Directions: Read all questions and instructions carefully. Check to make sure that this exams contains **30** pages. Please budget your time across the entire exam and attempt all questions.

Good Luck!

Happy Halloween!!

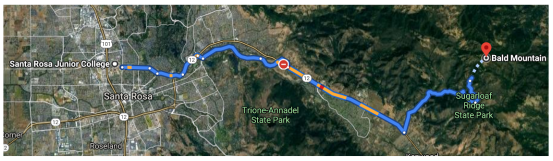
Exam Total	/100

1. (2 points) Do you understand SRJCs academic integrity policy and agree to follow all exam procedures during this exam? If you have any question about what is and is not allowed, you agree that you must email me during the exam time where I will gladly clarify.

(a) Yes
(b) No

(a) (2 points) YES! Please don't cheat!

2. (10 points) Chernabog is the demon from *Night on Bald Mountain.* Interestingly enough, Bald Mountain is located in Sonoma County!!



Escaping from the Earth on (the fictional) Bald Mountain is phosgene gas. Phosgene gas is highly toxic as it disrupts the blood-air barrier in the pulmonary alveoli. Phosgene gas has a molecular formula of $COCl_2$.

(a) (2 points)
What is the molecular weight of phosgene gas?

(a) $51.45 \frac{g}{mol}$
(b) $63.46 \frac{g}{mol}$
(c) $79.46 \frac{g}{mol}$
(d) $98.91 \frac{g}{mol}$
(e) $110.92 \frac{g}{mol}$

(b) (2 points)
What is the mass of one molecule of $COCl_2$? Note, 1 amu $= 1.661 \times 10^{-27}$ kg

(a) 1.643×10^{-25} kg
(b) 1.337×10^{-25} kg
(c) 5.892×10^{-25} kg
(d) 1.643×10^{-22} kg
(e) 1.337×10^{-22} kg

(c) (2 points)
What is the C:O mole ratio in $COCl_2$?

(a) 1:1
(b) 1:2
(c) 2:1
(d) 2:3
(e) 3:2

(d) (2 points)
How many moles of Cl does 3 moles of $COCl_2$ contain?

(a) 1 mol
(b) 2 mol
(c) 3 mol
(d) 5 mol
(e) 6 mol

(e) (2 points)
1 mole of phosgene gas escapes from the bowls of the Earth. How many $COCl_2$ molecules escaped into the atmosphere?

(a) 6.626×10^{-34} molecules
(b) 1.602×10^{-19} molecules
(c) 8.314 molecules
(d) 3.00×10^{8} molecules
(e) 6.023×10^{23} molecules

(a) (2 points) (d)

$$M_{COCl_2} = 1\,(M_C) + 1\,(M_O) + 2\,(M_{Cl})$$

$$M_{COCl_2} = 1\,(12.01\ {}^{g}/_{mol}) + 1\,(16.00\ {}^{g}/_{mol}) + 2\,(35.45\ {}^{g}/_{mol})$$

$$M_{COCl_2} = 98.91\ {}^{g}/_{mol}$$

(b) (2 points) (a)

$$m_{COCl_2} = 1\,(m_C) + 1\,(m_O) + 2\,(m_{Cl})$$

$$m_{COCl_2} = 1\,(12.01\ \text{amu}) + 1\,(16.00\ \text{amu}) + 2\,(35.45\ \text{amu})$$

$$m_{COCl_2} = 98.91\ \text{amu}$$

Now we can convert to kg!

$$m_{COCl_2} = 98.91\ \text{amu} \times \frac{1.661\times10^{-27}\ \text{kg}}{1\ \text{amu}}$$

$$m_{COCl_2} = 1.643\times10^{-25}\ \text{kg}$$

(c) (2 points) (a)
Since there is 1 carbon atom and 1 oxygen atom in one molecule of $COCl_2$, if we have one mole of $COCl_2$, we have a 1:1 (C:O) mole ratio.

(d) (2 points) (e)

$$n_{Cl} = 3\ \text{mol}\ COCl_2 \times \frac{2\ \text{mol Cl}}{1\ \text{mol}\ COCl_2}$$

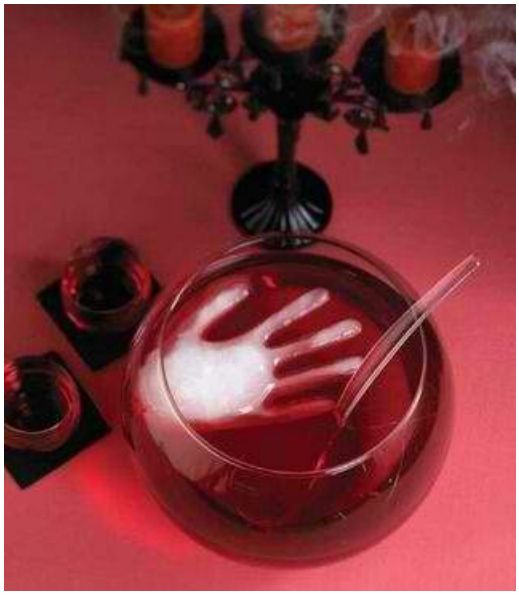
$$n_{Cl} = 6\ \text{mol Cl}$$

(e) (2 points) (e)
First, recall that Avogadro's number is $6.023\times10^{23}\ {}^{\text{units}}/_{\text{mole}}$, just like one dozen is $12\ {}^{\text{units}}/_{\text{dozen}}$.

$$N_{COCl_2} = 1\ \text{mol}\ COCl_2 \times \frac{6.023\times10^{23}\ \text{molecules}\ COCl_2}{1\ \text{mol}\ COCl_2}$$

$$N_{COCl_2} = 6.023\times10^{23}\ \text{molecules}\ COCl_2$$

3. (2 points) An impressive, yet simple, Halloween party tip is filling a glove with water and then freezing the hand. The frozen can then be used to chill Halloween punch!



