Examination Period 3: 2016/17

LEA200717N

Module Title: Leather Science 2
Level: Five
Time Allowed: Two hours

Instructions to students:

- Enter your student number **not** your name on all answer books.
- Answer **all** questions.
- All questions are equally weighted. Where a question has more than one part the division of marks is stated.
- Only work recorded in the answer books will be assessed.
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- Please clearly write your answer(s) in your answer booklet.
- Begin each question on a separate page, label each page clearly with the number of the question you are answering.
- If you make a mistake or wish to change an answer; clearly cross out the original. Answer and then clearly write your revised answer next to it.
- All answers should be written in pen only.
- The use of a non-programmable calculator is permitted.
- You may detach the supplementary material from the examination paper.

<table>
<thead>
<tr>
<th>No. of Pages</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Questions</td>
<td>4</td>
</tr>
</tbody>
</table>
Answer all questions.

**Question 1**

a. Describe how the Lewis acid-base theory differs from the Brønsted-Lowry theory.  
(4 Marks)

b. Leather processing utilises a wide pH range and a variety of weak acids are commonly used.

i. Provide a generic chemical equation demonstrating the reaction between a Brønsted acid and water; identify the conjugate pairs in your answer.  
(2 Marks)

ii. Define the difference between strong acids and weak acids and give an example of each.  
(2 Marks)

iii. If a 1.00 M solution of acetic acid has a pH of 2.40 at 25°C, what is the pKa (to two decimal places) of acetic acid?  
(4 Marks)

c. What concentration of sodium formate is required for a 0.8 M solution of formic acid, pKa = 3.77, to have a pH of 3.95?  
(5 Marks)

d. What type of solution is formed when weak acids or weak bases are mixed with their associated salts?  
(1 Mark)

e. Explain why hexane and water do not mix.  
(4 Marks)

f. With the aid of suitable diagrams, name the layer of associated water around a dissolved ion, and show how water molecules associate around Na+ and Cl- ions.  
(3 Marks)

**Total: 25 marks**

**Question 2**

a. Define a proteoglycan.  
(2 Marks)
b. Hyaluronic acid is a common proteoglycan, which requires removal from a pelt during beamhouse processing.

i. Why is hyaluronic acid difficult to remove from a substrate compared to dermatan sulfate? (2 Marks)

ii. Demonstrate with a suitable diagram, how sodium chloride molecules interact with hyaluronic acid. Explain how salt aids the removal of hyaluronic acid from a substrate. (6 Marks)

iii. Suggest two options for hyaluronic acid removal if raw stock is not preserved with salt. (2 Marks)

iv. With the aid of a suitable diagram, what are the potential consequences of not removing hyaluronic acid from a pelt on further processing? (4 Marks)

c. Melanins are another non-structural component of a pelt.

i. Define what melanins are and their purpose in mammals. (2 Marks)

ii. What are the two main classifications of mammalian melanins? Draw the starting component structures. (3 Marks)

d. What are the differences between: fats, oils and waxes? Use chemical structures to illustrate your answer. (4 Marks)

Total: 25 marks

Question 3

a. Explain the primary, secondary, tertiary and quaternary structures of a protein. (4 Marks)

b. Keratin is generally regarded as an unwanted protein and is commonly removed from the pelt during beamhouse processing.

i. Describe how the amino acid composition of keratin differs from that of collagen. Explain how keratin is structurally different to collagen. (5 Marks)
ii. Illustrate the reaction mechanism through which hair or wool is removed from a pelt during a hair burn process. **(4 Marks)**

iii. Under moderately alkaline conditions, a competing reaction occurs. Explain what immunisation is using chemical equations. **(4 Marks)**

c. With the aid of suitable diagrams, explain the purpose and function of elastin. As part of your answer you should consider the following:

- The influence of the types of amino acid present.
- The protein macro structure and how it changes under stress.
- The influence of thermodynamics. **(8 Marks)**

**Total: 25 marks**

**Question 4**

a. List **three** key permanent changes in a pelt after it has been tanned. **(3 Marks)**

b. The category “Syntans” describes a wide variety of synthetic tannages that are produced using a range of chemical methods.

i. Describe the processing steps required for the synthesis of “classic” syntans. **(2 Marks)**

ii. What are the overall properties of “classic” syntans dependent on? **(3 Marks)**

iii. What are the differences between a novolac and a nerodol? **(3 Marks)**

iv. What metals would typically be used in metal syntan complexes? **(1 Mark)**

c. Compare and contrast hydrolysable and condensed vegetable tannins. Your answer should consider:

- Base unit structure
- How both categories of tannin stabilise a pelt
- Differences in reactivity, and resulting hydrothermal stability **(5 Marks)**

**Question 4 continues overleaf**
**d.** Aldehyde tannages stabilise a pelt through the formation of a Schiff base.

i. Draw the mechanism for the synthesis of a Schiff base.  
   (5 Marks)

ii. Name the preferred amino acids for formaldehyde to react with?  
    (2 Marks)

iii. Why has formaldehyde been discontinued as a tanning agent?  
     (1 Mark)

**Total: 25 marks**
General Information

Speed of light: \(3 \times 10^8\) ms\(^{-1}\)
Planck’s constant: \(6.626 \times 10^{-34}\) Js
Avogadro constant: \(6.022 \times 10^{23}\) mol\(^{-1}\)