AM 05/III. 03 **INDEX NUMBER:**_____

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDA

MATRICULATION CERTIFICATE EXAMINATION
ADVANCED LEVEL
MAY SESSION 2003

Subject Title	**BIOLOGY**
Paper No./Title	**Paper 3**
Date	**28th May 2003**
Time	**4:00 p.m. to 5:30 p.m.**

Directions to Candidates

- *Write your index number in the space at the top right-hand corner of this page.*
- *Answer ALL questions. Write all your answers in the spaces provided in this booklet.*
- *The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated.*
- *You are reminded of the necessity for good English and orderly presentation in your answers.*
- *In calculations you are advised to show all the steps in your working, giving your answer at each stage. Unless otherwise specified, you are advised to list results to one decimal place.*
- *The use of electronic calculators is permitted.*

For examiners' use only:

Question	1	2	3	**Total**
Score				
Maximum	**34**	**33**	**33**	**100**

ADVANCED BIOLOGY III

1. A researcher is investigating the effects of stimulants and depressants on the rate of heart beat in water fleas (*Daphnia* sp.) using the following method:

Step 1:
A live water flea was placed in a cavity slide containing distilled water and a cover slip was placed on the slide.

Step 2:
The slide was viewed under a light microscope and the water flea visualised. The number of heartbeats per minute was recorded (the heart of a water flea is easily visible through its translucent cuticle). The rate of heartbeat was recorded at intervals of two minutes for a cumulative period of ten minutes.

Step 3:
The researcher repeated the experimental procedure with cavity slides containing solutions of ethanol, adrenaline, chlorpromazine and salicylic acid utilising a different water flea in each test.

The results obtained were recorded in Table 1:

Table 1: Rate of heart-beat in *Daphnia* sp. subjected to different chemical environments

Time (minutes)	Rate of heart beat (beats per minutes)				
	Water	Ethanol	Adrenaline	Chlorpromazine	Salicylic acid
0	184	184	184	184	184
2	188	120	220	86	174
4	189	120	232	60	160
6	190	140	240	48	154
8	192	145	244	24	151
10	196	150	232	18	138

1.1 Using the same scale and axes, plot graphs of rate of heart beat (y-axis) with time (x-axis) for each chemical used in the experiment. **Use the squared paper at the end of this answer booklet.**

[ten marks]

1.2 Briefly describe the effect of each chemical on the rate of heart beat in water fleas. In your answers you should state whether you think that the chemical in question is a stimulant, a depressant or neither.

Water:

[three marks]

Ethanol:

[three marks]

Adrenaline:

[three marks]

Chlorpromazine:

[three marks]

Salicylic acid: _____

_____

_____

_____

[three marks]

1.3 Which of these chemicals is the most toxic? Justify your answer.

_____

_____

_____

[two marks]

1.4 Why did the researcher use *distilled* water (as opposed to tap water or pond water) in this investigation?

_____

_____

_____

[three marks]

1.5 Suggest ONE precaution that should be taken before starting the experiment.

_____

_____

[two marks]

1.6 Suggest ONE possible source of error that may be influencing the result obtained.

_____

_____

[two marks]

[Total: thirty-four marks]

2. A researcher is investigating the variety and distribution of photosynthetic pigments in the leaves and roots of carrot through the use of Thin-Layer Chromatography (TLC). This technique is similar in principle to paper chromatography but is capable of achieving a more complete separation of photosynthetic pigments. The researcher also intends to test the effectiveness of two different solvents (labelled Solvent A and Solvent B) in TLC. The method used was the following:

Step 1:
Some leaves were removed from the carrot plant and ground into a thick paste using a mortar and pestle. The addition of acetone to the paste released an extract containing chlorophyll. This leaf extract was stored in a test tube.

Step 2:
The procedure described in Step 1 was repeated using the roots of the carrot plant and the root extract was stored in a different test tube.

Step 3:
The leaf extract was applied close to one edge of a TLC silica gel sheet, an oblong plastic strip coated with silica. It is the medium within which separation of pigments occurs. The point where the extract was applied shall be referred to as the origin.

Step 4:
The investigator prepared four TLC silica gel sheets containing leaf extract and another four TLC silica gel sheets containing root extract.

Step 5:
The researcher prepared four beakers. Two containing Solvent A and the other two containing Solvent B.

Step 6:
Two of the four TLC silica gel sheets containing **root extract** were placed in Solvent A and the other two in Solvent B. Two of the four TLC silica gel sheets containing **leaf extract** were placed in Solvent A and the other two in Solvent B. The beakers were then sealed with an aluminium or Clingfilm cover as shown in Figure 1.

Step 7:
The gradual development of the chromatograms was observed and the TLC silica gel sheets were removed from the beakers when the solvent front was approximately 0.5cm from the top edge of each sheet. The appearance of four representative chromatograms at the end of the experiment is shown in Figure 2.