Is the following change a physical change or a chemical change?

$$H_2O\,(l) \longrightarrow H_2O\,(s)$$

(a) Physical Change
(b) Chemical Change

(a) (2 points) Since water changes phase, not its chemical identity, this is a physical change.

4. (8 points) The Transylvanian wood of Dracula's coffin is attached using iron nails and dove-tail joints. Over the past several hundred years, the nails have rusted according to the following ***unbalanced*** chemical equation.

$$\mathrm{Fe\,(s) + O_2\,(g) \longrightarrow Fe_2O_4\,(s)}$$

(a) (2 points) Is the rusting of iron a physical or chemical change?

(a) Physical Change
(b) Chemical Change

(b) (6 points) Write the balanced chemical equation for the rusting of iron by adding the correct coefficient before each chemical species. ***Note, if a coefficient is 1 you MUST write 1 as Canvas will grade a blank answer as incorrect.***

$$\mathrm{Fe\,(s) + O_2\,(g) \longrightarrow Fe_2O_4\,(s)}$$

(a) (2 points) (b) Since iron and molecular oxygen react to form iron oxide, this is a chemical change because a chemical reaction has occured.

$$\mathrm{Fe\,(s) + O_2\,(g) \longrightarrow Fe_2O_4\,(s)}$$

(b) (4 points)

$$\mathrm{Fe\,(s) + O_2\,(g) \longrightarrow Fe_2O_4\,(s)}$$

Element	Reactant:Product Ratio
Fe	1:2
O	2:4

To balance Fe we add 2 before Fe.

$$\mathrm{2\,Fe\,(s) + O_2\,(g) \longrightarrow Fe_2O_4\,(s)}$$

Element	Reactant:Product Ratio
Fe	2:2
O	2:4

To balance O we add 2 before O_2.

$$\mathrm{2\,Fe\,(s) + 2\,O_2\,(g) \longrightarrow Fe_2O_4\,(s)}$$

Element	Reactant:Product Ratio
Fe	2:2
O	4:4

5. (10 points) A few friendly ghosts meet together on Halloween to have a BBQ. They are grilling on a BBQ that uses propane (C_3H_8) as the fuel source.

Shown below is the ***unbalanced*** chemical equation for the combustion of propane.

$$C_3H_8\,(g) + O_2\,(g) \longrightarrow H_2O\,(g) + CO_2\,(g)$$

(a) (8 points)
Write the balanced chemical equation for the combustion of propane by adding the correct coefficient before each chemical species. ***Note, if a coefficient is 1 you MUST write 1 as Canvas will grade a blank answer as incorrect.***
(b) (2 points)
The ghosts sadly realize that the electronic BBQ igniter no longer works. One ghost, named Casper, pulls out his liquid propane igniter to save the day! Shown below is the ***balanced*** chemical equation for the combustion of liquid butane.

$$2\,C_4H_{10}\,(l) + 13\,O_2\,(g) \longrightarrow 10\,H_2O\,(g) + 8\,CO_2\,(g)$$

How many moles of CO_2 are produced when 1 mole of C_4H_{10} is consumed? Assume you have excess O_2?

(a) 1 mol
(b) 2 mol
(c) 3 mol
(d) 4 mol
(e) 5 mol

(c) (3 points)
In addition to being friendly ghosts, the ghosts are environmentally friendly and reconsider using butane as a fuel source for the lighter. Another friendly ghost name Spooky claims to have a methane lighter and points out that the combustion of methane (natural gas) is more environmentally friendly than butane because consuming one mole of CH_4 produces only one mole of CO_2 (a greenhouse gas).

Fuel Source	Chemical Equation
Methane	$CH_4\,(g) + 2\,O_2\,(g) \longrightarrow 2\,H_2O\,(g) + CO_2\,(g)$
Butane	$2\,C_4H_{10}\,(l) + 13\,O_2\,(g) \longrightarrow 10\,H_2O\,(g) + 8\,CO_2\,(g)$

In addition to considering how much CO_2 is produced per mole of fuel, it is also important to consider how much O_2 is ***consumed*** during combustion. Since combustion is the reverse process of photosynthesis, burning all fossil fuel sources will deplete the world supply of O_2.
Considering ***only*** how much O_2 is consumed during the combustion of one mole of fuel (methane or butane), explain which fuel source is better for the environment (i.e. consumes less O_2).

(d) (3 points)
Combustion of one mole of butane produces about three times the energy produced by the combustion of one mole of methane (there is more energy stored in the additional bonds of butane). In math terms for the energy produced: $E_{\text{butane}} = 3E_{\text{methane}}$. With this consideration in mind, how does your assessment of butane's environmental impact change?

