CHEM 1004
Test #3
Fall 2010 (Buckley)

Circle the letter corresponding to the best answer for each of the following. Each multiple choice question is worth 2 points.

1. Which of the following is NOT true of the Arrhenius theory?
   a. Acids are defined as compounds that produce H\(^+\) ions in water solution.
   b. Bases are defined as compounds that produce OH\(^-\) ions in water solution.
   c. Arrhenius theory only applies to reactions in aqueous solution.
   d. Acids are defined as compounds that produce OH\(^-\) ions in water solution.

2. Which of the following is a correct definition of an acid that is not dependent upon the solvent?
   a. Acids produce hydronium ions.
   b. Acids are proton donors.
   c. Acids produce hydroxide ions.
   d. Acids are proton acceptors.

3. When HCl is added to pure water, HCl molecules lose protons, while water molecules gain protons. In this reaction, HCl is a(n)
   a. acid.
   b. base.
   c. salt.
   d. solvent.

4. Which of the following is a hydroxide ion?
   a. OH\(^-\)
   b. H\(^+\)
   c. H\(_3\)O\(^+\)
   d. H\(_2\)O\(^-\)

5. When added to water, which of the following would produce a base?
   a. Na\(_2\)O
   b. CO\(_2\)
   c. Cl\(_2\)
   d. SO\(_3\)
6. The same number of moles of acetic acid and hydrogen chloride are placed in beakers containing water. After this addition, the beaker with the HCl has more hydronium ions than the beaker with added acetic acid. HCl is classified as

a. a weaker acid than acetic acid.

b. a stronger acid than acetic acid.

c. equal in acid strength to acetic acid.

d. a base.

7. A solution of toilet bowl cleaner has a pH of 1.0. The solution is

a. strongly acidic.

b. weakly acidic.

c. strongly basic.

d. weakly basic.

8. The conjugate acid of HSO$_3^-$ is

a. SO$_3^{2-}$

b. HSO$_2^-$

c. H$_2$SO$_3$

d. HO$_3^-$

9. The conjugate base of HSO$_3^-$ is

a. SO$_3^{2-}$

b. HSO$_2^-$

c. H$_2$SO$_3$

d. HO$_3^-$

10. Which of the following is NOT a definition of reduction?

a. Reduction is the loss of oxygen from a substance.

b. Reduction is the addition of hydrogen to a substance.

c. Reduction is the loss of electrons from a substance.

d. Reduction is the gain of electrons by a substance.

11. In which of the following is the reactant undergoing oxidation? (Note: These reactions are not complete chemical equations.)

a. Cl$_2$ → 2 Cl$^-$

b. WO$_3$ → W

c. 2 H$^+$ → H$_2$

d. C → CO$_2$
12. What is reduced in the following reaction?

\[ 2 \text{Bi}^{3+} + 3 \text{Mg} \rightarrow 2 \text{Bi} + 3 \text{Mg}^{2+} \]

a. \( \text{Bi}^{3+} \)
b. \( \text{Mg} \)
c. \( \text{Bi} \)
d. \( \text{Mg}^{2+} \)

13. What is the name of the compound with a formula \( \text{CH}_3\text{CH}_2\text{CH}_3 \)?

a. methane
b. ethane
c. propane
d. butane

14. A compound containing only carbon and hydrogen and which has only single bonds between atoms is classified as an

a. alkane.
b. alkene.
c. alkyne.
d. aromatic.

15. What is the name of the compound with a formula \( \text{CH}_3\text{CH}_3 \)?

a. methane
b. ethane
c. propane
d. butane

16. What is the name of the compound with a formula \( \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \)?

a. methane
b. ethane
c. propane
d. butane

17. The parts of organic molecules that give compounds characteristic chemical and physical properties are known as

a. alkyl groups.
b. aromatic groups.
c. functional groups.
d. hydrocarbon groups.
18. Atoms that have the same atomic number but different numbers of neutrons are

a. radioactive.

☒ b. isotopes.

c. impossible.

d. ions.

19. The following nuclear reaction is an example of

\[ ^{226}_{88}\text{Ra} \rightarrow ^{4}_{2}\text{He} + ^{222}_{86}\text{Rn} \]

☒ a. alpha decay.

b. beta decay.

c. gamma decay.

d. an impossible reaction.

20. Nitrogen-13 has a half-life of 10 minutes. How much of a 16 mg sample would remain after 40 minutes?

a. 0.5 mg

☒ b. 1 mg

c. 2 mg

d. 4 mg

Short answer. Points are indicated in parentheses to the right of each question number.

21. (10 points) Provide the missing particle in each of the following nuclear equations.

\[ ^{238}_{92}\text{U} + ^{1}_{0}\text{H} \rightarrow ^{239}_{92}\text{U} \]

\[ ^{235}_{92}\text{U} + ^{1}_{0}\text{H} \rightarrow ^{14}_{5}_{6}\text{Ba} + ^{91}_{36}\text{Kr} + 3^1_0\text{n} \]

\[ ^{121}_{51}\text{Sb} + ^{1}_{0}\text{H} \rightarrow ^{121}_{52}\text{Te} + ^{1}_{0}\text{n} \]

\[ ^{14}_{7}\text{N} + ^{4}_{2}\text{He} \rightarrow ^{17}_{8}\text{O} + ^{1}_{0}\text{H} \]

\[ ^{9}_{4}\text{Be} + ^{1}_{1}\text{H} \rightarrow ^{4}_{2}\text{He} + \frac{6}{3}\text{Li} \]
22. (5 points) Lead-210 has a half-life of 22 years and can be used to estimate the age of skeletal remains. If the natural lead-210 activity in the environment is 2500 counts/minute, how old is a bone fragment for which the count is 625 counts/minute?

\[ \frac{2500}{1250} = \left( \frac{22}{44} \right) \text{ years} = 44 \text{ years} \]

23. (5 points) Carbon-14 has a half-life of 5730 years.

a. The ratio of carbon-14 to carbon-12 in an artifact from an excavation is found to be one-half the ratio found in modern wood. Approximately how old is the artifact?

\[ 5730 \text{ years (1 half-life)} \]

b. Suppose the ratio of carbon-14 to carbon-12 in another artifact is between one-half and one-fourth. What can you say about the age of this artifact?

\[ \frac{1}{2} \text{ 5730 years} \quad \text{between 5730 years and 1/460 years} \]