PRACTICE FREE RESPONSE THAT WILL BE HELPFUL TO STUDY FOR CHEMISTRY NCFE

1. Explain, in terms of electron configuration, why arsenic and antimony are chemically similar.
Arsenic has a noble gas configuration of [Ar] $4s^2$ $3d^{10}$ $4p^3$, for a total of 5 valence electrons.
Antimony has a noble gas configuration of [Kr] $5s^2$ $4d^{10}$ $5p^3$, for a total of 5 valence electrons.
Valence electrons determine an element's chemical properties. Because these two elements have the same number of valence electrons, they have similar chemical behavior.

2. Identify the element in Period 3 that is an unreactive gas at STP.
Argon (Ar) is the element in Period 3 that is an unreactive gas at STP.

3. Compare the energy of an electron in the first energy level of a cadmium atom to the energy of an electron in the third energy level of the same atom.
An electron in the first energy level of a cadmium atom is lower than the energy of an electron in the third energy level of cadmium. The electrons in an atom fill in the location where there is the lowest energy first, then move onto higher energy locations.

Use the information below to answer questions 4 and 5.

The densities for two forms of carbon at room temperature are listed in the table below.

Element Form	Density (g/cm^3)
Carbon (graphite)	2.2
Carbon (diamond)	3.513

4. Compare the number of carbon atoms in a 0.30 cm^3 sample of graphite and a 0.30 cm^3 sample of diamond.

$$\frac{0.30\ cm^3}{1\ cm^3} \times \frac{2.2\ g}{12.01\ g} \times \frac{1\ mole}{1\ mole} \times \frac{6.022 \times 10^{23}\ atoms}{} = 3.31 \times 10^{22}\ atoms\ graphite$$

$$\frac{0.30\ cm^3}{1\ cm^3} \times \frac{3.513\ g}{12.01\ g} \times \frac{1\ mole}{1\ mole} \times \frac{6.022 \times 10^{23}\ atoms}{} = 5.28 \times 10^{22}\ atoms\ diamond$$

5. A student calculated the density of a sample of graphite to be 2.3 g/cm^3. Show the numerical setup for calculating the student's percent error for the density of graphite.

$$\%\ error = \frac{|\ 2.2\ g/cm^3 - 2.3\ g/cm^3\ |}{2.2\ g/cm^3} \times 100 =$$ (answer = 4.5 % error)

Use the following information to answer questions 6 and 7.

A sample of calcium carbonate, $CaCO_3$, has a mass of 42.2 grams. Calcium carbonate has a molar mass of 100. g/mole.

6. Show a numerical setup for calculating the number of moles in the sample of $CaCO_3$.

$$42.2\ g\ CaCO_3 \times \frac{1\ mole}{100.\ g} =$$ (answer = 0.422 moles $CaCO_3$)

7. Determine the percent composition by mass of oxygen in the $CaCO_3$.
$3 \times 16.00 = 48.00$

$$\%\ O = \frac{48.00\ g\ O}{100.\ g\ total} \times 100 = 48.0\%\ oxygen$$

Base your answers to questions 8 and 9 on the information below and your knowledge of chemistry.

Carbon monoxide, CO (g), is a toxic gas found in automobile exhaust. The concentration of CO (g) can be decreased by using a catalyst in the reaction between CO (g) and O_2 (g). This reaction is represented by the balanced equation below.

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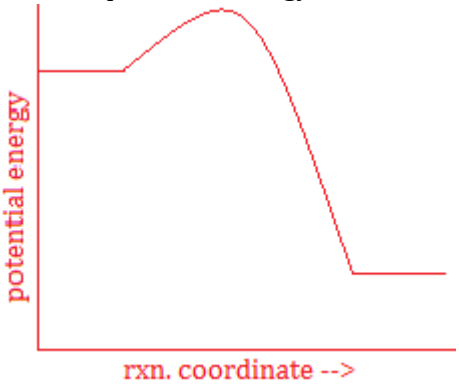
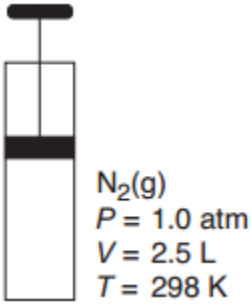
$$2\ CO\ (g) + O_2\ (g) \xrightarrow{\text{catalyst}} 2\ CO_2\ (g) + \text{energy}$$

8. Explain, in terms of collision theory, why an increase in temperature increases the rate of the reaction.
An increase in temperature increases the average kinetic energy of the molecules in a sample. When the average kinetic energy increases, the momentum with which particles collide increases. Also when the average kinetic energy increases, the frequency of collisions increases. More effective collisions lead to faster reactions.

9. Draw a potential energy curve for the reaction represented by this equation.



The diagram and data below represent a gas and the conditions of pressure, volume, and temperature of the gas in a rigid cylinder with a moveable piston.



10. Determine the volume of the gas in the cylinder at STP.
$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\frac{1.0 \times 2.5}{298} = \frac{1.0 \times V}{273}$ V = 2.3 L at STP

11. State one change in temperature and one change in pressure that will cause the gas in the cylinder to behave more like an ideal gas.
If the temperature increased or the pressure decrease, it would cause the gas in the cylinder to behave more like an ideal gas.

