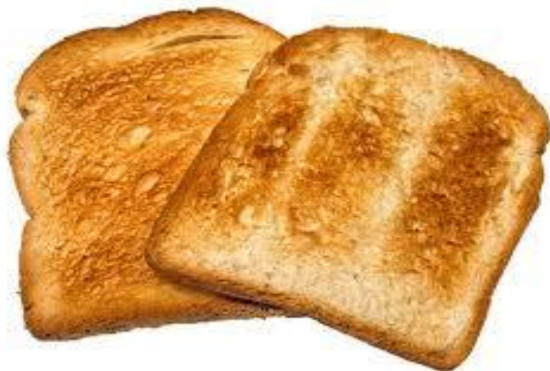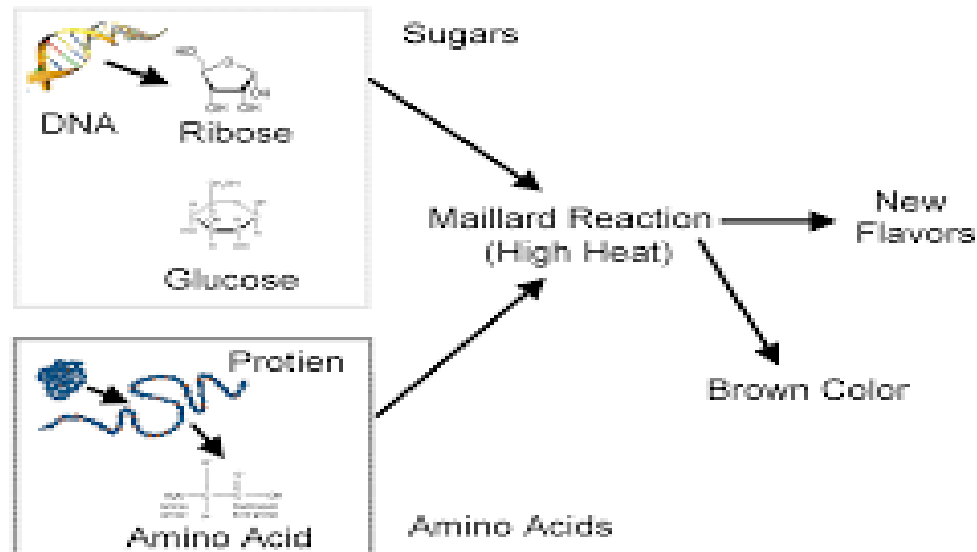# FE 271 FOOD CHEMISTRY

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

- *<u>Caramelization;</u>*

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

- *<u>Ascorbic acid oxidation;</u>*

✓ 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

- ## ***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.

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 0-15-30-45-60-75 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)