(a) (8 points)

$$C_3H_8\,(g) + O_2\,(g) \longrightarrow H_2O\,(g) + CO_2\,(g)$$

Element	Reactant:Product Ratio
C	3:1
H	8:2
O	2:3

To balance C we add 3 before CO_2.

$$C_3H_8\,(g) + O_2\,(g) \longrightarrow H_2O\,(g) + 3\,CO_2\,(g)$$

Element	Reactant:Product Ratio
C	3:3
H	8:2
O	2:7

To balance H we add 4 before H_2O.

$$C_3H_8\,(g) + O_2\,(g) \longrightarrow 4\,H_2O\,(g) + 3\,CO_2\,(g)$$

Element	Reactant:Product Ratio
C	3:3
H	8:8
O	2:10

To balance O we add 5 before O_2.

$$C_3H_8\,(g) + 5\,O_2\,(g) \longrightarrow 4\,H_2O\,(g) + 3\,CO_2\,(g)$$

Element	Reactant:Product Ratio
C	3:3
H	8:8
O	10:10

(b) (2 points)

$$n_{CO_2} = 1\text{ mol } C_4H_{10} \times \frac{8\text{ mol } CO_2}{2\text{ mol } C_4H_{10}}$$

$$n_{CO_2} = 4\text{ mol } CO_2$$

(c) (3 points)
The mole ratio of O_2:methane is 2:1 for the combustion of methane. This means two moles of O_2 are consumed by the combustion of one mole of methane. The mole ratio of O_2:butane is 13:2 or 6.5:1 for the combustion of butane. This means 6.5 moles of O_2 are consumed by the combustion of one mole of butane. Thus, we can see that the combustion of butane consumes more molecular oxygen on a per-mole basis than the combustion of methane.

(d) (3 points)
Since three times the energy is produced by combusting one mole of butane, this means three moles of methane must be combusted to produce the energy yielded from the combustion of one mole of butane. In other words, one third the amount of butane is needed to produce the same amount of energy produced by methane. This means butane would be equally environmentally friendly as methane if the CO_2:butane and O_2:butane mole ratios are three times the CO_2:methane and O_2:methane mole ratios. This analysis is summarized in the table below.

Fuel Source	CO_2:Fuel	O_2:Fuel
Methane	1:1	2:1
Butane	8:2 = 4:1	13:2 = 6.5:1

Now we need to check and see if the CO_2:butane and O_2:butane mole ratios are three times the CO_2:methane and O_2:methane mole ratios. Butane has a CO_2 :fuel ratio that is four times greater $\left(\frac{4}{1} = 1\right)$ than that for methane. We also see that butane has a O_2:fuel ratio that is 3.25 times greater $\left(\frac{6.5}{2} = 3.25\right)$ than that for methane. Thus, butane is less environmentally friendly than methane, but not as much as previously thought.

6. (3 points)
After Trick-or-Treating, you decide ***not*** to give over your hard-earned candy to the Switch Witch or the dentist. Instead, you decide to make rocket-candy. With rocket candy, sucrose (table sugar) ($C_{12}H_{22}O_{11}$) and potassium nitrate (KNO_3) are mixed together to produce a rocket propellant and lots of Halloween smoke.

Shown below is the ***balanced*** chemical reaction.

$$5\,C_{12}H_{22}O_{11}\,(s) + 48\,KNO_3\,(s) \longrightarrow 24\,K_2CO_3\,(s) + 36\,CO_2\,(g) + 55\,H_2O\,(g) + 24\,N_2\,(g)$$

If you mix excess potassium nitrate with a sugar cube ($m = 2.3$ g), how many grams of water are produced?

(a) 0.33 g
(b) 0.51 g
(c) 0.56 g
(d) 0.90 g
(e) 1.3 g

(3 points) (e)
First we need to calculate the molar masses of sucrose and water.

$$M_{C_{12}H_{22}O_{11}} = 12\,(M_C) + 22\,(M_H) + 11\,(M_O)$$

$$M_{C_{12}H_{22}O_{11}} = 12\,(12.01\ \text{g/mol}) + 22\,(1.01\ \text{g/mol}) + 11\,(16.00\ \text{g/mol})$$

$$M_{C_{12}H_{22}O_{11}} = 342.34\ \text{g/mol}$$

$$M_{H_2O} = 2\,(M_H) + 1\,(M_O)$$

$$M_{H_2O} = 2\,(1.01\ \text{g/mol}) + 1\,(16.00\ \text{g/mol})$$

$$M_{H_2O} = 18.02\ \text{g/mol}$$

Now we can calculate the mass of water produced!!

$$m_{H_2O} = 2.3\ \text{g}\ C_{12}H_{22}O_{11} \times \frac{1\ \text{mol}\ C_{12}H_{22}O_{11}}{342.34\ \text{g}\ C_{12}H_{22}O_{11}} \times \frac{55\ \text{mol}\ H_2O}{5\ \text{mol}\ C_{12}H_{22}O_{11}} \times \frac{18.02\ \text{g}\ H_2O}{1\ \text{mol}\ H_2O}$$

$$m_{H_2O} = 1.33\ \text{g}\ H_2O$$

$$m_{H_2O} = 1.3\ \text{g}\ H_2O$$

7. (2 points)
In Greek mythology, the river Styx separates Earth from the Underworld. The word *stygian* is defined as follows and owes its name to the river Styx.

stygian adjective, often capitalized

Save Word

sty·gian | \ ˈsti-j(ē-)ən \

Definition of *stygian*

1 : of or relating to the river Styx

2 : extremely dark, gloomy, or forbidding
// the *stygian* blackness of the cave

Dark clouds of poisonous gases can be described in literature as a "stygian cloud" or "stygian mist". Which of the following describes stygian gas molecules in motion?

