LAB 2: ENERGY TRANSFER

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INTRODUCTION: BOILING AND COOLING TEMPERATURES OF DISPERSIONS

This lab explored how various substances (salt, sugar, gelatin, and cornmeal), when dispersed in water, affected the boiling and cooling time and temperatures of that water.

Objectives - The purpose of this lab is to:

- To explain the factors that determine the boiling temperature of water alone and with various ingredients added.
- To gain experiences in plotting data.

Food Science Principles - Dispersions are mixtures of at least two materials that are classed by particle or molecule size.[1] The process of dispersion involves combining two substances and applying mechanical energy to suspend the solute within the solvent.[1] The result is either a solution or suspension, depending on particle size.[1]

METHODS

- Dr. D's data was used for this lab experiment. Noted variations in methods included:
  - Medium-high heat on an electric range for boiling dispersions
  - An environment slightly cooler than room temperature (69 degrees F vs. 72 degrees F)
  - Each substance was boiled separately in a small saucepan

RESULTS

Procedures:

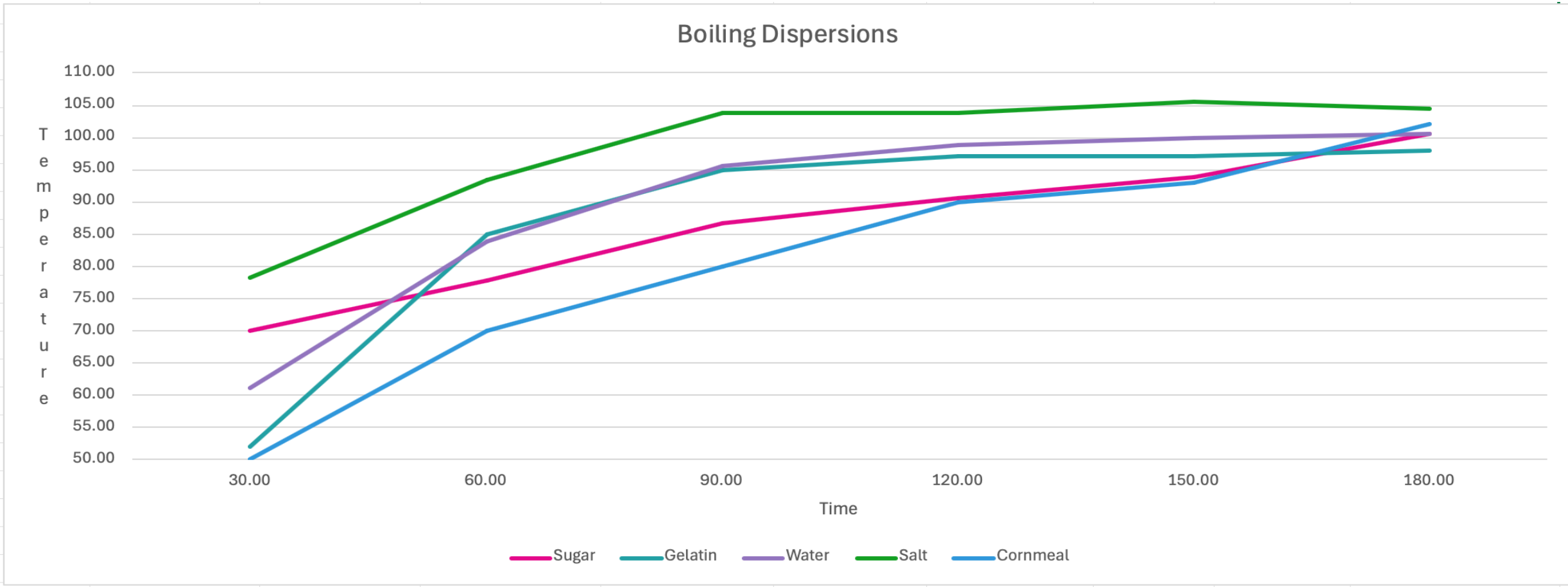
- Measure 450 mL water into a small saucepan.
- Add 15 g (1 tablespoon) of the assigned ingredient.
- Bring the water+ingredient (dispersion) to a full boil on top of the stove with the heat set to high.
- Read and record the temperature at 30 sec intervals until boiling temperature is reached.
- As soon as the dispersion comes to a boil, record the temperature and the time it took to boil.
- Repeat Steps 1-5 for each of the assigned ingredients.

For Cooling:

- Repeat Steps 1-5 for each of the assigned ingredients.
- Read and record the temperature at 30 sec intervals until room temperature is reached.

