Experiment 2

Salinity & Mussel Physiology

You are given 3 answer sheets for rough work.

The fourth answer sheet should contain your final answers.

Only this fourth answer sheet will be marked.

Attach your graphs to this answer sheet.

Task A carries 18 marks

Task B carries 14 marks

Task C carries 18 marks

Task A: Determination of the salinity of water using a titrimetric method.

When chloride solutions are titrated against silver nitrate, ($AgNO_3$), a precipitate forms. The end point of this particular titration can be detected using potassium chromate as indicator. The end point is indicated by the appearance of a red-orange colour in the mixture.

In this experiment, a standard solution of known sodium chloride (NaCl) mass concentration will be titrated against silver nitrate. Five other solutions (A – E) will then be titrated against the silver nitrate. The salinity of each of these solutions (A – E) will then be determined using an appropriate equation.

Experimental

Warning:

Both silver nitrate ($AgNO_3$), and potassium chromate are toxic and neither should be allowed in contact with your skin. $AgNO_3$ is also a photosensitive material and will cause staining if allowed in contact with skin.

You must wear the laboratory gloves provided for this procedure.

Step 1.

Titration of the standard NaCl (32.70 grams per litre) solution against the $AgNO_3$ solution provided.

1. Wash the burette once and then fill with the provided $AgNO_3$ solution.

2. Pipette 5 ml of the standard NaCl solution (32.70 grams per litre) into a 250 ml conical flask.

3. Using the dropper provided, add 25-30 drops of the yellow potassium chromate indicator.

4. Add 50 ml of distilled water to the contents of the conical flask using a graduated cylinder.

5. Titrate the mixture against the $AgNO_3$ solution. The endpoint is reached when the solution turns from being cloudy to a definite light red-orange colour that persists on shaking. Note the endpoint to two decimal places (you must estimate the second decimal place).

6. Place the contents of the titration flask in the container labelled **"Titration Wastes"**, and rinse the conical flask. A cloudy film may remain in the flask, but this will not affect subsequent results.

7. Repeat the titration at least **TWICE** more, approaching the end-point slowly and carefully. Record the average of your values to **two decimal places** in the space provided in the Answer Sheet (Answer 1).

Step 2.

Titration of each of the five solutions (A-E) that are provided in labelled containers on your workbench.

Titrate **Solution A** in exactly the same manner as the standard NaCl solution in Step 1 (i.e. place 5 ml of Solution A in a 250 ml conical flask, add 25-30 drops of the potassium chromate indicator and 50 ml of distilled water and titrate the contents of the flask against the $AgNO_3$ solution in the burette). The first titration will give an estimate of the end-point, and you should then carry out the two replicates, approaching the end-point slowly and carefully.

Record the end-point for Solution A in the appropriate place in Table 1 in the Answer Sheet.

Repeat the procedure for each of the solutions B, C, D, E, recording the end-point each time in Table 1 of the Answer Sheet (Answer 2).

Step 3.

Calculation of the salinity of each Solution (A – E):

The following equation is used to convert the titration figures obtained for each solution to a salinity value:

$$\text{Salinity of Solution} = \frac{(\text{Volume of } AgNO_3 \text{ used to titrate the Solution})\ (1.069)\ (32.70)}{\text{Volume of } AgNO_3 \text{ used to titrate the Standard NaCl solution}}$$

1.069 is a constant value relating sodium chloride concentration to salinity.
By convention salinity has no units.

*Record (**to one decimal place)** the salinity values you calculate for each of the solutions A, B, C, D, E in Table 2 of the Answer Sheet for Part A* (Answer 3).

Step 4.

The titration involves reaction of chloride with $AgNO_3$. You will have observed that a precipitate formed immediately on commencement of the titration.

Write the chemical formula for the precipitate in the Answer Sheet (Answer 4).

Step 5.

The concentration of the standard NaCl solution used was 32.70 grams per litre.

Write the concentration of the $AgNO_3$ solution used for the titration in moles per litre in the answer sheet (Answer 5).

Task B: To determine the salinity value at which 50% of the mussels in a sample are open.

Introduction

The blue mussel (*Mytilus edulis* Figure 1.) is one of the main species cultivated in Europe. This filter-feeding mollusc thrives in cold seawater. Market size is typically 50 mm or more and it can take from 12 to 24 months to reach this, depending on local conditions. Bivalve (two shelled) molluscs such as *Mytilus edulis* open or close their shells in response to salinity changes.

