Open Ended Question

In this activity, you will go through the process of elimination to figure out the identity of an unknown solid based on its physical and chemical properties from the following descriptions. The identity of the compound is among the following list of 20 compounds in no particular order. When you go through the elimination process, **use the letter** that corresponds to the following list **to place your answer**. (20 total)

A. albumin (protein in egg white)	**B**. ascorbic acid (aka vitamin C, $C_6H_8O_6$)
C. benzoic acid ($C_6H_5CO_2H$, sol=3.44 g/L)	**D**. calcium chloride
E. calcium hydroxide	**F**. ammonium chloride
G. copper (II) sulfate	**H**. iron (III) chloride
I. lead (II) nitrate	**J**. lithium sulfite
K. lithium nitrate	**L**. potassium chloride
M. potassium nitrate	**N**. sodium acetate
O. sodium bicarbonate	**P**. sodium chloride
Q. calcium sulfite	**R**. sodium nitrate
S. sodium sulfite	**T**. sucrose (table sugar)

(2pt) Sample preparation: 1. In a 150 mL beaker at room temperature of ~25°C, measure out 0.500 g of an unknown solid. 2. Measure out 100 mL distilled water and add the water to the beaker from step 1. 3. Stir the solid in the distilled water with a glass stirring rod for 1 minute. Let the beaker set on the bench top for 5 minutes. At this point, no settling of solid is observed. 1.Based on this observation, list the compound(s) from the list that can be eliminated as the unknown and 2. Concisely give any relevant physical property that allow you to eliminate these compounds. You can click the picture to make it bigger. Make notes, the next several questions deal with this lab.

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(2.5pts) The liquid inside the beaker is colorless. Based on this observation, 1.List the compound(s) from the above list that can be eliminated as the unknown and 2. Concisely give any relevant physical property that allow you to eliminate these compounds.

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(2pts) Pipet 5 mL of the unknown mixture into a small test tube and shine a light on the test tube. The light passes through the transparent mixture. Based on this observation, 1. List the compound(s) from the above list that can be eliminated as the unknown and 2. Concisely give any relevant physical property for the elimination.

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(2pts) When a strip of blue litmus paper is dipped in the above test tube, the paper remained blue. Based on this observation, 1. List the compound(s) from the above list that can be eliminated as the unknown and 2. Concisely give any relevant physical property for the elimination.

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(2.5pts) When 2 drops of a 1% phenolphthalein indicator are added to a 3-mL portion of the unknown solution, the resulting solution remained colorless. Based on this observation, 1. List the compound(s) from the above list that can be eliminated as the unknown and 2. Concisely give any relevant physical property for the elimination.

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(2pts) When a 3-mL solution of potassium carbonate is combined with a 3-mL portion of the unknown solution, no precipitate is observed. Based on this observation, 1. List the compound(s) from the above list that can be eliminated as the unknown and 2. Concisely give any relevant physical property for the elimination.

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K. lithium nitrate
L. potassium chloride
M. potassium nitrate
N. sodium acetate
O. sodium bicarbonate
P. sodium chloride
Q. calcium sulfite
R. sodium nitrate
S. sodium sulfite
T. sucrose (table sugar)

(2pts) When a conductivity meter is dipped in the solution, the tester shows that the unknown solution is an electrolyte. Based on this observation, 1. List the compound(s) from the above list that can be eliminated as the unknown and 2. Concisely give any relevant physical property for the elimination.

Open Ended Question

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M. potassium nitrate	**N**. sodium acetate
O. sodium bicarbonate	**P**. sodium chloride
Q. calcium sulfite	**R**. sodium nitrate
S. sodium sulfite	**T**. sucrose (table sugar)

(2pts) When a 3-mL solution of silver acetate is combined with a 3-mL portion of the unknown solution, no precipitate is observed. Based on this observation, 1. List the compound(s) from the above list that can be eliminated as the unknown and 2. Concisely give any relevant physical property for the elimination.