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)
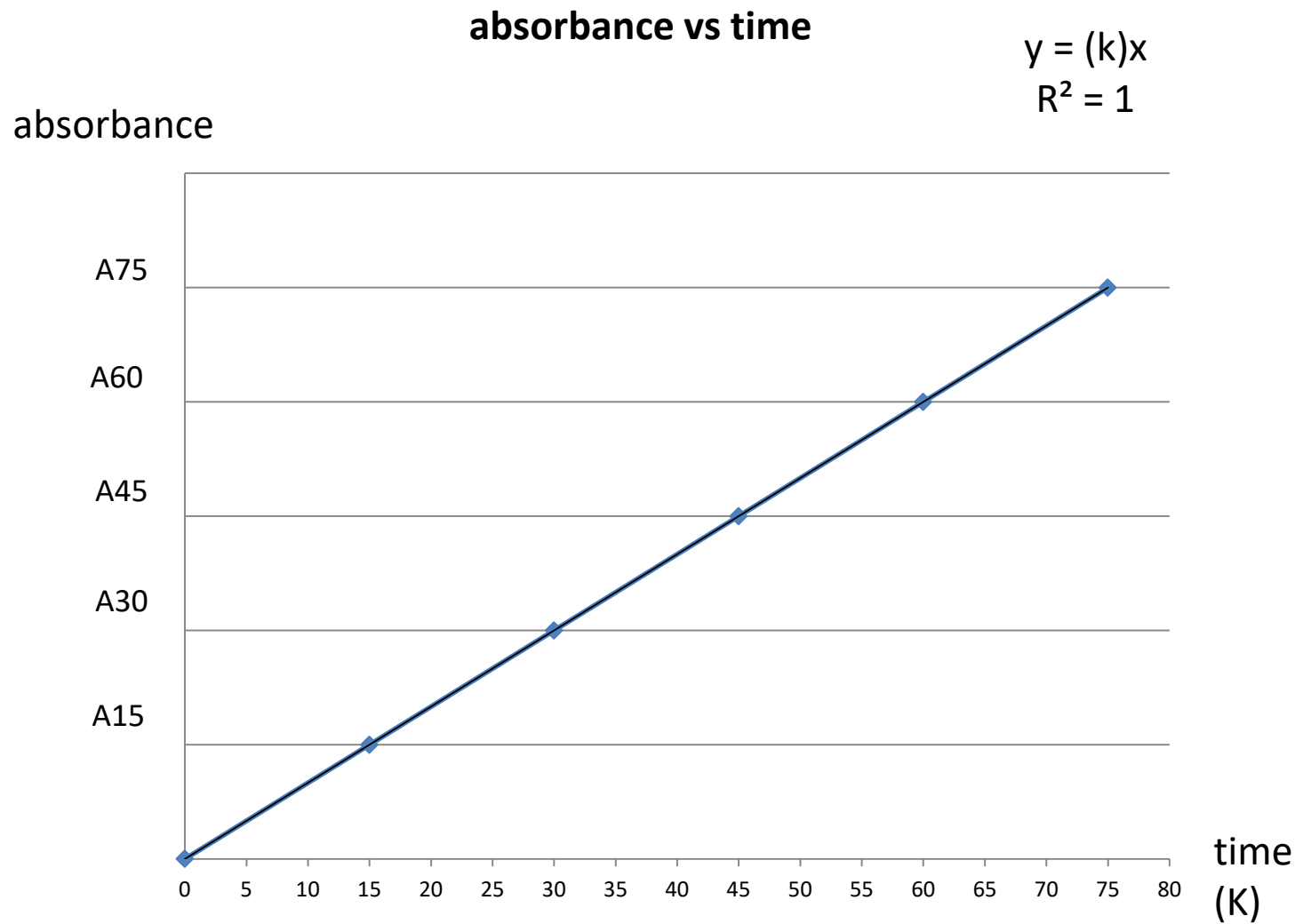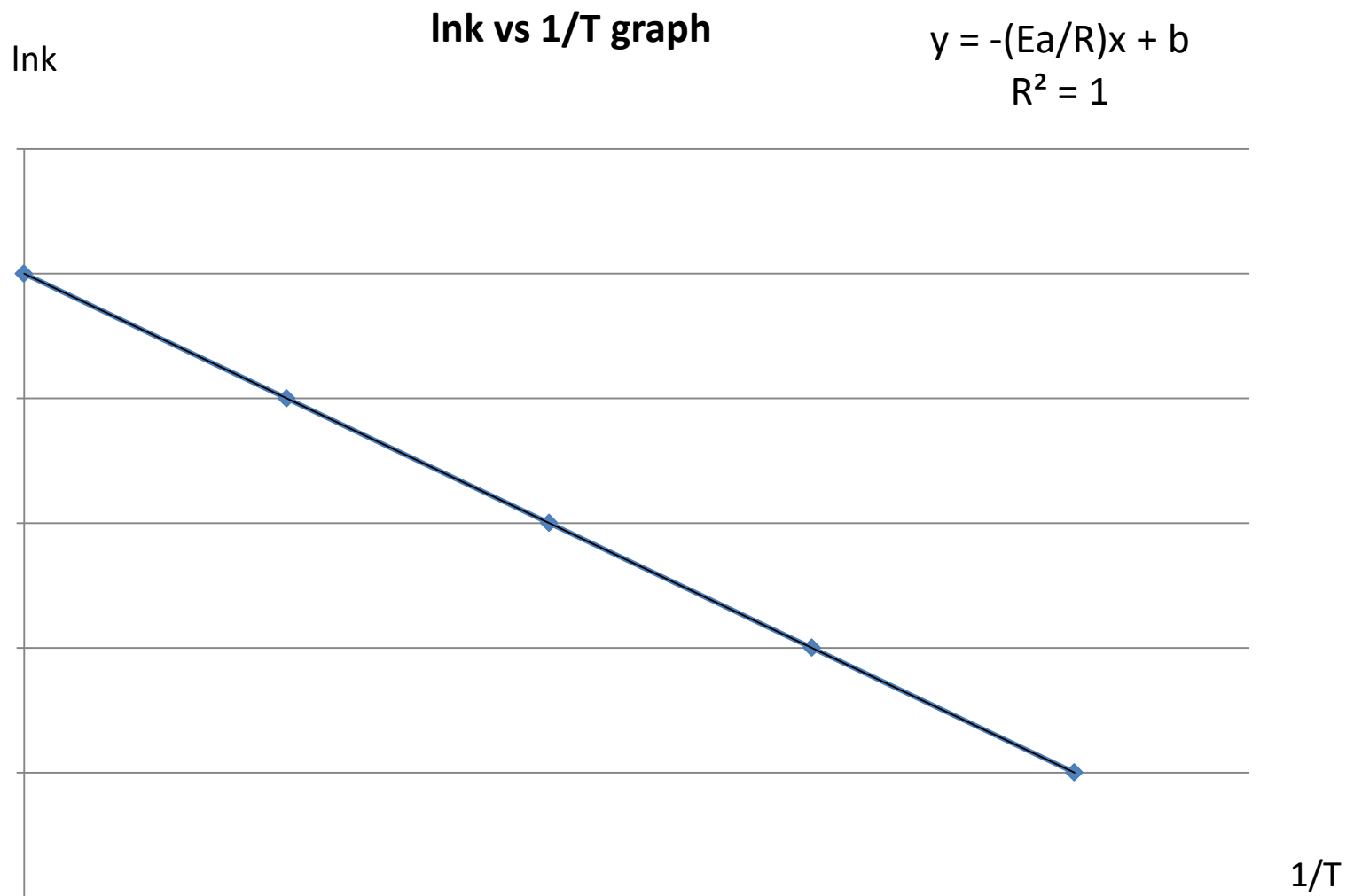
T: Temperature (K)

A: Pre-exponential factor

Figure 1

absorbance vs time

$y = (k)x$
$R^2 = 1$

Figure 2

lnk vs 1/T graph

lnk

$y = -(Ea/R)x + b$
$R^2 = 1$

1/T

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.