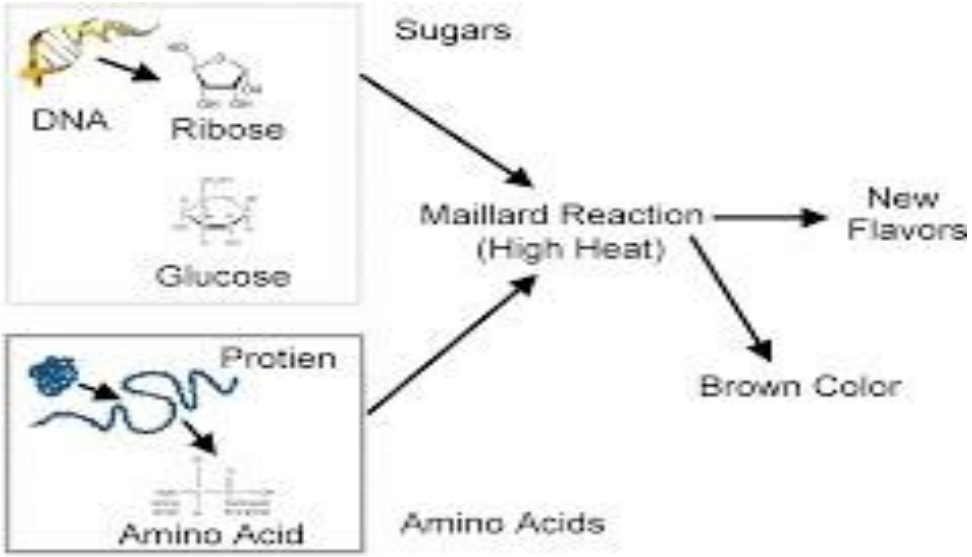
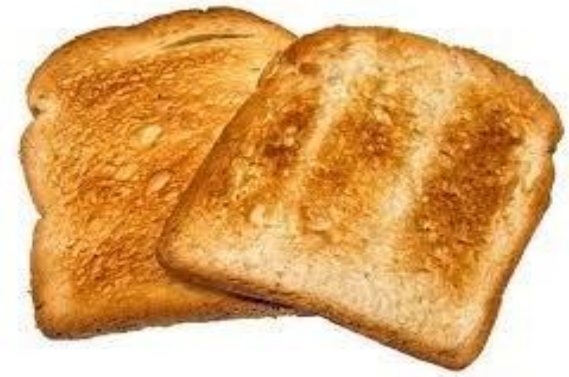
# FE 271 FOOD CHEMISTRY