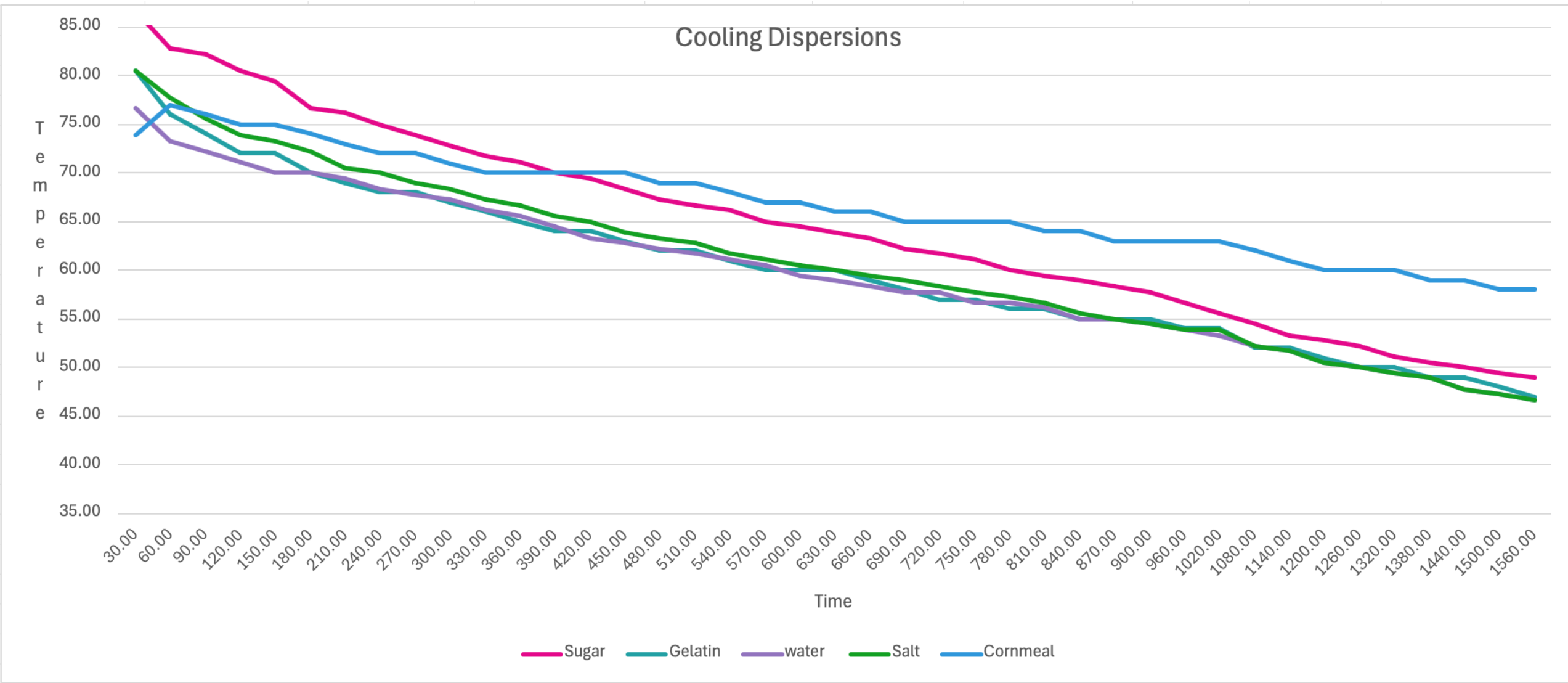
Time and Temperature TO BOIL

Time (seconds)	Sugar (F)	sugar (C)	gelatin (F)	gelatin (C)	Water (F)	Water (C)	salt (F)	Salt (C)	cornmeal (F)	cornmeal (C)
30.00	158.00	70.00	125.60	52.00	142.00	61.11	173.00	78.33	122.00	50.00
60.00	172.00	77.78	185.00	85.00	183.00	83.89	200.00	93.33	158.00	70.00
90.00	188.00	86.67	203.00	95.00	204.00	95.56	**219.00**	103.89	176.00	80.00
120.00	195.00	90.56	206.60	97.00	210.00	98.89	219.00	103.89	194.00	90.00
150.00	201.00	93.89	206.60	97.00	212.00	100.00	222.00	105.56	199.40	93.00
180.00	**213.00**	100.56	**208.40**	98.00	**213.00**	100.56	220.00	104.44	**215.60**	102.00