I. Gas molecules are in constant motion
II. The gas molecules speed up with decreasing temperature
III. There is a lot of space in-between the molecules compared to the sizes of the molecules themselves

Which of the following answers has only TRUE statements?

(a) I
(b) II
(c) III
(d) I and II
(e) I and III

(2 points) (e)
According to the kinetic molecular theory of gases gas 1) gas molecules are in constant motion and 2) there is a lot of space in-between the molecules compared to the sizes of the molecules themselves.

8. (6 points) For a Halloween party you are serving root beer with pizza. With the bottle closed, you notice it feels quite firm. Upon opening, the bottle is no longer firm. Fill in the blanks.

Upon opening the root beer bottle, CO_2 *escapes into the room. This* ***increases/decreases*** *the number of* CO_2*molecules contained within the bottle and results in* ***more/less*** *molecular collisions with the bottle's wall. Given this change to the number of collisions, the pressure of the bottle* ***increases/decreases****.*

(6 points)
Upon opening the root beer bottle, CO_2 *escapes into the room. This* ***decreases*** *the number of* CO_2*molecules contained within the bottle and results in* ***less*** *molecular collisions with the bottle's wall. Given this change to the number of collisions, the pressure of the bottle* ***decreases****.*

9. (2 points) You are walking through a haunted house and a werewolf jumps out at you!

You scream! Being a future health professional, you then pull out your sphygmomanometer and record your blood pressure as 140 mmHg/90 mmHg. Use the following equation for pressure to explain why having a clear blood pathway results in a lower blood pressure. $P = \frac{F}{A}$, where P is the pressure, F is the force exerted, and A is the area upon which that force is exerted.

(2 points)
Having a clear blood pathway results in a greater area for the force to be applied. This gives a therefore lower blood pressure.

10. (2 points) For a Halloween party you use dry ice to produce smoke. Dry ice is produced via the following phase transformation.

$$CO_2\,(s) \longrightarrow CO_2\,(g)$$

What is the name for this phase transition?

(a) Boiling
(b) Condensation
(c) Freezing
(d) Melting
(e) Sublimation

(e) (2 points)
A direct phase transition from the solid state to the gas phase is sublimation.

11. (2 points) In The Wizzard of Oz, Dorothy throws water on the Wicked Witch of the West. In one of the most iconic misuses of scientific terminology, what should the Wicked Witch of the West be saying as she meets her demise? If you haven't seen the movie, the witch turns into a puddle of wickedness.

(a) I'm boiling! I'm boiling!
(b) I'm condensing! I'm condensing!
(c) I'm dissolving! I'm dissolving!
(d) I'm melting! I'm melting!
(e) I'm subliming! I'm subliming!

(2 points) (c)

Boiling turns a liquid into a gas, condensing turns a gas into a liquid. Melting turns a solid into a liquid. Subliming turns a gas into a solid or a solid into a gas. Only in dissolving is a solvent added (in this case water!) to produce a solution. In the case here, we have the Wicked Witch of the West as the solute, and water as the solvent. Thus, she turns into a solution so the Wicked Witch of the West should be saying "I'm dissolving! I'm dissolving!"

12. (4 points) Shown below is a witch's brew that is bubbling.

(a) (2 points) Is the witch's brew evaporating or boiling during the potion making?

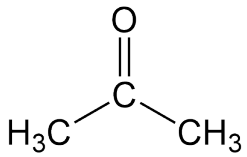
(a) Boiling
(b) Evaporating

(b) (2 points) You decide measure the brew's temperature over five minutes. If the brew is boiling, what do you expect to observe over these five minutes?

(a) Temperature decreases
(b) Temperature remains constant
(c) Temperature increases

(a) (2 points)
Since there are bubbles, the brew is boiling.
(b) (2 points)
When a liquid is boiling, the temperature remains constant during this phase transition.

13. (2 points) Dr. Frankenstein's lab has several specimens preserved with formaldehyde.



Formaldehyde

Shown below are three different kinds of intermolecular forces.

I	Dispersion Forces
II	Permanent Dipole-Permanent Dipole
III	Hydrogen Bonding

Select the answer that has all the intermolecular forces formaldehyde can participate in.

(a) I
(b) I and II
(c) I and III
(d) II and III
(e) I, II, and III

(b) (2 points) All molecules participate in dispersion forces. Since the C=O bond is polar covalent, formaldehyde has dipole-dipole interactions. Although formaldehyde has hydrogen and oxygen, the hydrogen atom is not directly bonded to the oxygen atom. As a result, formaldehyde cannot participate in hydrogen bonding.

14. (2 points) A necromancer casts dark magic using methanol flames.