## EXPERIMENT 5

# KINETICS OF THE MAILLARD REACTION



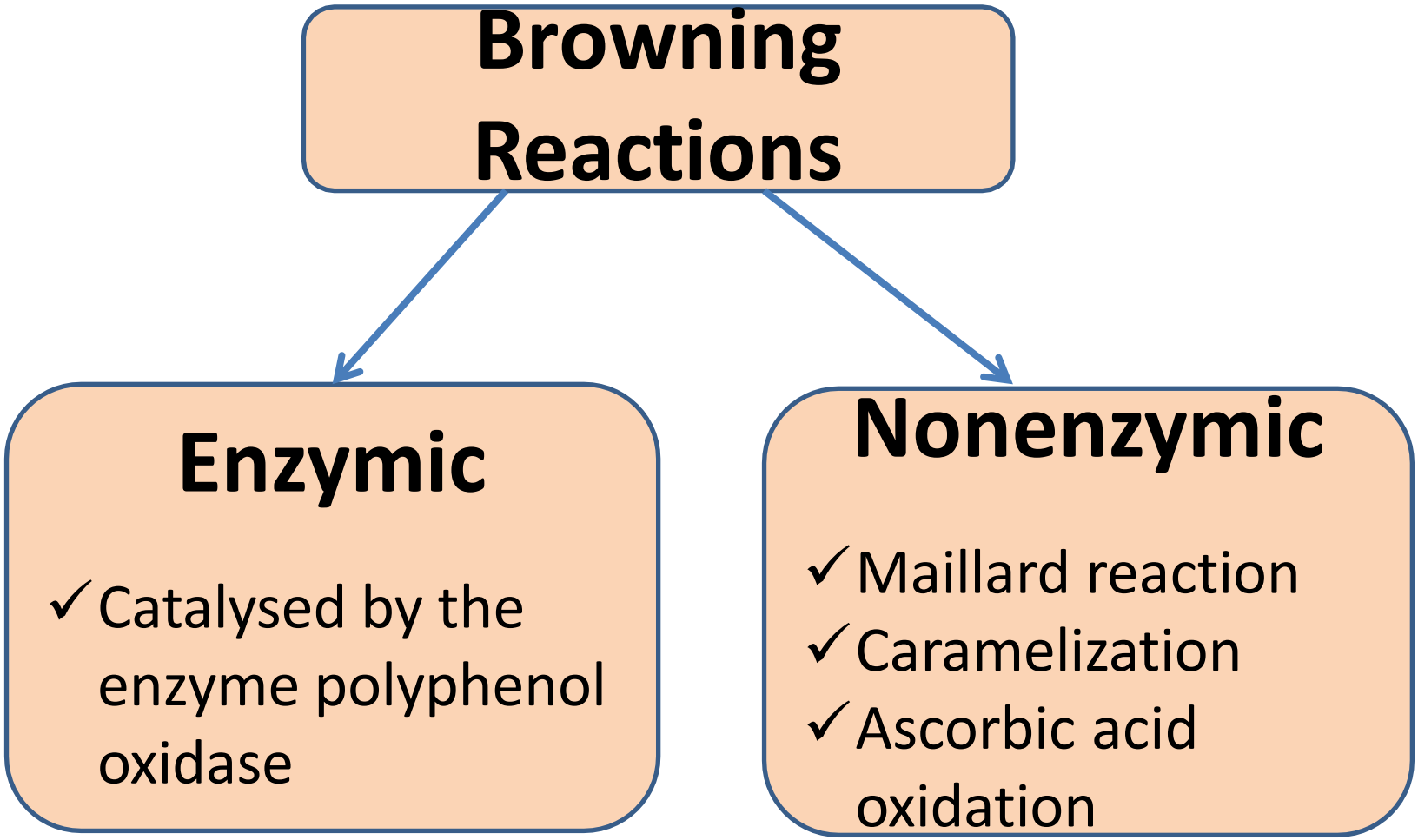



## ***Deteriorative reactions in food***

- Occur during storage of foods
- Depends on T
  - pH
  - aw
  - light
  - presence of $O_2$
- Generally changes the color, flavour, appearance and nutritional values

# Browning

- Is one of these deteriorative reactions which is encountered quite often in foods,
- generally changes the color, flavor, appearance and nutritional values of foods,
- plays an important role in the acceptance of a food product by consumers.


Browning Reactions
Enzymic
✓Catalysed by the enzyme polyphenol oxidase
Nonenzymic
✓Maillard reaction
✓Caramelization
✓Ascorbic acid oxidation

- ***Caramelization;***

✓ sugars $\xrightarrow{\text{Heated to very high temperatures}}$ darkening

- ***Ascorbic acid oxidation;***

✓ ascorbic acid (vitamin C, $C_6H_8O_6$ )is oxidized in the presence of $O_2$

✓ Leads to formation of furfural, derivatives of furfural and $CO_2$

# ***Maillard Reaction:***

- The most important nonenzymic browning reaction in foods
- Includes the reaction of reducing sugars with amino acids, peptides and proteins
- Final reaction products are brown melanoidin pigments
- Various off-flavors may be produced and nutritional value of the food is decreased

## ***Rate of Maillard reaction depends on:***

- Temperature
- pH
- Water activity and
- Reactant concentration

# The aim of the experiment?

To find activation energy of maillard reaction for glucose and fructose.

- ***Procedure;***

1)Place 1 mL of sugar solution (0.5 M) into the test tube

2)Then add 1 mL of amino acid solution (0.5 M) into the test tube and blank tube.

3)Then add 3 ml of buffer to the both of the tubes for the adjusting of pH 10.

4) Place the test and blank tubes in the boiling water bath at specific temperatures (60, 70 and 80$^{o}$C).

5) Read out the absorbance values of these solutions at the wavelength of 420 nm in the 15 min time intervals for 6 times (at 0-15-30-45-60 min)

## ***Calculations:***

1)Plot the graphs of absorbance versus the time for each of sugars at each temperature (Total 6 graphs). You must obtain a linear line. The slope gives you **reaction rate constant (k)** of the reaction between studied sugar and amino acid at constant temperature. (Figure 1)

2)Then from these reaction rate constants, calculate the activation energy of these Maillard reactions with using Arrhenius eqn (Total 2 graph: For glucose and fructose). The slope of the lnk versus 1/T gives you –Ea/R. (Figure 2)

