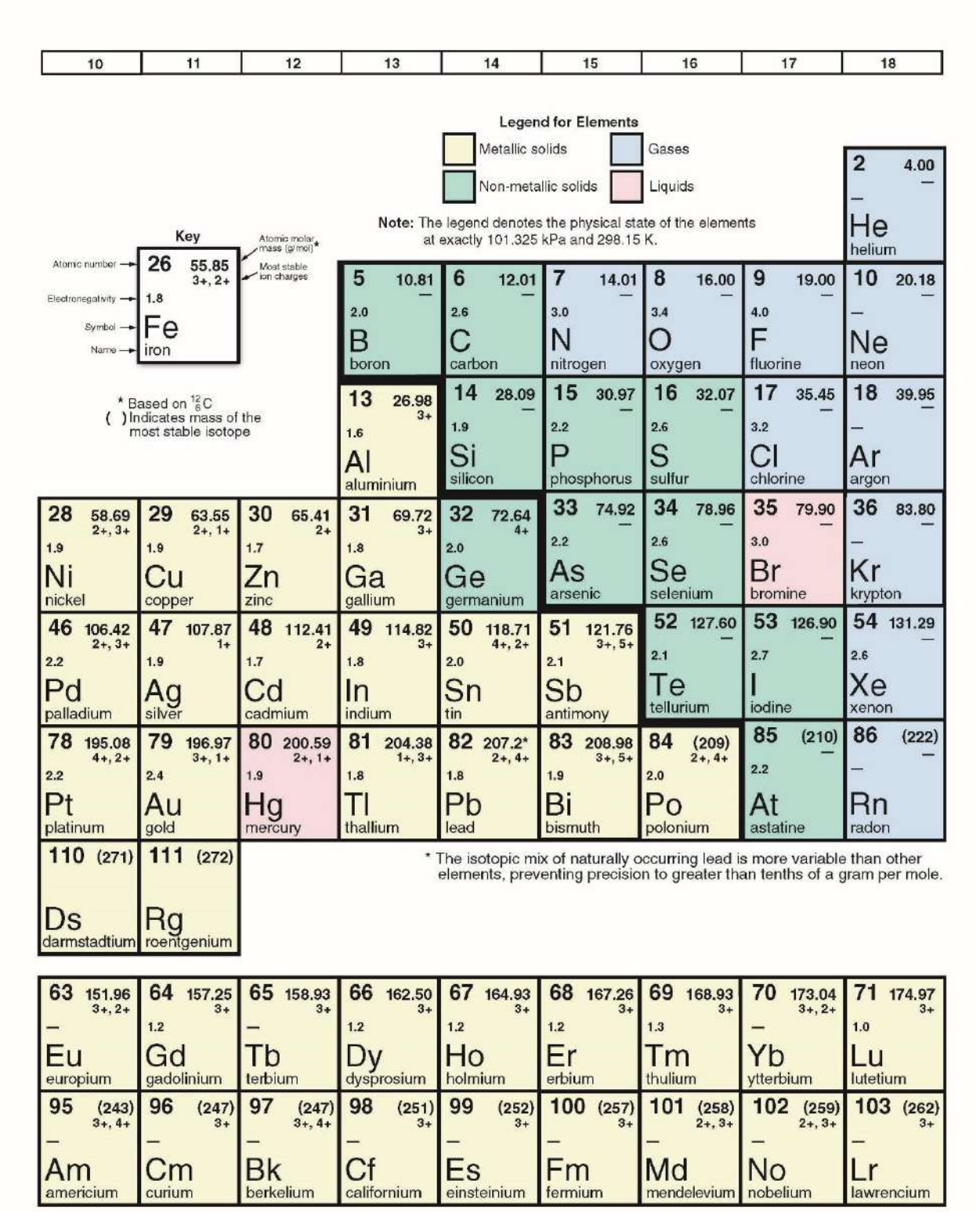
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Legend for Elements
Metallic solids
Gases
Non-metallic solids
Liquids
Note: The legend denotes the physical state of the elements at exactly 101.325 kPa and 298.15 K.
Key
Atomic number
Atomic molar mass (g/mol)*
Most stable ion charges
Electronegativity
Symbol
Name
26 55.85 3+, 2+ 1.8 Fe iron
* Based on 12 6 C
( ) Indicates mass of the most stable isotope
2 4.00 — — He helium
5 10.81 — 2.0 B boron
6 12.01 — 2.6 C carbon
7 14.01 — 3.0 N nitrogen
8 16.00 — 3.4 O oxygen
9 19.00 — 4.0 F fluorine
10 20.18 — — Ne neon
13 26.98 3+ 1.6 Al aluminium
14 28.09 — 1.9 Si silicon
15 30.97 — 2.2 P phosphorus
16 32.07 — 2.6 S sulfur
17 35.45 — 3.2 Cl chlorine
18 39.95 — — Ar argon
28 58.69 2+, 3+ 1.9 Ni nickel
29 63.55 2+, 1+ 1.9 Cu copper
30 65.41 2+ 1.7 Zn zinc
31 69.72 3+ 1.8 Ga gallium
32 72.64 4+ 2.0 Ge germanium
33 74.92 — 2.2 As arsenic
34 78.96 — 2.6 Se selenium
35 79.90 — 3.0 Br bromine
36 83.80 — — Kr krypton
46 106.42 2+, 3+ 2.2 Pd palladium
47 107.87 1+ 1.9 Ag silver
48 112.41 2+ 1.7 Cd cadmium
49 114.82 3+ 1.8 In indium
50 118.71 4+, 2+ 2.0 Sn tin
51 121.76 3+, 5+ 2.1 Sb antimony
52 127.60 — 2.1 Te tellurium
53 126.90 — 2.7 I iodine
54 131.29 — 2.6 Xe xenon
78 195.08 4+, 2+ 2.2 Pt platinum
79 196.97 3+, 1+ 2.4 Au gold
80 200.59 2+, 1+ 1.9 Hg mercury
81 204.38 1+, 3+ 1.8 Tl thallium
82 207.2* 2+, 4+ 1.8 Pb lead
83 208.98 3+, 5+ 1.9 Bi bismuth
84 (209) 2+, 4+ 2.0 Po polonium
85 (210) — 2.2 At astatine
86 (222) — — Rn radon
110 (271) Ds darmstadtium
111 (272) Rg roentgenium
* The isotopic mix of naturally occurring lead is more variable than other elements, preventing precision to greater than tenths of a gram per mole.
63 151.96 3+, 2+ — Eu europium
64 157.25 3+ 1.2 Gd gadolinium
65 158.93 3+ — Tb terbium
66 162.50 3+ 1.2 Dy dysprosium
67 164.93 3+ 1.2 Ho holmium
68 167.26 3+ 1.2 Er erbium
69 168.93 3+ 1.3 Tm thulium
70 173.04 3+, 2+ — Yb ytterbium
71 174.97 3+ 1.0 Lu lutetium
95 (243) 3+, 4+ — Am americium
96 (247) 3+ — Cm curium
97 (247) 3+, 4+ — Bk berkelium
98 (251) 3+ — Cf californium
99 (252) 3+ — Es einsteinium
100 (257) 3+ — Fm fermium
101 (258) 2+, 3+ — Md mendelevium
102 (259) 2+, 3+ — No nobelium
103 (262) 3+ — Lr lawrencium