Open Ended Question

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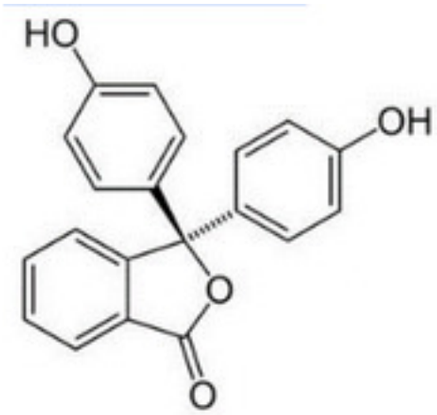
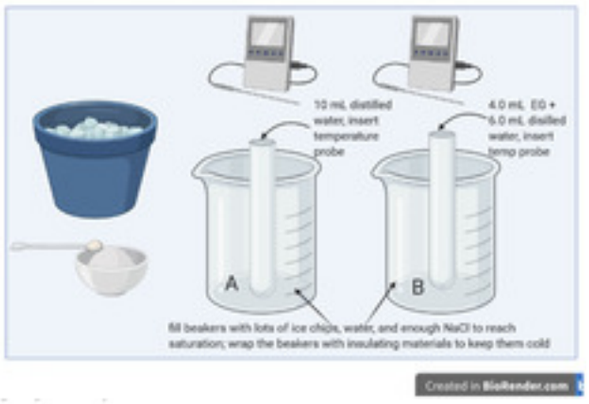
(2pts) Flame test of the unknown solution gives a violet-colored flame. 1. Based on this observation, give the identity of the unknown compound.

Open Ended Question



(1pt) The 1% phenolphthalein solution used in this activity was prepared in a solution containing 1 part distilled water to 3 parts ethanol. Based on the structure of phenolphthalein given, what is the property of ethanol compared to water that makes phenolphthalein soluble?

Open Ended Question

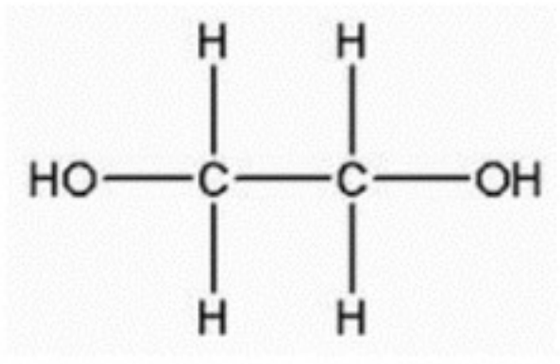


(1pt) In this activity, the effects of adding ethylene glycol (EG) and sodium chloride on the freezing point of distilled water is explored. Prepare 2 cold baths by making a slurry of ice chips, water, and enough salt to saturation in 2 x 400 mL beaker wrapped with a layer of polyester fiberfill. Prepare 2 test tubes labeled A and B. Dispense 10 mL of distilled water in test tube A and 6 mL water + 4 mL ethylene glycol mixture in test tube B. Place the two test tubes in their respective ice-water bath. Insert a digital thermometer in each test tube and monitor the temperatures of each of the test tube. Record the temperature at 2-minutes intervals. Note the length of time the first test tube starts to form ice crystals/sign of freezing. Record its freezing temperature. Continue to monitor and record the second test tube for 10 more minutes. Predict which test tube has a lower freezing temperature, A or B.

Open Ended Question

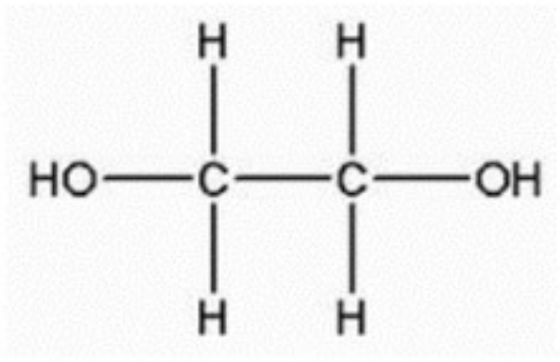
(2pts) Very concisely state the reason for your answer for your previous question from chemistry point of view.

Open Ended Question



(1pt) The structure of ethylene glycol is shown here. Based on the structure, do you expect its boiling point to be higher, lower, or the same as that of water?

Open Ended Question



(2pts) 1. What is the major intermolecular force of ethylene glycol? 2. What is the major attractive force between water and ethylene glycol?

Open Ended Question

time (minutes)	temperature (°C)	
	A	B
0	25.0	25.0
2	22.6	22.5
4	18.8	18.4
6	13.7	13.2
8	7.5	7.0
10	2.8	0.2
12	0.7	−5.8
14	0.3	−11.6
16	0.1	−16.9
18	ice crystals observed	−19.3
20		−19.8
22		−20.2
24		−20.2
26		−20.2
28		−20.2, still no ice crystals

(2 pts) The data recorded from this activity is shown here. What does the last recorded temperature value for B (40% ethylene glycol) represent?