Dictionary

Search for a word

nec·ro·man·cer

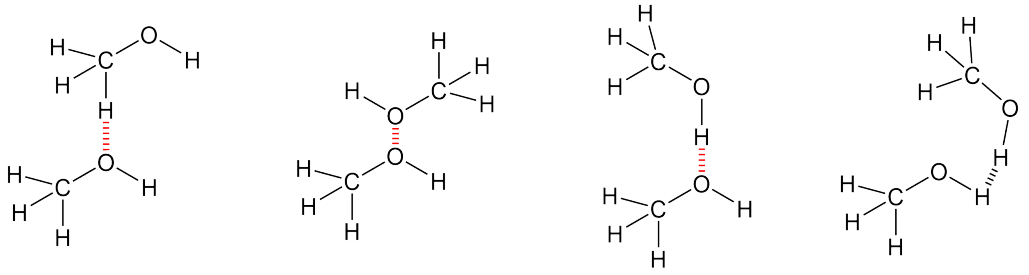
/ˈnekrəˌmansər/

noun

a person who practices necromancy; a wizard or magician.

An interesting feature for methanol flames is that they do not produce smoke, thereby allowing the necromancer to better observe the results of the spell!

Which of the following shows a hydrogen-bonding interaction between two methanol molecules?



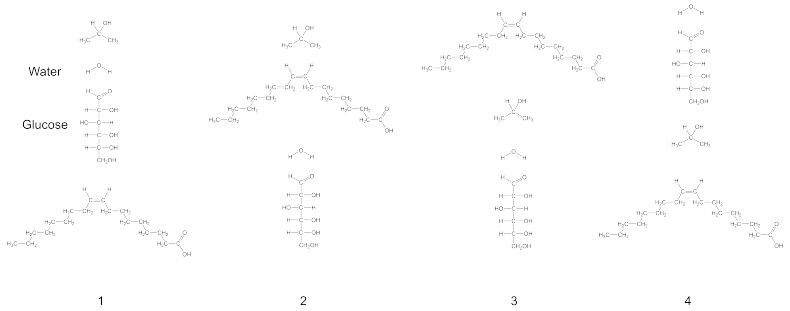
(a) A
(b) B
(c) C
(d) D

(c) (2 points) Hydrogen bonding occurs between F, O, or N and a hydrogen atom that is bonded to F, O, or N.

15. (6 points)
Shown below is a Halloween density experiment that can be done with children (for the recipe please see the solutions!).

From top to bottom there are four layers: 1) green, 2) yellow, 3) burgandy, and 4) colorless/clear. Note, the bottom part of the skeleton's head is ***not*** glass, but rather a liquid that is colorless.

Note/Hint: Water and corn syrup (glucose) are miscible if you try to mix them (stir, shake, etc.); however, if water is added ***slowly*** to corn syrup they will ***not*** mix due to the different densities: corn syrup has a greater density than water so water will be the top phase and corn syrup will be the bottom phase. This observation is represented in all four possible answers below.



(a) (2 points)

Which of the following orders corresponds to the order of the liquids shown above in the skull glass: as you read the answers from top to bottom you are stating the top-most molecule has the lowest density and the bottom-most molecule has the greatest density? For example, since the note/hint stated that corn syrup is moe dense than water, all the answers show water directly above the molecule for corn syrup (glucose). IMPORTANT: some of the liquids in this science experiment include small amounts of dye so don't base your answer off of what these everyday liquids look like!

(a) 1
(b) 2
(c) 3
(d) 4

(b) (4 points)
Explain your reasoning for your answer above. Use the idea of polarity to support your answer.

(a) and (b) (6 points)

In Option 2, we see the top molecule (rubbing alcohol) is polar. The next molecule (oleic acid/olive oil) is very nonpolar. The next molecule is water. The final molecule is corn syrup (glucose) and we know it does not mix with water if the water is added slowly (given in the question). The key idea here is we know from the problem the bottom two molecules have one interface. The top three molecules go from polar, to nonpolar, to polar. This gives two interfaces for the three layers. All other options have two rubbing alcohol right above or below a polar molecule, where there will be mixing and no separation observed.

In summary, the answer is presented as follows!!

The recipe is located here!!

https://littlebinsforlittlehands.com/spooky-science-halloween-density-experiment/

16. (4 points)
Werewolfs are sometimes called lycans. Lycanthropy is defined as follows.

Dictionary

Search for a word

ly·can·thro·py
/lī ˈkanTHrəpē/

noun

the supernatural transformation of a person into a wolf, as recounted in folk tales.

- ARCHAIC
  a form of madness involving the delusion of being an animal, usually a wolf, with correspondingly altered behavior.

Definitions from Oxford Languages *Feedback*

Translations and more definitions

In medieval Europe it was thought that administering wolfsbane to a werewolf would cure the individual. Wolfsbane is a genus that contains over 250 flowering plants. Shown below is *Aconitum variegatum*.

However, administering wolfsbane, unfortunately much like many other medieval treatments, proved deadly: an active ingredient of one type of wolfsbane is the alkaloid pseudaconitine, which is an extremely toxic poison due its ability to break down acetylcholine.
The poison is slightly soluble in water, but more soluble in alcohols.

