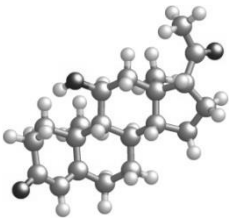


Chem!stry

Name: …… **( )**

Class: ……

Date: …… **/** …… **/** ……

Chemistry SPA Skill 3 – Planning an Experiment

To Investigate the Effect of Temperature on the Concentration of Vitamin C in Orange Juice – Answer

a) Hypothesis

Increasing temperature increases the rate of a chemical reaction. Increasing the temperature of the orange juice will increase the rate at which the vitamin C in the orange juice decomposes / breaks down. The higher the temperature that the orange juice is stored, the lower the concentration of vitamin C the orange juice will contain.

As the kinetic energy of the particles increases, they collide more frequently and with more energy, therefore there is an increase in the *frequency of effective collisions*.

b) Variables

- Independent variable (*input variable* – what you modify):

  Temperature of the orange juice.

- Dependent variable (*output variable* – what you measure):

  Concentration of vitamin C in the orange juice.

- Constant (variables that must remain the same for all experiments):

  Volume of orange juice used for each experiment.

If in any doubt about what an independent and dependent variables are, then just clearly state what will be *changed*, what will be *measured* and what will *remain constant* during the experiments.

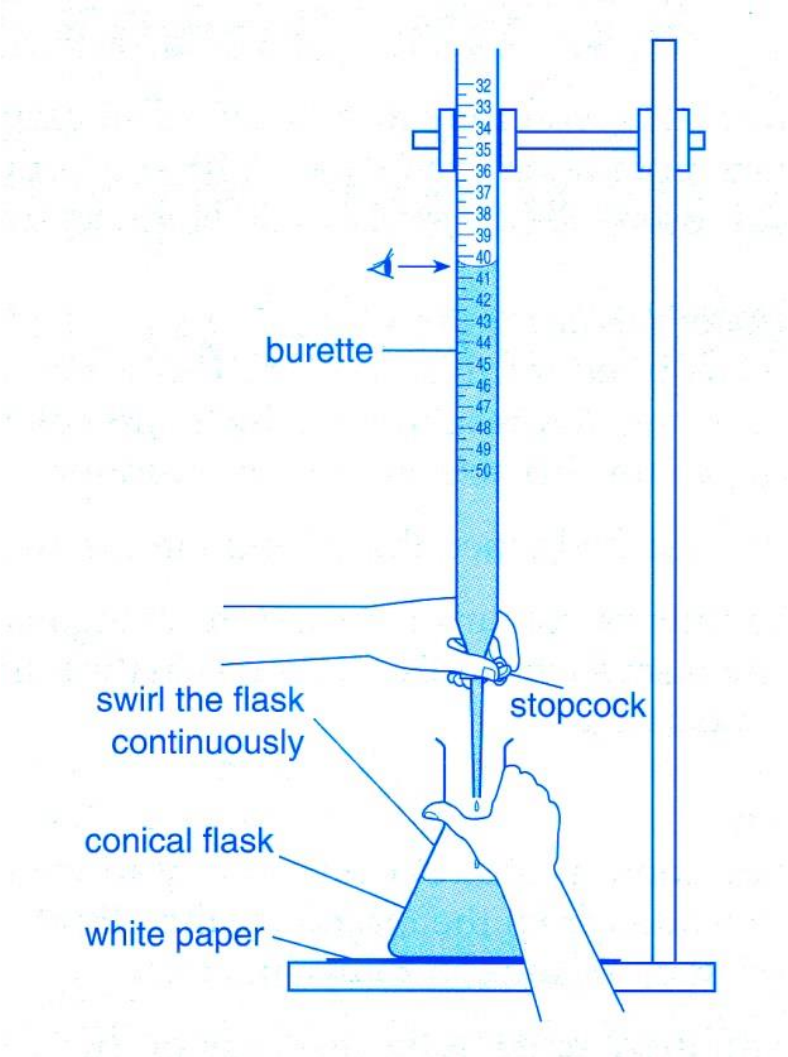
c) Brief Outline of the Experiment

A 1000 cm^3 carton of orange juice will be opened and divided into three equal portions. One sample will be kept in a fridge at 5 °C for 24 hours. A second sample will be left at room temperature (take to be 25°C) for 24 hours. A third sample will be warmed to 50°C for 24 hours. After 24 hours, 25.0 cm^3 of orange juice will be taken from each sample and titrated separately against iodine solution using starch indicator. A mole calculation will be performed on the results to determine the concentration of vitamin C in each sample of orange juice. The higher the temperature the orange juice was stored at, the lower the concentration of vitamin C that the orange juice will contain.