Use the information below to answer questions 12 through 15.

During a titration, 10.00 mL of acetic acid, $HC_2H_3O_2$ (aq), is completely neutralized by adding 12.50 mL of 0.64 M sodium hydroxide, NaOH (aq).

12. Identify the only positive ion in the $HC_2H_3O_2$ (aq). H^{+1} is the only positive ion.

13. State the number of significant figures used to express the volume of acetic acid.
10.00 mL has 4 significant figures.

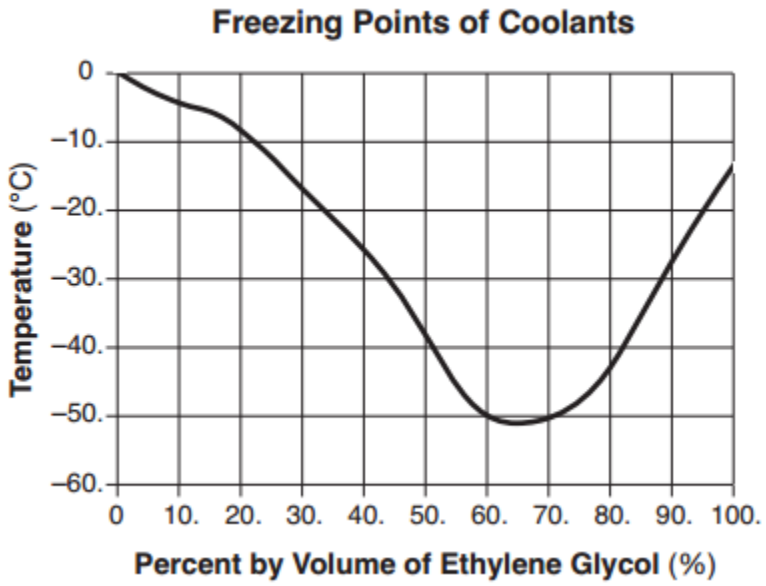
14. Determine the molarity of the acetic acid. 1 x M x 10.00 = 1 x 0.64 x 12.50
M = 0.80 M acetic acid

15. Explain why it is better to use data from multiple trials to determine the molarity of acetic acid, rather than data from a single trial.
If you only use data from one trial, you are not showing precision. Without showing precision, there is the possibility that there could be a mistake in one of the measurements being made and not reflect an accurate calculation. If multiple trials are performed and one of these trials produces significantly different results, then the data are probably mistakes and can be recalculated with appropriate measurements.

PRACTICE FREE RESPONSE THAT WILL BE HELPFUL TO STUDY FOR CHEMISTRY NCFE

Base your answers to questions 16 through 19 on the information below and your knowledge of chemistry.

A solution of ethylene glycol and water can be used as the coolant in an engine-cooling system. The ethylene glycol concentration in a coolant solution is often given as percent by volume. For example, 100. mL of a coolant solution that is 40.% ethylene glycol by volume contains 40. mL of ethylene glycol diluted with enough water to produce a total volume of 100. mL. The graph below shows the freezing point of coolants that have different ethylene glycol concentrations.



16. Explain, in terms of particle distribution, why a coolant solution is a homogeneous mixture.
A coolant solution is a homogeneous mixture because the coolant particles are NOT chemically combined with the water (keep their properties) and they are evenly distributed throughout the water.

17. Explain, in terms of the molecular polarity, why ethylene glycol dissolves in water to form a solution.
Ethylene glycol dissolves in water because it is a polar molecule like water is too. Polar molecules do not have an even charge distribution so there is a slightly negative end of the molecule and a slightly positive end of the molecule. These slight charges are attracted to the opposite charge and allow for polar substances to be dissolved in polar solvents like water.

18. Identify the percent by volume of ethylene glycol in a solution that freezes at -10.^{o}C.
About 22% ethylene glycol by volume

19. One engine-cooling system has a volume of 6400 mL. Determine the volume of ethylene glycol in the completely filled engine-cooling system when the concentration of ethylene glycol is 50.% by volume.
50% of 6400 mL total = 3200 mL of ethylene glycol

The radioisotope Mo-99 naturally decays to produce the metastable isotope Tc-99m, which is used in medical diagnosis. A doctor can obtain images of organs and bonds by injecting a patient with a solution of Tc-99m. The half-life of the metastable Tc-99m is six hours.

20. Write the complete nuclear equation for the decay of Mo-99.
$^{99}_{42}Mo \rightarrow {}^{99}_{43}Tc + {}^{0}_{-1}e$

21. State both the number of protons and the number of neutrons in a Tc-99 nuclide.
Tc-99 has 43 protons (atomic number is 43) and 56 neutrons.

PRACTICE FREE RESPONSE THAT WILL BE HELPFUL TO STUDY FOR CHEMISTRY NCFE

22. Determine the fraction of an original sample of metastable Tc-99m that remains unchanged after 24 hours.

The half-life of Tc-99m is 6 hours. So, 24 hours would represent 4 half-lives. At the beginning, one would start with 1 unit of Tc-99m. After one half-life, ½ unit would remain. After two half-lives, ¼ unit would remain. After 3 half-lives, $^1/_8$ unit would remain. After 4 half-lives, $^1/_{16}$ of the original amount would remain.