Time and Temperature to COOL DOWN

Time (seconds)	Sugar (F)	Sugar (C)	Gelatin (F)	gelatin (C)	Water (F)	Water (C)	salt (F)	Salt (C)	Cornmeal (F)	Cornmeal (C)
30.00	188.00	86.67	177.00	80.56	170.00	76.67	177.00	80.56	165.00	73.89
60.00	181.00	82.78	168.80	76.00	164.00	73.33	172.00	77.78	170.60	77.00
90.00	180.00	82.22	165.20	74.00	162.00	72.22	168.00	75.56	168.80	76.00
120.00	177.00	80.56	161.60	72.00	160.00	71.11	165.00	73.89	167.00	75.00
150.00	175.00	79.44	161.60	72.00	158.00	70.00	164.00	73.33	167.00	75.00
180.00	170.00	76.67	158.00	70.00	158.00	70.00	162.00	72.22	165.20	74.00
210.00	169.00	76.11	156.20	69.00	157.00	69.44	159.00	70.56	163.40	73.00
240.00	167.00	75.00	154.40	68.00	155.00	68.33	158.00	70.00	161.60	72.00
270.00	165.00	73.89	154.40	68.00	154.00	67.78	156.00	68.89	161.60	72.00
300.00	163.00	72.78	152.60	67.00	153.00	67.22	155.00	68.33	159.80	71.00
330.00	161.00	71.67	150.80	66.00	151.00	66.11	153.00	67.22	158.00	70.00
360.00	160.00	71.11	149.00	65.00	150.00	65.56	152.00	66.67	158.00	70.00
390.00	158.00	70.00	147.20	64.00	148.00	64.44	150.00	65.56	158.00	70.00
420.00	157.00	69.44	147.20	64.00	146.00	63.33	149.00	65.00	158.00	70.00
450.00	155.00	68.33	145.40	63.00	145.00	62.78	147.00	63.89	158.00	70.00
480.00	153.00	67.22	143.60	62.00	144.00	62.22	146.00	63.33	156.20	69.00
510.00	152.00	66.67	143.60	62.00	143.00	61.67	145.00	62.78	156.20	69.00
540.00	151.00	66.11	141.80	61.00	142.00	61.11	143.00	61.67	154.40	68.00
570.00	149.00	65.00	140.00	60.00	141.00	60.56	142.00	61.11	152.60	67.00
600.00	148.00	64.44	140.00	60.00	139.00	59.44	141.00	60.56	152.60	67.00
630.00	147.00	63.89	140.00	60.00	138.00	58.89	140.00	60.00	150.80	66.00
660.00	146.00	63.33	138.20	59.00	137.00	58.33	139.00	59.44	150.80	66.00
690.00	144.00	62.22	136.40	58.00	136.00	57.78	138.00	58.89	149.00	65.00
720.00	143.00	61.67	134.60	57.00	136.00	57.78	137.00	58.33	149.00	65.00
750.00	142.00	61.11	134.60	57.00	134.00	56.67	136.00	57.78	149.00	65.00
780.00	140.00	60.00	132.80	56.00	134.00	56.67	135.00	57.22	149.00	65.00
810.00	139.00	59.44	132.80	56.00	133.00	56.11	134.00	56.67	147.20	64.00
840.00	138.00	58.89	131.00	55.00	131.00	55.00	132.00	55.56	147.20	64.00
870.00	137.00	58.33	131.00	55.00	131.00	55.00	131.00	55.00	145.40	63.00
900.00	136.00	57.78	131.00	55.00	130.00	54.44	130.00	54.44	145.40	63.00
960.00	134.00	56.67	129.20	54.00	129.00	53.89	129.00	53.89	145.40	63.00
1020.00	132.00	55.56	129.20	54.00	128.00	53.33	129.00	53.89	145.40	63.00
1080.00	130.00	54.44	125.60	52.00	126.00	52.22	126.00	52.22	143.60	62.00
1140.00	128.00	53.33	125.60	52.00	125.00	51.67	125.00	51.67	141.80	61.00
1200.00	127.00	52.78	123.80	51.00	123.00	50.56	123.00	50.56	140.00	60.00
1260.00	126.00	52.22	122.00	50.00	122.00	50.00	122.00	50.00	140.00	60.00
1320.00	124.00	51.11	122.00	50.00	121.00	49.44	121.00	49.44	140.00	60.00
1380.00	123.00	50.56	120.20	49.00	120.00	48.89	120.00	48.89	138.20	59.00
1440.00	122.00	50.00	120.20	49.00	118.00	47.78	118.00	47.78	138.20	59.00
1500.00	121.00	49.44	118.40	48.00	117.00	47.22	117.00	47.22	136.40	58.00
1560.00	120.00	48.89	116.60	47.00	116.00	46.67	116.00	46.67	136.40	58.00
Time (seconds)	Sugar (F)	Sugar (C)	Gelatin F	gelatin C	Water (F)	Water (C)	salt (F)	Salt (C)	Cornmeal (F)	Cornmeal (C)