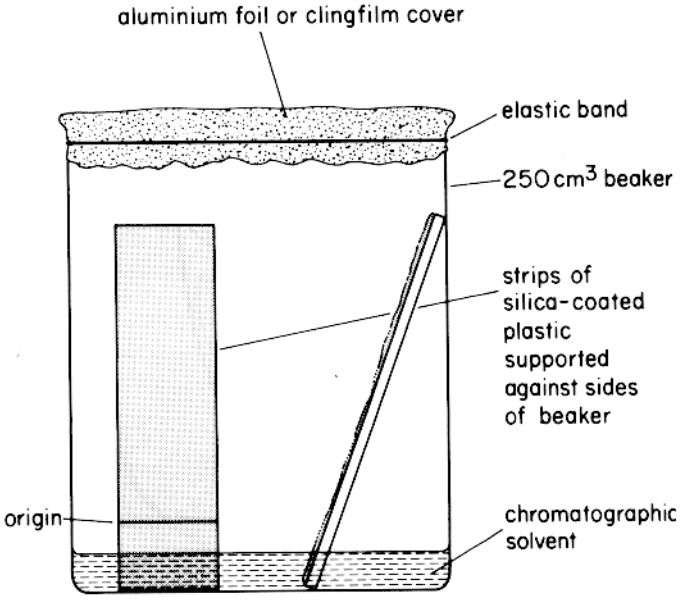

Figure 1: Arrangement of TLC apparatus

2.1 What conclusions are you able to draw regarding the relative effectiveness of Solvent A and Solvent B in TLC?

[two marks]

2.2 What conclusions are you able to draw regarding the distribution of pigments in the leaves and roots of carrots? Suggest a biological reason for the pattern you have observed.

[three marks]

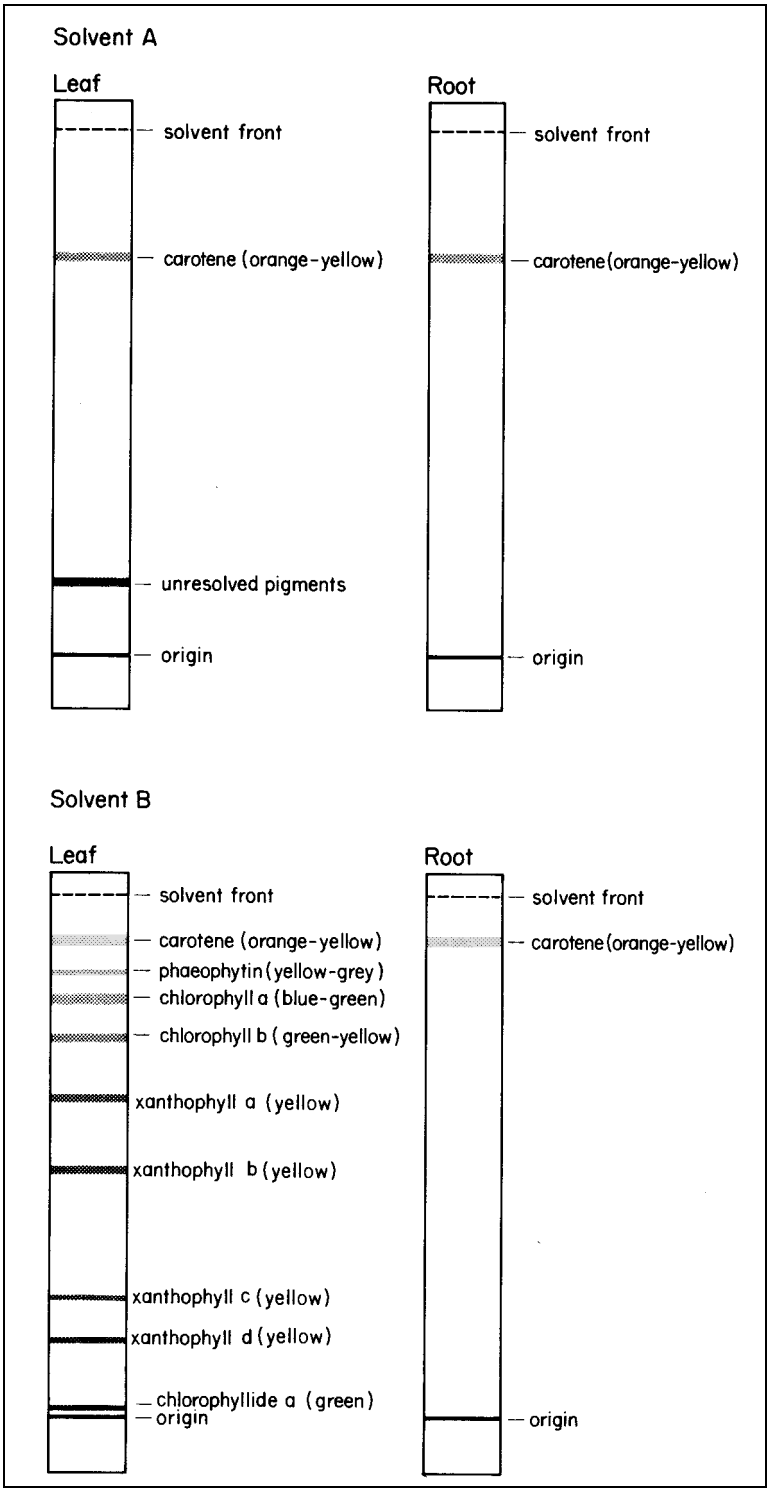

Figure 2: Appearance of chromatograms at the end of the experiment.

