

First Year Chemistry Assessment Test

SAMPLE QUESTIONS

BROCK UNIVERSITY DEPARTMENT OF CHEMISTRY

Section 1 – Basic Math

1. Round the following calculations to the proper number of significant figures:

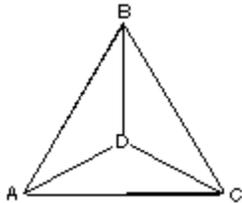
(i) $140.115 + 64.12 + 127.9952 = 332.2302$

(ii) $\frac{22.7}{0.068326} = 332.230776$

(iii) $\frac{80.200}{(3.2314 - 2.99)} = 332.228666$

2. Solve the following expression for f: $m/c = w/f$

3. Point D lies in the center of the equilateral triangle ABC. What is angle ADB (in degrees)?



4. Multiply 4×10^{52} by 2×10^{60} . Express your answer in exponential form.

5. Given the following two equations with two unknowns, x and y. What is the value of x?

$$x + y = 1$$

$$3x + 5y = 4.2$$

6. The quadratic formula for the roots of x in a quadratic equation are

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

What are the values of x in the equation, $x^2 + 2x - 3 = 0$?

7. Use the quadratic formula in question 6 above, and determine the values of x in the following equation:

$$x^2 + 1.0 \cdot 10^{-4}x - 1.00 \cdot 10^{-5} = 0$$

8. Use the quadratic formula in question 6 above, and determine the values of x in the following equation:

$$4.73 = \frac{(0.10 - x)(0.30 - x)}{x^2}$$

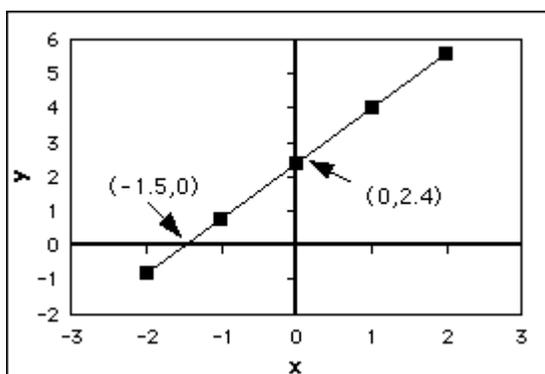
9. If 20.0 grams of sugar are dissolved in 80.0 grams of water, what is the mass percentage of sugar in the solution?

10. How many grams of H_2SO_4 are contained in 125 mL of a solution that has a density is 1.80 g/mL and contains 96.0 mass % H_2SO_4 ?

11. Copper has a density of 8.92 g/cm^3 . If copper wire has a radius of 0.0500 cm, how many centimeters of wire must be measured to obtain 2.00 g of copper?

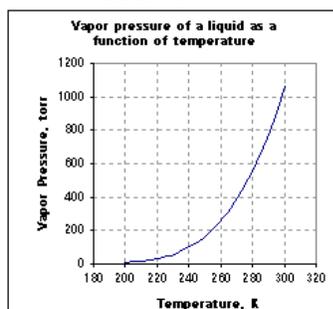
12. How many square meters are there in an area of 72 square feet? (1 ft = 0.305 m)

13. The equation of a straight line is given by $y = mx + b$, where m is the slope and b is the intercept. What is the equation of the straight line below?



14. The graph below shows the vapor pressure of a certain liquid as a function of the temperature. Use the graph to answer the following questions:

- At what temperature is the vapor pressure 1000 torr?
- Estimate the vapor pressure when the temperature is 260 K.
- The normal boiling point of a liquid is the temperature at which the vapor pressure is equal to 1 atmosphere (760 torr). What is the normal boiling point of the liquid whose graph is shown below?



Section 2 – Periodic Table

1. How many valence electrons are there in an atom of silicon?

2. How many protons , electrons and neutrons does the ion ${}^{55}_{26}\text{Fe}^{3+}$ contain?

3. What is the symbol for the element manganese?

4. What is the name of the element whose symbol is K?

5. Which of the following atoms is largest: Na, K, Mg, Ca?

6. Which of the following ions is largest: Na^+ , K^+ , Mg^{2+} , Ca^{2+} ?

7. Which of the following elements is most likely to form a -2 ion? Ca, Fe, C, S, Br

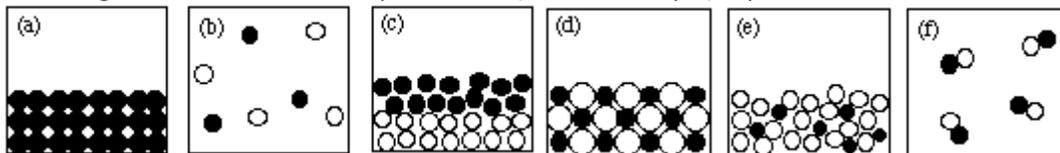
8. Which of the following elements is/are diatomic gases at ordinary temperature and pressure?
neon, sodium, oxygen, bromine, carbon

9. What is the period number and the group number for the element iodine?

10. Which element is easiest to ionize (has the lowest first ionization energy)?
sodium, potassium magnesium, calcium, fluorine

Section 3 – Chemical Compounds

1. The figures shown below are particulate (submicroscopic) representations of various states of matter.



Answer the following questions by giving the letter of the figure that corresponds to the description. Drawings may be used more than once or not at all. There may be more than one answer to a given question.