Figure 1 For Glucose at 60 °C

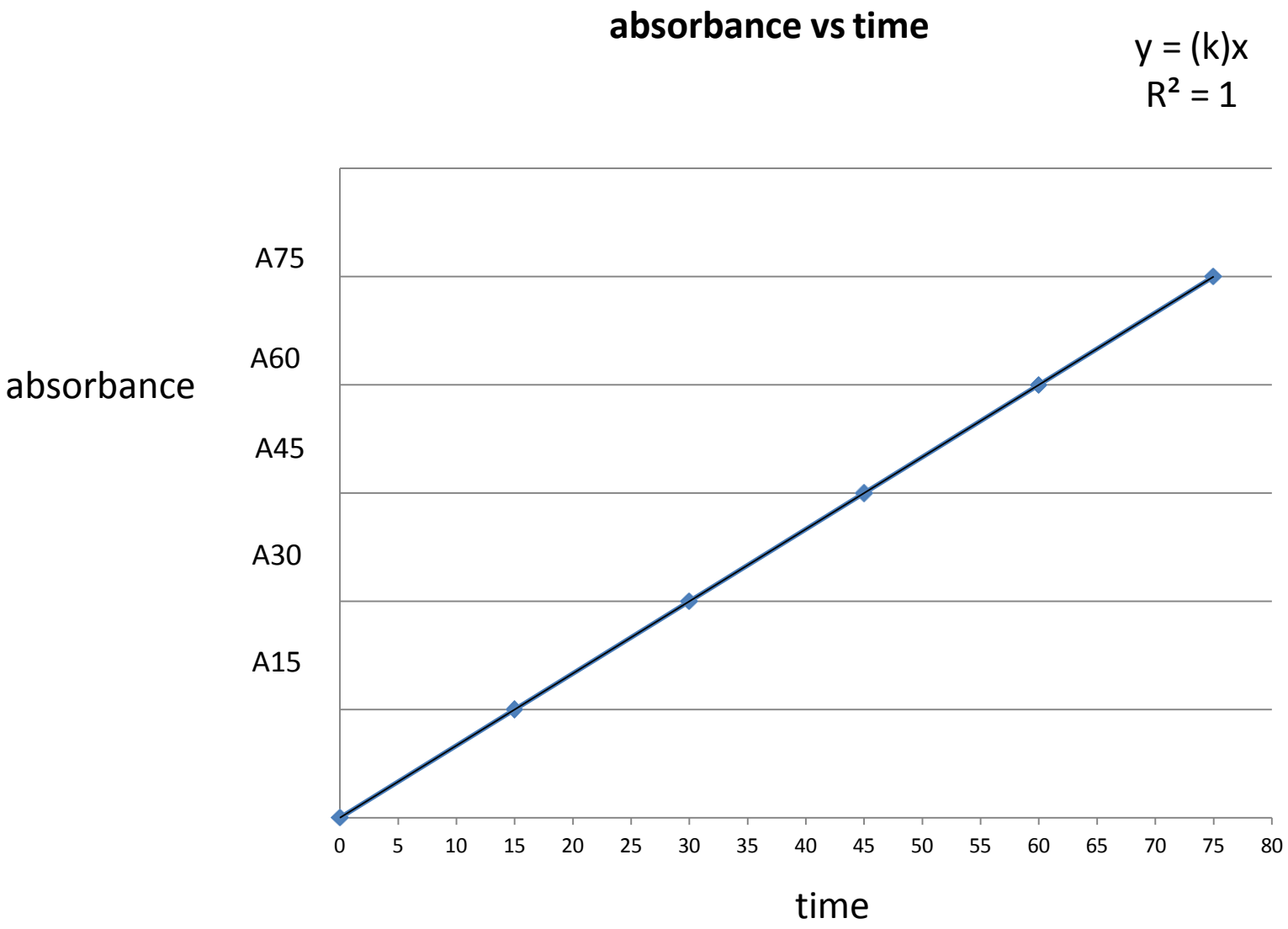
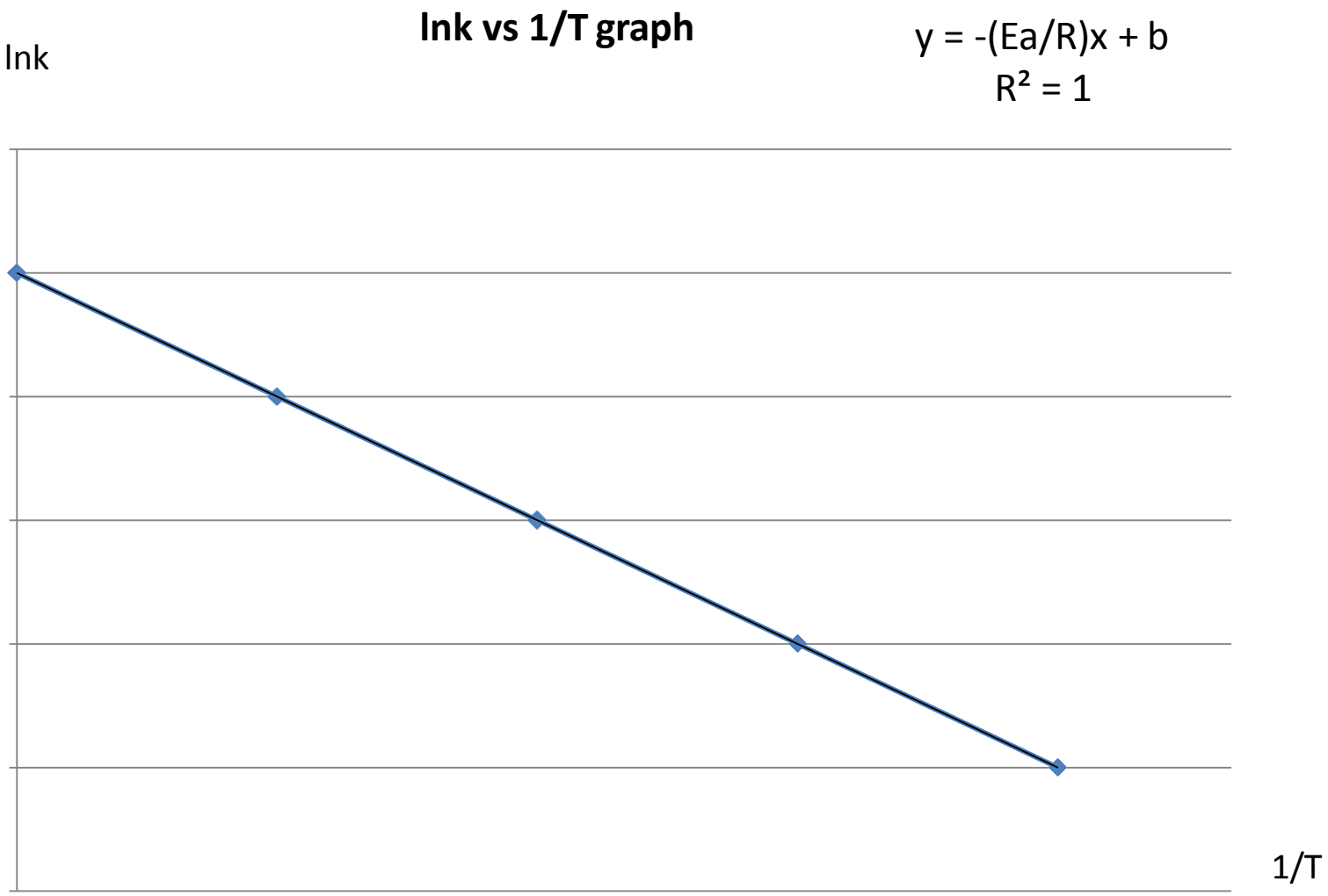