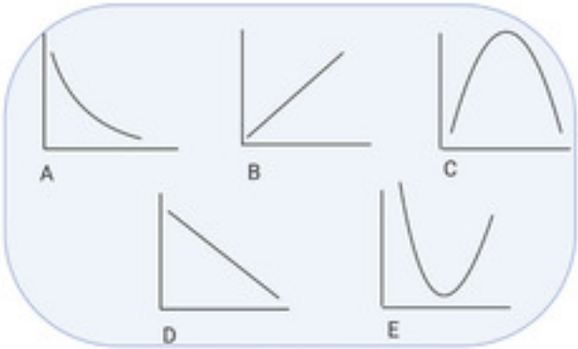
Open Ended Question

time (minutes)	temperature (°C)	
	A	B
0	25.0	25.0
2	22.6	22.5
4	18.8	18.4
6	13.7	13.2
8	7.5	7.0
10	2.8	0.2
12	0.7	−5.8
14	0.3	−11.6
16	0.1	−16.9
18	ice crystals observed	−19.3
20		−19.8
22		−20.2
24		−20.2
26		−20.2
28		−20.2, still no ice crystals

(3pts) 1. Based on the data, what can you say about the freezing point of B? 2. What is the concentration in molality of B (40% EG)? Molar mass of EG = 62.07 g/mol, density of EG = 1.11 g/mL. 3. Calculate the freezing point of 40% EG solution. (Kf of water = 1.86 °C·kg·mol−1) Number your answers and hit submit before the timer gets to 0:00.

Quiz

Quiz Section 1

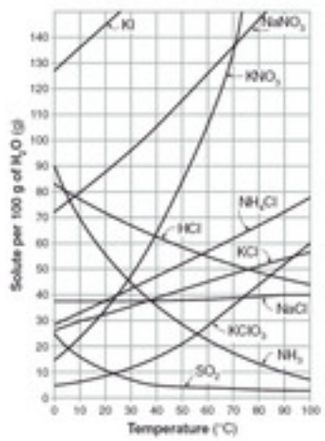


The freezing point (Tf) of pure EG is −13°C. Given this information, which of the following curves best represent a plot of Tf (y-axis) vs. %EG (x-axis) of an aqueous solution?

- A
- B
- C
- D
- E

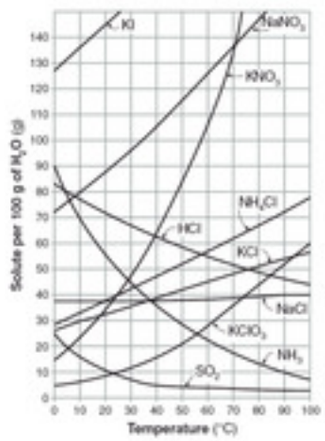
In the lab set up for this activity, what is the purpose of adding NaCl to the ice water bath?

- To lower the temperature of the bath to below the freezing point of water
- To raise the temperature of the bath to above the freezing point of water
- To keep the bath from freezing
- To increase the insulating factor of the bath



A graph of water solubility vs. temperature of several salts is shown here. Based on this graph, concisely state an advantage of using NaCl to prepare the ice water bath for this activity?

- It is a neutral salt
- It is more soluble
- Its solubility is relatively invariant with temperature
- It is readily available



In advance of inclement weather, MgCl_(2) or CaCl_(2) are often applied as an anti-icer or de-icer due to the concern that wildlife are often attracted to ingesting Na^(+). How effective is MgCl_(2)/CaCl_(2) as an anti-icer compared to NaCl if equal molar concentration is used?

- More effective
- Less effective
- comparable

What is the reason for your answer for your previous question from chemistry point of view?

- It has a higher ionic charge
- It contains more particles per formula unit
- The solid crystals are smaller
- They are less corrosive

As mentioned above, many animals are attracted to sodium salt. They tend to overshoot their salt deficit and then drink salty snow melt to relieve thirst. How does drinking salt solution affect the hydration level of the cells of the animals?

- The cells will take in too much water
- The salt solution will pull out water from the cells
- The salinity of the cells will increase
- The salinity of the cells will decrease

What is the reason for your answer for your previous question from chemistry/biochemistry point of view?