(a) (2 points)
Fill in the blanks:

When dissolved in alcohol, pseudaconitine is the ***solute/solvent*** *and alcohol is the* ***solute/solvent****.*

(b) (2 points)
A pseudaconitine solution is prepared by dissolving 5.00 μg of pseudaconitine $(C_{36}H_{51}NO_{12})$ in 10.00 mL of water. What is the molarity of the solution? Note, $M_{C_{36}H_{51}NO_{12}} = 689.80\ \frac{g}{mol}$.

(a) 0.725 nM
(b) 0.725 μM
(c) 725 μM
(d) 7.25 mM
(e) 7.25 M

(a) (4 points)

*When dissolved in alcohol, pseudaconitine is the **solute** and alcohol is the **solvent**.*

(b) (2 points)

$$\mathrm{M}_{\mathrm{C_{36}H_{51}NO_{12}}} = \frac{n_{\mathrm{C_{36}H_{51}NO_{12}}}}{V_{\mathrm{solution}}}$$

Now we can calcuate the molarity!!

$$\mathrm{M}_{\mathrm{C_{36}H_{51}NO_{12}}} = \frac{5.00\times10^{-6}\ \mathrm{g\ C_{36}H_{51}NO_{12}} \times \frac{1\ \mathrm{mol\ C_{36}H_{51}NO_{12}}}{689.80\ \mathrm{g\ C_{36}H_{51}NO_{12}}}}{10.00\times10^{-3}\ \mathrm{L}}$$

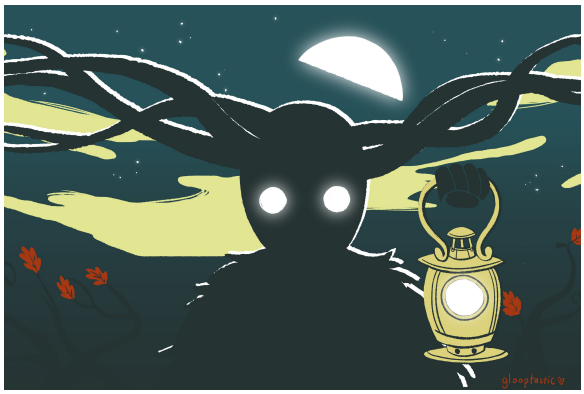
$$\mathrm{M}_{\mathrm{C_{36}H_{51}NO_{12}}} = 7.25\times10^{-7}\ \mathrm{M}$$

Converting from M to μM!

$$\mathrm{M}_{\mathrm{C_{36}H_{51}NO_{12}}} = 7.25\times10^{-7}\ \mathrm{M} \times \frac{1\ \mu\mathrm{M}}{1\times10^{-6}\ \mathrm{M}}$$

$$\mathrm{M}_{\mathrm{C_{36}H_{51}NO_{12}}} = 0.725\ \mu\mathrm{M}$$

17. (4 points)
In the animated miniseries *Over the Garden Wall*, a fictional character named the Beast must survive by keeping his lantern lit using edelwood oil as fuel.



The oil is harvested by the woodsman and collected into small vials.

(a) (2 points)
Edelwood oil is a mixture of edelwoodic acid dissolved in liquid asphalt. The woodsman discovered that he can use solutions as low as 0.203 M to fuel the lantern. If the woodsman harvests 15.0 mL of 4.00 M edelwood oil, what volume of 0.203 M edelwood oil can the woodsman prepare?

(a) 0.76 mL
(b) 25 mL
(c) 151 mL
(d) 296 mL
(e) 306 mL

(b) (2 points)
The woodsman's axe is made of carbon steel, which is an alloy of various elements as shown below.

Element	% Composition
Carbon	2.0
Copper	0.40
Manganese	1.65
Silicon	0.60
Chromium	20
Cobalt	15
Nickel	55
Vanadium	2
Zirconium	3.35

Is carbon steel a solution?

(a) Yes
(b) No

(a) (2 points) (d)

$$M_1V_1 = M_2V_2$$

$$V_2 = \frac{M_1V_1}{M_2}$$

$$V_2 = \frac{(4.00\ \text{M})(15.0\ \text{mL})}{(0.203\ \text{M})}$$

$$V_2 = 296\ \text{mL}$$

(b) (2 points) (a)
Carbon steel is a solution with the majority component (nickel) being the solvent. All other elements are solutes. It is important to keep in mind that solutions are not limited to liquids!

18. (4 points) You buy your Halloween cat some yummy treats =^..^=!

As an added bonus they are pumpkin flavored with electrolytes! Being a health science student you look over the ingredients and read the following.

THE BEST IN NATURE FORMULATED
WITH THE BEST OF SCIENCE™

HELPS SUPPORT:

Healthy Digestive Tract
Replenishment of Electrolytes in Healthy Dogs and Cats
Healthy Microflora
Normal Stool Formation

Ingredients:

Dried pumpkin, Calcium carbonate, Potassium citrate, Sodium bicarbonate, Natural vegetable flavor

From the ingredient list select one of the electrolytes and explain conceptually what how adding this chemical to water produces an electrolyte solution.

(4 points) Calcium carbonate in water dissociates into the calcium cation and carbonate anion, thereby introducing charged species into the water ***OR*** potassium citrate in water dissociates into the potassium cation and citric acid (deprotonated form) ***OR*** sodium bicarbonate dissociates into the sodium cation and bicarbonate anion. These charged species significantly increase water's conductivity, thereby making the solution an electrolyte solution.