Write "NONE" if no drawing fits the description.

- (i) Which drawing(s) represent submicroscopic particles in a sample of an element?
- (ii) Which drawing(s) represent submicroscopic particles in a gas?
- (iii) Which drawing(s) represent submicroscopic particles in a sample of a liquid compound?
- (iv) Which drawing(s) represent submicroscopic particles in a sample of a molecular solid?
- (v) Which drawing(s) represent submicroscopic particles in a sample of a heterogeneous mixture?
- (vi) Which drawing(s) represent submicroscopic particles in a sample of an ionic solid?
- (vii) Which drawing(s) represent submicroscopic particles in a sample of a compound?
- (viii) Which drawing(s) represent submicroscopic particles in a gaseous mixture?
- (ix) Which drawing(s) represent submicroscopic particles in a gaseous compound?

2. What is the formula of sulfuric acid?

3. What is the formula for calcium chloride?

4. What is the formula for iron(III) oxide?

5. What is the systematic (IUPAC) name of P_4O_{10} ?

6. What is the systematic (IUPAC) name of $Cu(NO_3)_2$?

7. Which of the following compounds is (are) ionic?

SO ₃	FeSO ₄	PCl ₅	HCl	NaF
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8. What is the oxidation number of phosphorus in H₃PO₃?

9. What is the oxidation number of nitrogen in Ca(NO₂)₂?

10. What is the oxidation number of sulfur in Na₂S₂O₃?

11. Which of the following Lewis (electron-dot) structures is/are wrong. (Give their letters.)

(a) SO ₂	(b) NH ₃	(c) NO ₂ ⁺	(d) NH ₄ Cl	(e) NH ₄ Cl

12. What do the letters VSEPR stand for?

13. Describe the geometric shapes of the molecules or ions whose Lewis structures are shown below.

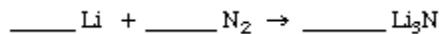
Your choices are

- linear
- bent
- triangular planar
- tetrahedral
- square planar
- triangular pyramid
- triangular bipyramid
- octahedral
- T-shape

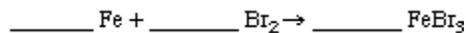
(a) H ₂ O	(b) SO ₄ ²⁻	(c) CO ₂	(d) XeO ₃	(e) NO ₂ ⁻

Section 4 – Chemical Reactions

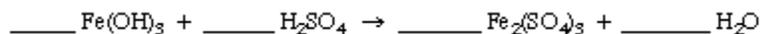
1. What is the formula of the reaction product when sodium reacts with iodine?
2. What are the formulas of the products when nitric acid, HNO_3 , reacts with aluminum hydroxide, $\text{Al}(\text{OH})_3$?
3. Give the formulas of the acid and the base that must be used to make the salt, $(\text{NH}_4)_2\text{SO}_4$.
4. Balance the equation for the reaction of copper(II) hydroxide, $\text{Cu}(\text{OH})_2$, with hydrochloric acid, HCl .
5. Balance the following equation for the reaction of lithium with nitrogen (lowest whole number coefficients).



6. Balance the following equation for the reaction of iron with bromine (lowest whole number coefficients).



7. Balance the following equation for the reaction of iron(III) hydroxide with sulfuric acid.



8. Reactions may be classified in several ways, for example:

- Combination reaction
- Acid-base reaction
- Precipitate-forming reaction
- Gas-producing reaction
- Oxidation-reduction reaction
- Decomposition reaction

Give the types of each of the following reactions. Some reactions can be classified in more than one way; give all of the types that are applicable. Equations are not balanced.

- a. $\text{P}_4\text{O}_6 (\text{s}) + \text{O}_2 (\text{g}) \rightarrow \text{P}_4\text{O}_{10} (\text{s})$
- b. $\text{H}_2\text{SO}_4 (\text{aq}) + \text{Ba}(\text{NO}_3)_2 (\text{aq}) \rightarrow \text{BaSO}_4 (\text{s}) + \text{HNO}_3 (\text{aq})$
- c. $\text{NH}_4\text{Cl} (\text{s}) + \text{NaOH} (\text{aq}) \rightarrow \text{NaCl} (\text{aq}) + \text{H}_2\text{O} (\text{l}) + \text{NH}_3 (\text{g})$

