Date Completed: _____
Mentor Initials: _____

Outside Knowledge

1. Rust is the product of the combination of iron metal and oxygen gas. Choose the balanced chemical equation that represents this process.

A. $Fe + O_2 \rightarrow Fe_2O_3$
B. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$
C. $2Fe_2O_3 \rightarrow 2Fe + 3O_2$
D. $Fe + 3O_2 \rightarrow 2Fe_2O_3$
E. $2Fe_2O_3 \rightarrow Fe + O_2$

2. In the absence of a radar gun – used for determining vehicle speeds – a police officer can use the length of a stretch of road and a stopwatch to determine speed. Two events occur:

- A red car travels a 1 km distance in 35 seconds.
- A blue car travels a 2 km distance in 1 minute.

The officer pulls over the car traveling at a higher relative speed. Which choice correctly identifies the car and its speed?

A. Red; $28.6\ m/s$
B. Blue; $28.6\ m/s$
C. Red; $33.3\ m/s$
D. Blue; $33.3\ m/s$

3. A student repeatedly measures the velocity of a toy car and finds that the standard deviation of the set is relatively low. The student then checks the actual velocity of the car, as recorded by the manufacturer, and finds that the value is vastly different. Assuming that the manufacturer is reporting the correct value, the student's measurements are suffering from which of the following:

A. Low precision
B. Low accuracy
C. Low precision and low accuracy
D. Success

4. In an experiment, sodium chloride, potassium chloride, and ammonium sulfate are dissolved in water. Which of these would be classified as a solvent?

A. Water
B. Ammonium sulfate
C. Potassium chloride and sodium chloride
D. Sodium chloride, potassium chloride, and ammonium sulfate
E. Sodium chloride, potassium chloride, ammonium sulfate, and water

5. Hydrochloric acid (HCl) is a so-called strong acid. The strength of the acid solution is dependent on the molarity (M). As molarity increases, the pH of an HCl solution decreases. If an HCl solution with a 0.0001M concentration is slightly acidic, which of the following could be a possible pH of a 0.1M solution of HCl?

A. 1
B. 6
C. 7
D. 8
E. 13

6. The gravitational field on the Moon's surface is approximately $\frac{1}{6}$th of the strength of the field caused by Earth on its surface. Given two identical objects are placed on each of those surfaces, identify the correct statement about their masses.

A. The mass of the object on the Moon is greater than its counterpart on Earth.
B. The mass of the object on the Earth is greater than its counterpart on the Moon.
C. The objects have the same mass.
D. It is impossible to distinguish which mass is larger.

7. Each trophic level can only extract roughly 10% of the energy from lower levels. If 10,000 Joules (J) of energy are stored in the grain that a mouse consumes over its life, how much energy is gained by a snake that eats that mouse?

A. 10 J
B. 100 J
C. 1,000 J
D. 10,000 J
E. 100,000 J

8. The atomic number of an element is the number of protons in the nucleus of an atom of that element. Using the figure below, identify the correct order of the elements from most protons to least.

11 Na 0.9	12 Mg 1.2
19 K 0.8	20 Ca 1.0

A. Na > Mg > K > Ca
B. Mg > Ca > Na > K
C. Mg > Na > Ca > K
D. Ca > K > Mg > Na
E. Ca > Mg > K > Na

9. Which of the following could be used to represent the alleles present for a given gene in an individual that is heterozygous ?
A. FF
B. DD
C. tt
D. Gg

10. During a classroom demonstration of phase changes, a teacher adds energy to a system that contains H_2O. The system, which was previously at an equilibrium below 0 degrees Celsius, increases to 10 degrees celsius. The phase transition of the H_2O in the system can be described as which of the following:
A. Recombination
B. Melting
C. Sublimation
D. Condensation
E. Vaporization

11. An experiment is conducted with two identical solutions each containing an elodea (water plant). Tube 1 receives no light while Tube 2 receives a moderate amount for 24 hours. After the 24 hours, the CO_2 concentration was measured for both solutions. The CO_2 concentration in a solution is one of the factors that affects the pH level and the higher the concentration of CO_2, the lower the pH value. Tube 1 is found to have a pH value of 5.5 while Tube 2 is measured at 6.5. Which explanation correctly identifies both the process and explanation for this result?

A. photosynthesis, the elodea in Tube 1 consumed less CO_2 than did the elodea in Tube 2.

B. photosynthesis, the elodea in Tube 1 consumed more CO_2 than did the elodea in Tube 2.

C. cellular respiration, the elodea in Tube 1 consumed less CO_2 than did the elodea in Tube 2.

D. cellular respiration, the elodea in Tube 1 consumed more CO_2 than did the elodea in Tube 2.

12. 100 cm^3 of aluminum has a mass of 270 grams. What is the density of this chunk of aluminum?

A. .37 g/cm^3

B. .37 cm^3/g

C. 2.7 g/cm^3

D. 2.7 cm^3/g

13. When experimenting with sheep livestock to see if they produce more wool with or without legumes in their diet, a scientist uses six sheep. The experimenter feeds various amounts of legumes to all but one sheep. What type of variable is the presence of legumes in the sheep's diet?

A. Dependent

B. Control

C. Independent

D. Compound

E. Mixed

14. A student performs an experiment in their Chemistry course to determine the volume of an acid required to neutralize a basic solution, and the volume necessary is recorded as 1.34 *L*. The teacher asks the student to give the volume in mL instead of L. What value would the student provide?

A. .00134 mL
B. .0134 mL
C. .134 mL
D. 134 mL
E. 1340 mL

15. Two different spiders, *Latrodectus hasselti* and *Latrodectus mactans*, are being investigated in a study undertaken by the local university. A student journalist from the university wants to ensure that they describe the details of the study as accurately as possible, so they ask the researchers to describe the differences between the two specimens. Regarding the genus and species, what should the researchers say?

I. The spiders are in the same genus.
II. The spiders are the same species.

A. I only
B. II only
C. Both I and II
D. Neither I nor II
E. Impossible to tell from the information

16. If you were asked to give a speech to your class about electrostatics (the field of physics that concerns itself with forces between charges, among other things), which of the following statements would you exclude because it is incorrect?

A. Charges can be at rest
B. Charges can be in motion
C. There are 2 possible signs for electric charge
D. Charges of opposite sign repel each other
E. Current consists of charges in motion

17. Which of the following numbers has the *fewest* significant digits?

A. 1020
B. 1.0203
C. .00203
D. 10200
E. .00023

18. If two individuals with the genotypes shown below for a trait R were to reproduce, what percentage of their offspring would be expected to show the dominant phenotype for the trait? Assume that trait R has only two potential phenotypes, and that its expression is not impacted by any other gene.

Individual 1: rr
Individual 2: Rr

A. 25%
B. 50%
C. 75%
D. 100%
E. Cannot be determined from the given information

19. If you pay much attention to trends in nutrition and exercise, you've probably noticed the increased interest in protein consumption over the past handful of years. Chemically speaking, what are proteins composed of?

A. Fatty acids
B. Monosaccharides
C. Amino acids
D. Nucleotides
E. Polysaccharides