Summer Examinations 2015

LEA200715N

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.
- Please clearly write your answer(s) in your answer booklet.
- Clearly write the question number next to your answer.
- 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.
- Neither books nor notes may be taken into the examination.
- The use of a standalone non-programmable calculator is permitted.
- Please feel free to detach supplementary material e.g. periodic table from the question booklet. Do not remove 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. Define Brønsted–Lowry acid/base theory and explain how this differs from the Lewis acid/base theory. In all cases provide examples.  

   (5 marks)

b. Consider ethanoic acid (acetic acid)
   
   i. With reasoning explain whether ethanoic acid is a strong or a weak acid.  

      (2 marks)

   ii. Write an equation for the addition of ethanoic acid to water.  

       (1 mark)

   iii. Given that ethanoic acid has a pKa of 4.76 what is the pH (to 2 decimal places) of a 0.15 mol dm$^{-3}$ solution?  

       (7 marks)

c. What is Le Chatelier's principle?  

   (2 marks)

d. Define what a buffer is.  

   (1 mark)

e. Explain how you would make a buffer solution with ethanoic acid and its salt. Then, with the use of a chemical equation, describe how this buffer system works after both the addition of an acid, and of a base.  

   (7 marks)

**Total: 25 marks**

**Question 2**

a. Consider the treatment of bovine hide with calcium hydroxide:

   i. What type of reaction occurs between fats and the calcium hydroxide?  

      (1 mark)

   ii. Using a general ester as your example, draw out the reaction mechanism for the removal of fat during liming.  

      (6 marks)

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**Question Two continues overleaf**
Question 2 continued.

b. Proteoglycans play an important role in raw hides and skins:
   i. Define what proteoglycans are. (2 marks)
   ii. How does hyaluronic acid differ from other proteoglycans? (2 marks)
   iii. What impact does hyaluronic acid have on the processing of a skin/hide and on the final leather if it’s not removed? (3 marks)

c. Scientifically, how does the structure of elastin compare with the structure of collagen? The answer should use diagrams to aid the explanation and address the following:
   i. Amino acid make up.
   ii. How any difference in amino acids explains the variance in properties between the two.
   iii. What elastin’s macro structure is.
   iv. How this structure provides elasticity and what the driving force is for elastin to contract back after stretching. (11 marks)

Total: 25 marks

Question 3

a. What is the name of the location (in the skin) where keratin is produced and what is this location made from? (2 marks)

b. Keratin has much higher cysteine content than other proteins found in the skin. What role does cysteine play? (1 mark)

c. Summarise the ‘hair burn’ process using chemical equations where possible. The answer should consider the following:
   i. The advantages and disadvantages.

Question Three continues overleaf
Question 3 continued.

ii. The relationship between sulphide species as a function of pH.

iii. The importance of lime in the process; stating the solubility and thus the concentration of hydroxyl.

iv. The reaction mechanism by which hair is removed in hair burn.

(16 marks)

d. Given that the cysteine content of hair is approximately 50mmol/100g and that hair is 10% of hide weight:

i. Calculate the theoretical sodium sulphide (Na$_2$S) content needed.

(3 marks)

ii. Why this is different to the actual quantity added?

(3 marks)

Total: 25 marks

Question 4

a. Describe the protein hierarchy in terms of primary, secondary, tertiary and quaternary levels of protein structure.

(4 marks)

b. Chemically, what are enzymes and why must the pH of a reaction that utilises enzymes be carefully controlled?

(4 marks)

c. Define both the terms: enzyme value, and enzyme unit.

(2 marks)

d. Consider oxazolidine tanning:

i. How are aldehydic tannages distinguished from conventional aldehydes?

(1 mark)

ii. What is the mechanism by which oxazolidines tan? Use as an example of oxazolidine.

(4 marks)

Question Four continues overleaf
Question 4 continued.

e. Define the following terms and explain their different roles within the tanning of leather:

   i. Replacement syntans;
   
   ii. Retanning syntans;
   
   iii. Auxiliary syntans.

(10 marks)

Total: 25 marks
General Information

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

End of Paper