2.3 Why are most photosynthetic pigments either greenish or yellowish?

_____

_____

_____

[two marks]

The R_f value of each pigment is calculated as follows:

$$R_f = \frac{P}{S}$$

Where P is the distance, in millimetres, moved by the pigment from the origin.
S is the distance, in millimetres, moved by the solvent front from the origin.

2.4 Use the diagrammatic chromatograms in Figure 2 to measure the distances travelled by each pigment and by the solvent front from the origin and hence calculate the R_f value for each pigment extracted from the leaves of carrot. Insert the values in the table below:

Pigment	**P (mm)**	**S (mm)**	**R_f**
Carotene			
Phaeophytin			
Chlorophyll a			
Chlorophyll b			
Xanthophyll a			
Xanthophyll b			
Xanthophyll c			
Xanthophyll d			
Chlorophyllide a			

[eighteen marks]

2.5 List two factors that may affect the distance travelled by the solvent front or by the pigments and that would therefore influence R_f values.

_____

_____

[four marks]

2.6 Suggest ONE precaution that should be taken before starting the experiment.

_____

_____

[two marks]

2.7 Suggest ONE possible source of error that may be influencing the result obtained.

_____

_____

[two marks]

[Total: thirty-three marks]

3. An experiment is carried out to determine the optimal *p*H for the breakdown of albumen by pepsin. Five test tubes, labelled A through E were prepared and 5cm^3 of albumen suspension, which was white in colour and clouded in appearance, was placed in each. Acid or alkali was then added to each test tube as summarised in Table 2. The final step involved the addition of 1cm^3 of pepsin solution to the contents of each of A, B, C, D and E and all five test tubes were then transferred to the same water bath set at 40°C. The test tubes were all removed from the water bath after twenty-five minutes and the appearance of their content was noted. The *p*H of the content of each test tube at the end of the experiment was also recorded.

Table 2

Test tube	**Acid or alkali added to albumen suspension and pepsin**	**Final *p*H**	**Appearance after 25 minutes in water bath at 40°C**
A	2 cm^3 sodium carbonate solution	10	Clouded
B	0.5 cm^3 sodium carbonate solution	8	Clouded
C	None	7	Clouded
D	1 cm^3 0.1M hydrochloric acid	5	Slightly clouded
E	2 cm^3 0.1M hydrochloric acid	2	Clear and transparent

3.1 What is pepsin?

[three marks]

3.2 What, in chemical terms, does the *p*H of a solution represent?

[three marks]

3.3 Why was the suspension in test-tubes A, B and C clouded at the end of the experiment?

[two marks]

3.4 Why was the suspension in test-tube D slightly-clouded at the end of the experiment?

_____

_____

[two marks]

3.5 Why was the suspension in test-tube E clear and transparent at the end of the experiment?

_____

_____

[two marks]

3.6 What do the results suggest concerning the chemical environment within which pepsin is active?

_____

_____

[two marks]

3.7 Describe the probable appearance of the content of test tube E at the end of the experiment had the initial volume of albumen suspension been 20 cm^3 rather than 5 cm^3. Give a reason for your answer.

_____

_____

[two marks]

3.8 Describe the probable appearance of the content of the test tubes at the end of the experiment had the water bath been at a temperature of 20°C. Give a reason for your answer.

_____

_____

[two marks]

3.9 Describe the probable appearance of the content of the test tubes at the end of the experiment had the water bath been at a temperature of 80°C.

[two marks]

3.10 Describe the probable appearance of the content of test tubes D and E had the experiment run for five minutes rather than twenty-five minutes.

[two marks]

3.11 How may sodium carbonate and hydrochloric acid influence the reaction between albumen and pepsin, apart from merely altering the *p*H?

[two marks]

3.12 The terms used to describe the final state (clouded, slightly clouded, clear and transparent) of the content of each test tube are rather subjective, depending on the observer's bias as to what constitutes, for instance, a slightly clouded suspension. Briefly describe one way through which the state of the suspension could be described quantitatively rather than qualitatively. This may be a standard method used in laboratory practice or a method that you have devised yourself.

[five marks]

3.13 Suggest ONE precaution that should be taken before starting the experiment.

_____

_____

[two marks]

3.14 Suggest ONE possible source of error that may be influencing the result obtained.

_____

_____

[two marks]

[Total: thirty-three marks]

ADVANCED BIOLOGY III