Cooling Dispersions
Temperature
85.00
80.00
75.00
70.00
65.00
60.00
55.00
50.00
45.00
40.00
35.00
30.00
60.00
90.00
120.00
150.00
180.00
210.00
240.00
270.00
300.00
330.00
360.00
390.00
420.00
450.00
480.00
510.00
540.00
570.00
600.00
630.00
660.00
690.00
720.00
750.00
780.00
810.00
840.00
870.00
900.00
960.00
1020.00
1080.00
1140.00
1200.00
1260.00
1320.00
1380.00
1440.00
1500.00
1560.00
Time
Sugar
Gelatin
water
Salt
Cornmeal

RESULTS

Conclusions From the Results:

- The boiling and cooling temperatures of dispersions depend on the number of solutes dissolved (colligative properties).[2]
- Suspensions, colloidal dispersions, and true solutions all exhibit different boiling and cooling behaviors from one another.
- The vapor pressure of water is altered when solutes are present.[1]

DISCUSSION - ANALYSIS OF RESULTS

- Why did we get these results?
  - Colligative Properties:
    - The concentration of particles in a solution (i.e., the number of particles dissolved) explains the increase in boiling point observed in the salt-water dispersion.
  - Changes in Vapor Pressure:
    - This is also a colligative property - The vapor pressure is lowered when a solute is added to a solvent.[3] This leads to an increase in boiling point and would also account for what was observed in the salt and cornmeal conditions.
  - Nature of True Solutions, Colloidal Dispersions, and Suspensions:
    - Generally, suspensions exhibit more greatly reduced efficiency of heat transfer than colloidal dispersions, which show lower efficiency of heat transfer than true solutions.[4,5] Many factors dictate this outcome, including particle size (affects uniformity of heating; areas with higher or lower temperatures in the dispersion).[5]
- Explanation of Differences: Cooler ambient temperature; reading on the thermometer was inaccurate; "hot spots" or cooler spots in the cooking vessel or dispersion itself came into contact with the thermometer, impacting the temperature being displayed; additional factors that were not discussed: specific heat capacity of dispersions, viscosity, etc.

DISCUSSION - SUMMARY OF WHAT WE LEARNED

- Boiling Behavior:
  - Under normal conditions, the addition of a solute to a solvent (like water) causes the boiling point to increase, depending on how much of the solute can dissolve in the solvent.
- Cooling Behavior:
  - Suspensions generally take longer to cool than colloidal dispersions and true solutions due to impaired efficiency of heat transfer.
- General Insights:
  - Different solutes affect the boiling and cooling points of dispersions in various ways.

DISCUSSION - HOW WE MET THE OBJECTIVES

- To explain the factors that determine the boiling temperature of water alone and with various ingredients added.
  - We have noted that:
    - Changes in vapor pressure with the addition of solutes generally increases boiling point.[1,2]
    - Colligative properties of solutions dictate that the concentration of particles in a solution affects its boiling point (i.e., boiling point elevation).[2]
    - Particle size affects heat transfer in dispersions.
- To gain experiences in plotting data.
  - We made two graphs showing the time and temperatures of boiling and cooling dispersions from the data that Dr. D collected.

DISCUSSION - CONCLUSION: TAKE-HOME MESSAGE

The size and presence of solutes affects energy transfer in water dispersions; this, then, impacts the observed boiling and cooling temperatures of dispersions, as well as the time it takes for them to heat or cool.

WORKS CITED

1. DellaValle DM. Week 2 phys aspects food prep; water. Lecture slides. ND 608. King's College; October 27, 2025. Moodle. Accessed November 1, 2025. https://moodle.kings.edu/mod/resource/view.php?id=967671

2. LibreTexts. 13.9: freezing point depression and boiling point elevation- making water freeze colder and boil hotter. Chemistry LibreTexts. Published June 10, 2020. Accessed November 1, 2025. https://chem.libretexts.org/Courses/College_of_Marin/CHEM_114%3A_Introductory_Chemistry/13%3A_Solutions/13.09%3A_Freezing_Point_Depression_and_Boiling_Point_Elevation-_Making_Water_Freeze_Colder_and_Boil_Hotter

3. LibreTexts. Colligative properties. Chemistry LibreTexts. Published September 24, 2022. Accessed November 1, 2025. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Physical_Properties_of_Matter/Solutions_and_Mixtures/Colligative_Properties

4. LibreTexts. 6.3: suspensions and colloids. Chemistry LibreTexts. Published June 2, 2020. Accessed November 1, 2025. https://chem.libretexts.org/Courses/Grand_Rapids_Community_College/CHM_110%3A_Chemistry_of_the_Modern_World_(Neils)/6%3A_Solutions/6.3_Suspensions_and_Colloids

5. Zeng G, Hou S, Guo Q, Cai Y, Xu M. Advances in solid particle thermal energy storage: a comprehensive review. *Sustainability*. 2025; 17(16):7244. doi:10.3390/su17167244