- d. $\text{Al (s)} + \text{HCl (aq)} \rightarrow \text{AlCl}_3 \text{ (aq)} + \text{H}_2 \text{ (g)}$
- e. $\text{NO}_2 \text{ (g)} \rightarrow \text{NO (g)} + \text{O}_2 \text{ (g)}$
- f. $\text{Zn(OH)}_2 \text{ (s)} + \text{HCl (aq)} \rightarrow \text{ZnCl}_2 \text{ (aq)} + \text{H}_2\text{O (l)}$
- g. $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O (s)} \rightarrow \text{Na}_2\text{SO}_4 \text{ (s)} + \text{H}_2\text{O (g)}$
- h. $\text{Cu (s)} + \text{S}_8 \text{ (s)} \rightarrow \text{Cu}_2\text{S (s)}$

Section 5 – Chemical Calculations

1. Find the mass percentage of iron in Fe_2O_3 . Atomic weights: Fe 55.8, O 16.0.
2. What is the molar mass of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$? Include the correct units in your answer. Atomic weights: Sr 87.6, Cl 35.5, H 1.01, O 16.0.
3. How many moles of oxygen are required to react with 12.0 grams of carbon to produce carbon monoxide? Atomic weights: C 12.0, O 16.0. The balanced equation is $2\text{C} + \text{O}_2 \rightarrow 2\text{CO}$
4. How many moles of NaOH are required to react with the SO_2 produced by the oxidation of 0.500 moles of FeS_2 ? The balanced equations are
 $4\text{FeS}_2 + 11\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3 + 8\text{SO}_2$
 $\text{SO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_3 + \text{H}_2\text{O}$
5. A compound of sulfur and fluorine contains 29.7% S and 70.3% F (percentages are by mass). What is the empirical formula of the compound?
6. (a) How many grams of AlCl_3 can be produced when 0.100 moles of aluminum reacts with excess chlorine? Atomic weights: Al 27.0, Cl 35.5. The balanced equation is
 $2\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3$
(b) What is the % yield of this reaction if 12.5 grams of AlCl_3 are actually obtained?
7. What is the molarity of a copper(II) chloride solution if 10.0 grams of CuCl_2 are dissolved in water to give 250.0 mL of solution? The molar mass of CuCl_2 is 134.5 g/mol.
8. What is the molarity of a sodium hydroxide solution if 50.0 mL of the solution requires 38.6 mL of 0.0976 M HCl for titration?

Section 1 – Basic Math – Answers

1.
 - (i) 332.23
 - (ii) 332.
 - (iii) 330
2. $f=wc/m$
3. 120 degrees
4. 8×10^{112}
5. $y=0.6, x=0.4$
6. $x=-3, x=1$
7. $x= -3.2 \times 10^{-3}, x= 3.1 \times 10^{-3}$
8. $x=0.0508, x=-0.158$
9. 20 mass%
10. 216 g
11. 28.5 cm
12. 6.7 m^2
13. $y = 1.6x + 2.4$
14. 297 K, 286 torr, 286 K

Section 2 – Periodic Table – Answers

1. 4
2. 26 protons, 29 neutrons, 23 electrons
3. Mn
4. Potassium
5. K
6. K^+
7. S
8. oxygen
9. Period 5, Group 7A (or 17)
10. potassium

Section 3 – Chemical Compounds – Answers

1.
 - (i) a
 - (ii) b, f
 - (iii) none
 - (iv) none
 - (v) c
 - (vi) d
 - (vii) d, f
 - (viii) b
 - (ix) f
2. H_2SO_4
3. CaCl_2

4. Fe_2O_3
5. Tetraphosphorousdecoxide
6. Copper(II) nitrate
7. FeSO_4 , HCl , NaF
8. +3
9. +3
10. +2
11. a, d
12. Valence Shell Electron Pair Repulsion
13. (a) bent
(b) tetrahedral
(c) linear
(d) triangular pyramid
(e) bent

Section 4 – Chemical Reactions – Answers

1. NaI
2. $\text{Al}(\text{NO}_3)_3 + \text{H}_2\text{O}$
3. NH_4OH and H_2SO_4
4. $\text{Cu}(\text{OH})_2 + 2\text{HCl} \rightarrow \text{CuCl}_2 + 2\text{H}_2\text{O}$
5. $6\text{Li} + \text{N}_2 \rightarrow 2\text{Li}_3\text{N}$
6. $2\text{Fe} + 3\text{Br}_2 \rightarrow 2\text{FeBr}_3$
7. $2\text{Fe}(\text{OH})_3 + 3\text{H}_2\text{SO}_4 \rightarrow \text{Fe}_2(\text{SO}_4)_3 + 6\text{H}_2\text{O}$
8. (a) combination
(b) precipitate-forming
(c) gas-producing
(d) oxidation-reduction, gas-producing
(e) decomposition
(f) acid-base
(g) decomposition, gas-forming
(h) combination, oxidation-reduction

Section 5 – Chemical Calculations – Answers

1. 69.8%
2. 266.7 g/mol
3. 0.5 moles of O_2
4. 2 moles of NaOH
5. SF_4
6. (a) 13.4 g
(b) 93.6 %
7. 0.297 mol/L
8. 0.0753M