- There's a net movement of water from cells to the surrounding due to concentration differential
- Salt ion particles flow into the cells due to concentration differential
- Salt ion particles flow out of the cells due to concentration differential
- There's a net movement of water from surrounding into the cells due to concentration differential

Boulder Colorado began using a liquid solution comprising 29% aqueous solution of MgCl_(2) in 1993 to lessen the impact on the harm to wildlife and at the same time decrease the use of sand (to increase traction). What is the concentration of a 29% aqueous solution of MgCl_(2) in molality?

- 2.4 $mol \cdot kg^{-1}$
- 1.7 $mol \cdot kg^{-1}$
- 3.0 $mol \cdot kg^{-1}$
- 4.1 mol·kg-1
- 3.8 mol·kg-1

How low a temperature would you expect a 29% MgCl_(2) de-icing solution to be effective at preventing ice formation?

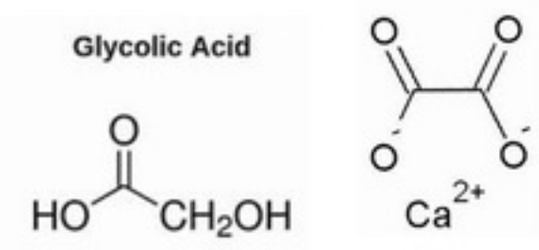
- −8.9°C
- −13°C
- −9.5°C
- −17°C
- −23°C

Sodium ion is an essential component of electrolytes for human and other living organisms for a variety of bodily function. The optimal blood [Na^(+)] is 139 mEq/L. Most of us gets enough Na^(+) from our diet; however, a condition called hyponatremia (when blood [Na^(+)] < 135 mEq/L) can occur with excessive sweating combined with drinking a large quantity of liquid without added electrolyte. If the amount of blood in the human body is 7% of body weight and the density of blood is 1060 kg/m3, how many L of pure water can a 68-kg marathon runner tolerate without lowering the runner's blood [Na^(+)] from 139 to 135 mEq/L?

- 1.7 L
- 2.0 L
- 3.6 L
- 4.5 L
- 5.3 L

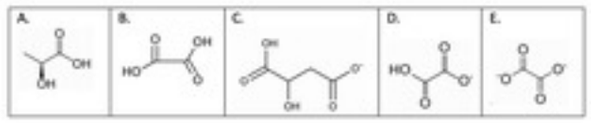
Quiz

Section 2



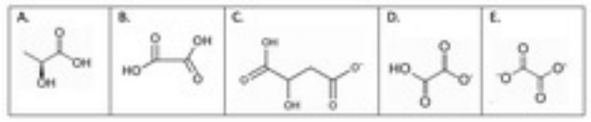
As shown from the data table earlier, the addition of ethylene glycol (EG) is effective in lowering the freezing point of water. EG is used as antifreeze in car engines. However, EG is toxic to human and household pets (so, don't let your dog drink puddle water when you walk your dog, especially on urban streets.) Through a complex series of biochemical reaction, EG is metabolized in the body to form several products. The two metabolites thought to be most responsible for the toxicity of EG are glycolic acid and oxalate (which usually complex with Ca^(2+) to form calcium oxalate.) The structure of glycolic acid (GA) and calcium oxalate (CO) are shown in the picture. Oxalates has a 2^(−) charge in a relatively small compound. How is the structure stabilized?

- It is unstable
- It readily takes up positive charge
- It often precipitates out
- It relates its charge to other compounds
- The negative charge is delocalized among all oxygens



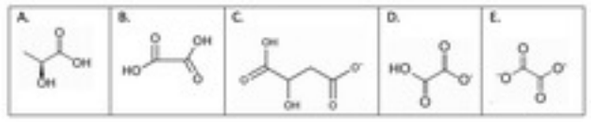
Select the structure for the conjugate acid of the oxalates

- A
- B
- C
- D
- E



Which of the structures has the highest value of K_(a)?

- A
- B
- C
- D
- E



Which of the structures has the lowest value of pK_(b)?

- A
- B
- C
- D
- E

Give the volume in mL of a 0.125 M KOH needed to reach the end point of titration with a 25.0 mL 0.0950 M oxalic acid.

- 19.0 mL
- 33.0 mL
- 38.0 mL
- 16.0 mL
- 66.0 mL

Which form of oxalate/oxalic acid is most water soluble?