d) Apparatus and Reagents

Orange juice	Aqueous iodine solution of concentration 0.0100 mol/dm^3
Distilled water	Starch indicator
50 cm^3 Burette	25 cm^3 Pipette
Pipette filler	250 cm^3 Conical flask
500 cm^3 Beakers	White tile
Filter funnel	Retort stand and clamp

e) Diagram



f) Step-by-step Method

1. Take a 1000 cm^3 carton of orange juice and divide it equally into three 500 cm^3 beakers.
2. Store one beaker of orange juice for 24 hours at 0 °C (fridge), one for 24 hours at room temperature (25 °C) and one for 24 hours at 50 °C (thermostatically controlled water bath).
3. Rinse the 50 cm^3 burette with distilled water and then with the 0.0100 mol/dm^3 iodine solution.
4. Using the filter funnel, fill the Burette with the 0.0100 mol/dm^3 iodine solution.
5. Clamp the Burette vertically in the retort stand and clamp. Remove the filter funnel from the Burette.
6. With your eye level with the meniscus, take the initial Burette reading. Record this in the results table.
7. Rinse the 25 cm^3 pipette with distilled water and then with the orange juice that was stored at 0 °C.
8. Pipette 25.0 cm^3 of orange juice into a 250 cm^3 conical flask.
9. Add 3 drops of starch indicator the flask of orange juice.
10. Place the flask containing the mixture of orange juice and starch indicator on a white tile underneath the Burette.
11. Run the iodine solution from the Burette into the flask of orange juice and starch indicator until a permanent blue/black colour is seen in the flask.
12. With your eye level with the meniscus, take the final Burette reading. Record this in the results table.
13. Repeat the titration until results $\pm$ 0.1 cm^3 are obtained. Remember to add the iodine solution dropwise near to the end-point.
14. Repeat the experiment for the orange juice that had been stored at 25 °C and 50 °C.
15. Perform calculations to determine the concentration of vitamin C in each sample of orange juice.

g) Results and Manipulation of the Results

	Rough	First	Second
Final Burette Reading / cm^3			
Initial Burette Reading / cm^3			
Volume of Iodine Solution Used / cm^3			
Select Titration Results (Tick Best 2)			

- Note: *Burette Reading* **not** *Burette Volume*. Do not forget to include units.

- Average of best two titration results = ……..

- There will be three separate results tables for the orange juice at **i)** 5 °C, **ii)** 25 °C and **iii)** 50 °C.

$x = c \times v \times 10^{-3}$

x = moles of iodine used / mol

c = concentration of aqueous iodine solution = 0.0100 mol/dm^3

v = average of best two titration results / cm^3

• From the balanced chemical equation:

$$C_6H_8O_{6(aq)} + I_{2(aq)} \rightarrow C_6H_6O_{6(aq)} + 2I^-_{(aq)} + 2H^+_{(aq)}$$

1 mole of iodine reacts with 1 mole of vitamin C

$\therefore$ there are x mol of vitamin C in the 25.0 cm^3 of orange juice that were pipetted

$\therefore$ there are $(x \div 25) \times 1000$ mol of vitamin C in 1000 cm^3 of orange juice

i.e. the concentration of vitamin C in the orange juice is $(x \div 25) \times 1000$ mol/dm^3

• Perform the calculation for the orange juice at 5 °C, 25 °C and 50 °C. Compare the results in order to determine the effect that temperature has on the concentration of vitamin C in orange juice.

h) Source of Error

The reaction between vitamin C and iodine is a redox reaction:

$$C_6H_8O_{6(aq)} + I_{2(aq)} \rightarrow C_6H_6O_{6(aq)} + 2I^-_{(aq)} + 2H^+_{(aq)}$$

The iodine is reduced ($\therefore$ an oxidising agent) and the vitamin C is oxidised ($\therefore$ a reducing agent). If the orange juice contains another chemical, in addition to vitamin C, that behaves as a reducing agent, then it will react with the iodine, causing the concentration of vitamin C in the orange juice to be overestimated.