Figure 2

For Glucose



## ***Calculations:***

$$k = Ae^{-\frac{E_a}{RT}} \quad or \quad ln\ k = -\frac{E_a}{RT} + ln\ A$$

k: reaction rate constant constant

Ea: Activation energy (J/mol)

R: Universal gas constant (8.314 J/Kmol)

T: Temperature (K)

A: Pre-exponential factor

# ***Results:***

- Fill this table with your calculations

| | k | lnk | T | 1/T | E | A |
|---|---|---|---|---|---|---|
| Glucose | | | | | | |
| 333 K (60°C) | | | | | | |
| 343 K (70°C) | | | | | | |
| 353 K (80°C) | | | | | | |
| Fructose | | | | | | |
| 333 K (60°C) | | | | | | |
| 343 K (70°C) | | | | | | |
| 353 K (80°C) | | | | | | |

## ***Discussion:***

! Your discussion must be answer these questions:

- What is the explanation of the arrhenius equation?
- What is the effect of temperature on the maillard reaction?
- Is the sugar type effect the maillard reaction or not?
- Why we use buffer solution in the experiment?
- What is your personal comments about your results (all for graphs, k values, activation energies)?
- What are the critical steps in this experiment?

## POST LAB QUESTIONS

- Explain browning reactions in foodstuffs.
- What is the importance of Maillard reactions for food products?
- What are the factors effecting the rate of Maillard reactions? Explain each factor briefly.