- The acidic form
- The monobasic form
- The dibasic form

The pK_(a1) and pK_(a2) of oxalic acid are 1.27 and 4.28, respectively. In a healthy human, the blood maintains a fairly constant pH of 7.4. Which form of oxalic acid/oxalate is present in such condition?

- Predominately in the acidic form
- Predominately in the monobasic form
- Predominately in the dibasic form
- Significant amounts of both acidic and monobasic forms
- Significant amounts of both monobasic and dibasic forms
- Significant amounts of all three forms

The pH of urine is more variable. Which form of oxalic acid/oxalate is present for someone with a urine pH of 5.0?

- Predominately in the acidic form
- Predominately in the monobasic form
- Predominately in the dibasic form
- Significant amounts of both acidic and monobasic forms
- Significant amounts of both monobasic and dibasic forms
- Significant amounts of all three forms

The toxic effect of oxalate from EG poisoning is due to the formation of calcium oxalate crystals which leads to damages to tissues, kidney, and urinary tract. The solubility product in water at 20°C of calcium oxalate is 1.5 E−8. What is the molar solubility of calcium oxalate?

- 1.5 E-8 M
- 1.2 E−4 M
- 2.3 E-16 M
- 7.5 E-9 M
- 3.2 E-6 M

The human body is set to have a normal [Ca^(2+)] of around 1.2 mM. What concentration in mM of oxalate would cause calcium oxalate crystals to start to form for someone with a normal [Ca^(2+)]?

- 1.3 E-5 mM
- 1.3 E-8 mM
- 1.3 E−2 mM
- 1.3 E-6 mM
- 1.3 E-4 mM

Quiz

Section 3

Which aqueous solution of the following oxalate salt is expected to give highest pH?

- silver oxalate
- lead (II) oxalate
- sodium oxalate
- calcium oxalate

What is the reason for your answer in the previous question?

- most water soluble
- least water soluble
- highest pKb
- lowest pKb
- highest Kb

The toxic effect of glycolic acid (GA) from EG poisoning is mainly due to that its accumulation causes metabolic acidosis. Metabolic acidosis can lead to acidemia, which is defined as arterial blood pH that is lower than 7.35 (the normal pH range is 7.35-7.45). Human blood contains a buffer of carbonic acid/bicarbonate. Which of the following can lead to acidemia?

- increased acid production
- ingestion of too much acid or acid precursor
- loss of bicarbonate
- a reduced ability of the kidneys to excrete excess acids
- all of the above

What is the increase in [H_(3)O^(+)] for someone to decrease his/her blood pH from 7.40 to 7.30?

- 0.10 M
- 1.0 M
- 1.0 E-7 M
- 1.0 E−8 M

Hyperventilation can occur when someone is in a distressed or an over-excited state. It happens when the rate or tidal volume of breathing eliminates more carbon dioxide than the body can produce. How does hyperventilation affect the blood pH?

- increase
- decrease
- no change

During the pandemic, many people are employing DIY approach to beauty routine. Due to its lack of color and odor and high solubility in water and its excellent capability to penetrate skin, GA is often used as a chemical peel agent. GA can be purchased from 10% to 30% (% in mass/volume) formulation for at home use. What is the molar concentration of a 10% GA formulation?

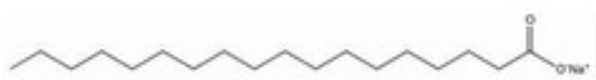
- 0.65 M
- 1.3 M
- 1.7 M
- 2.3 M
- 3.6 M

What pH is a 1.3 M GA solution? The pK_(a) of GA is 3.6.

- 1.74
- 2.23
- 2.89
- 3.14
- 3.89

Human skin is covered by a protective layer of film generated by sebum mixed with sweat. The sebum is composed of a variety of lipids that are secreted by the sebaceous gland. An example of a lipid from sebum is shown here. Based on the structure, do you expect the pH of human skin to be:

- acidic
- near neutral
- basic



The optimal pH value of skin is acidic and between 4.7 to 5.7. The layer of film is called acid mantle and acts as a protective barrier to bacteria, viruses, and other potential contaminants that might penetrate the skin. The chemical structure of a typical soap molecule is shown here. Based on the structure, do you expect the pH of soap to be:

- acidic
- near neutral
- basic