19. (2 points) When the kidneys are not functioning properly, they cannot remove excess potassium. Potassium regulation is very important because too much potassium results can stop the heart. As a result individuals with weakened kidneys are on dialysis.

What do you think the name for high levels of potassium in the blood is?

(a) Hyperdrive
(b) Hyperglycemia
(c) Hyperkalemia
(d) Hyperphosphatemia
(e) Hypertonic

(c) (2 points)

A hyperdrive is what allows the *Millennium Falcon* to travel at light speed. Hyperglycemia is when a individual has too much sugar (glucose) in their blood. Hyper phosphatemia is when the blood has elevated levels of phosphate. A hypertonic solution is a solution that has a greater concentration of solutes compared to another solution on the other side of a semi-permeable membrane, such as a cell membrane. Hyperkalemia is when the blood has elevated levels of potassium.

As a hint to solving this problem, recall that the element symbol for potassium is K. This is because the Latin name for potassium is *kalium* and translates as *potash*.

$$\text{K} \longrightarrow \text{Kalium} \longrightarrow \text{Potash} \longrightarrow \text{Potassium}$$

20. (4 points) Shown below are the nutrition facts for a Hershey's bar and a box of Dots.

Nutrition Facts

1 servings per container

Serving Size	1 bar (43g)
Amount per serving	
Calories	**220**
	% Daily Value*
Total Fat 13g	20%
Saturated Fat 8g	40%
Trans Fat 0g	
Cholesterol 10mg	3%
Sodium 35mg	1%
Total Carbohydrate 25g	8%
Dietary Fiber 1g	4%
Total Sugars 24g	
Protein 3g	
Vitamin D 27.1iu	6%
Calcium 84.7mg	8%
Iron 1.5mg	8%
Potassium 154.9mg	4%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

HERSHEY'S BAR

Nutrition Facts

Serving Size 11 Dots (40g)
Servings Per Container about 13

Amount Per Serving	
Calories 130	
	% Daily Value*
Total Fat 0g	**0%**
Sodium 15mg	**1%**
Total Carbohydrate 33g	**11%**
Sugars 21g	
Protein 0g	

Not a significant source of calories from fat, saturated fat, trans fat, cholesterol, dietary fiber, vitamin A, vitamin C, calcium and iron.

*Percent Daily Values are based on a 2,000 calorie diet.

INGREDIENTS: CORN SYRUP, SUGAR, FOOD STARCH-MODIFIED, MALIC ACID, NATURAL AND ARTIFICIAL FLAVORS, SODIUM CITRATE, ARTIFICIAL COLORS (INCLUDING FD&C RED 40, YELLOW 5, BLUE 1).

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DOTS

Fill in the blanks.

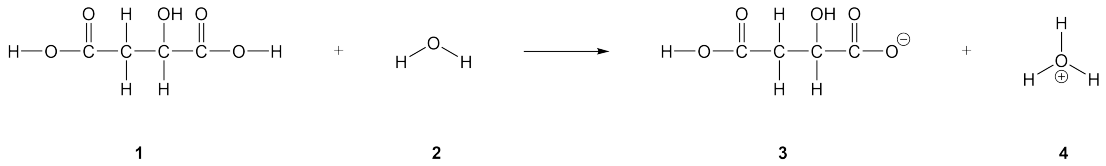
*For a dialysis patient, a Hershey's bar **is/is not** recommended to eat on Halloween while a box of Dots **is/is not** recommended to eat on Halloween.*

(4 points)
The Hershey's bar contains 154.9 mg of potassium whilt the box of Dots is not a source of potassium. As a result Dots can be eaten on Halloween!!

*For a dialysis patient, a Hershey's bar **is not** recommended to eat on Halloween while a box of Dots **is** recommended to eat on Halloween.*

21. (4 points) In late September you can buy See's sour bats before they sell out in October.

To make gummies sour, they are coated with different types of fruit compounds. Shown below is the reaction between two molecules present upon eating the sour candy.



1 2 3 4

Fill in the blanks; the reaction proceeds from left to right (reactants to products).

*Species **1/2/3/4** is the acid, Species **1/2/3/4** is the base, Species **1/2/3/4** is the conjugate acid, and Species **1/2/3/4** is the conjugate base.*

(4 points)
The acid is the proton donor (malic acid) and it becomes the conjugate base. The base is the proton acceptor (water) and it becomes the conjugate acid (hydronium ion).

*Species **1** is the acid, Species **2** is the base, Species **4** is the conjugate acid, and Species **3/** is the conjugate base.*

22. (6 points) Shown below is part of a Discover magazine article detailing how scorpion venom works.

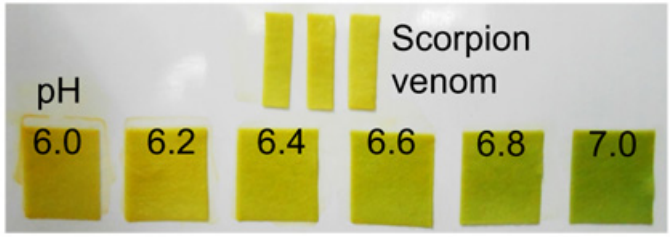
Researchers knew that scorpion venom could specifically target pain receptors in our bodies. When it comes to scorpion venom, though, that's not the whole story. To truly bring the pain, the venom must first alter the environment surrounding the neuron itself, effectively priming it to relay as much pain as possible.

That is where Zheng says previous studies failed — they didn't take into account the natural pH in the venom prior to the sting.

"A lot of venomous animals — snakes, scorpions, spiders — when they deliver that venom, that venom is quite acidic," Zheng says. "It's something we've known for quite a while but that people forget about."

But that acidity is important. Acids contain a high concentration of protons, which bind to neurons and increase the intensity of the signals they transmit. The venom is already primed to spark pain — the acid helps by forcing open the ion channels that allow neurons to communicate with each other.

(a) (2 points)
Shown below is pH paper: the bottom strips are the colors for reference solutions of known pH and the top strips are run on scorpion venon. Which of the following most correctly characterizes scorpion venom?



(a) The venom is strongly acidic
(b) The venom is weakly acidic
(c) The venom is neutral
(d) The venom is weakly basic
(e) The venom is strongly basic

(b) (2 points)
Which of the following describes pH paper?

(a) Activator
(b) Catalyst
(c) Deactivator
(d) Fluorophore
(e) Indicator

(c) (2 points)
A 5-mL sample of scorpion venom contains 36 ng H_3O^+. What is the pH of the scorpion venom?

(a) 6.42
(b) 6.46
(c) 6.50
(d) 6.54
(e) 6.58

(a) (2 points) (b)

Since pH is just below 7.0, near 6.5, scorpion venom is weakly acidic.

(b) (2 points) (e)

Since pH paper changes color with pH, pH paper is an indicator.

(c) (2 points) (a)

First, recall that $\text{pH} = -\log_{10}[H_3O^+]$, where $[H_3O^+]$ is the hydronium ion concentration reported in molarity (M).

First we need to calculate $[H_3O^+]$!

$$[H_3O^+] = \frac{n_{H_3O^+}}{V}$$

$$[H_3O^+] = \frac{36\times10^{-9}\text{ g } H_3O^+ \times \frac{1\text{ mol } H_3O^+}{19.03\text{ g } H_3O^+}}{5\times10^{-3}\text{ L}}$$

$$[H_3O^+] = 3.78\times10^{-7}\text{ M}$$

Now we can calculate the pH!!

$$\text{pH} = -\log_{10}[H_3O^+]$$

$$\text{pH} = -\log_{10}\left[3.78\times10^{-7}\right]$$

$$\text{pH} = 6.42$$

23. (3 points)

The history of vampires dates back to a rare genetic disease called congenital erythropoietic porphyria (CEP). If a person has CEP, this means that porphyrin molecules cannot circulate throughout the blood. Porphyrins are important because they are a key component of heme. The symptoms are CEP are extreme paleness, sensitivity to light, and anemia. This then introduced the lore of such individuals wanting blood.

Why are Vampires supposedly from Transylvania? Transylvania is isolated geographically and in this area individuals from prominent families would marry. Due to the isolation, over time this narrowed the gene pool. This resulted with a higher number of people in Transylvania with CEP. Since porphyria results in porphyrin molecules being unequally distributed throughout the body, if a high concentration of porphyrins accumulate in the skin, the porphyrin's exposure to sunlight results in a rash and irritation. This explains the origins for why vampires avoid the sunlight.

In addition to blood cells, human blood contains a bicarbonate buffer system. Fill in the blanks.

Bicarbonate ***increases/decreases/regulates*** *blood pH to a range of 7.35 to 7.45. In this acid-base system, 1) the* ***acid/base*** *part of the buffer system reacts with any added* H_3O^+ *and 2) the* ***acid/base*** *part of the buffer system reacts with any added* OH^-.

(3 points)

Bicarbonate ***regulates*** *blood pH to a range of 7.35 to 7.45. In this acid-base system, 1) the* ***base*** *part of the buffer system reacts with any added* H_3O^+ *and 2) the* ***acid*** *part of the buffer system reacts with any added* OH^-.

24. (4 points) Just as vampires hunt humans, vampire hunters hunt vampires. Tracing back to Slavic lore, a special type of vampire hunter is the *krsnik* (also called *crusnik*). The *krsnik* is a shaman spirit that transforms into an animal at night to fight the *kudlak* (aka vampire).

(a) (2 points)
Vampires drink blood for the nutritive value of a human's plasma (solid food does not agree with vampiric physiology). The pH of blood is about 7.35–7.45. Which of the following most correctly characterizes plasma?

(a) Plasma is strongly acidic
(b) Plasma is weakly acidic
(c) Plasma is neutral
(d) Plasma is weakly basic
(e) Plasma is strongly basic

(b) (2 points)
It is hypothesized that the crusnik (vampire hunter) feeds off the blood of the kudlak (vampire) since vampire blood has a greater concentration of nutrients than human blood. Fill in the blanks:

As the concentration of a solution increases, the volume that delivers the same amount of nutrients ***increases/decreases****.*

(a) (2 points) (d)
SInce the pH is just above 7.00 (neutral), plasma is weakly basic.
(b) (2 points)

As the concentration of a solution increases, the volume that delivers the same amount of nutrients ***decreases****.*