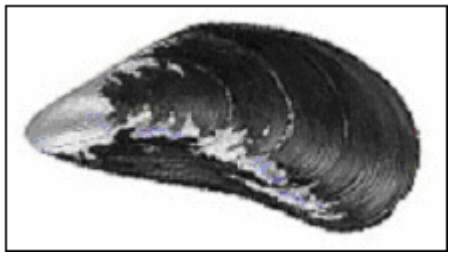


Figure 1. The blue mussel, *Mytilus edulis*.

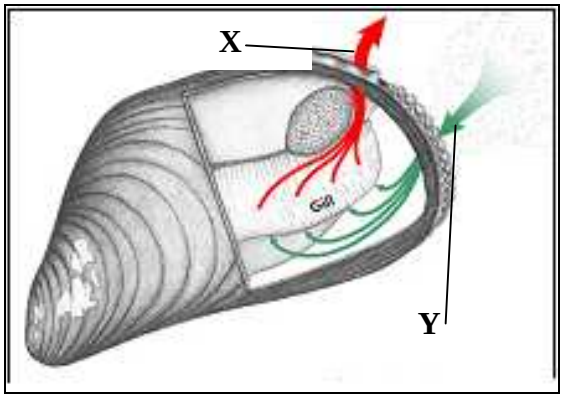


Figure 2. Internal structure of *Mytilus edulis*.

X = Exhalant siphon Y = Inhalant siphon

Since the mussel is a filter feeder, it needs to bring water in through an inhalant siphon, filter it using the gill filaments and remove the phytoplankton on which it feeds. In order to do this, the mussel shell must be open. However, as previously mentioned, *M. edulis* has been shown to open or close its shell in response to changes in salinity. When choosing a suitable site for mussel culture one must take into account any changes in salinity in the water during the ebb and flow of the tide. As the tide comes in salinity may increase, as it goes out, salinity may decrease, depending on local conditions.

Your task is to determine at what salinity 50% of the mussels in your sample are likely to be open, and thus able to feed. An ideal site is one where at least 50% of the mussels could feed continuously. Based on the information you obtain you are asked to recommend a location for mussel culture.

Experimental

You are presented with specimens of *Mytilus edulis*, a glass container and solutions with different salinities.

Procedure:

1. Ensure all the mussels in your sample are alive, i.e. closed prior to placing them in the water.
2. Starting with solution A, rinse the glass container with 200ml of solution taken from the large container labelled Solution A on the side bench.
3. Place 8 mussels into the glass container provided. Then, using a graduated cylinder, add approximately 1 litre of solution A in order to cover the mussels.
4. Turn the mussels so that the hinge side is down and you can see the area where the siphons are located (as demonstrated).
5. Do not touch the mussels again until you have completed step 6.
6. Start the stopclock. After 10 minutes, **call a supervisor, then with the supervisor observing,** count the number of mussels that are open and write the number in Table 3 on your answer sheet for part B (Answer 6).
7. Place used mussels in the white bucket. Dispose of the solution down a sink.
8. Repeat Steps 2 – 7 for all of the other solutions, B, C, D, E using fresh mussels each time.

   The supervisor must sign the answer sheet for each observation.
9. For each solution, calculate the % of mussels that were open at the end of the 10 minutes and record this in Table 3 provided in the answer sheet for part B (Answer 6).
10. Plot a curve of % mussels open against salinity (as determined in Task A).
11. Use this curve to estimate at what salinity 50% of the mussels are likely to be open (Answer 8).

12. Using the information obtained in the above, decide which of the three locations P, Q, R described below would be most suitable, in terms of salinity profile, for mussel culture and record your choice in the answer sheet for part B (Answer 9).

Location P	Minimum salinity 8, Maximum salinity 25
Location Q	Minimum salinity 10, Maximum salinity 33
Location R	Minimum salinity 17, Maximum salinity 25

13. An experiment was carried out to determine feeding rates of *Mytilus edulis* in a range of different salinities using an equal number of mussels per treatment. Table 4, in the answer sheet for part B, contains the results of this experiment.

14. You are required to calculate the mean number of cells filtered per hour at each salinity.

15. *Record your answers in Table 4 in the answer sheet for part B (Answer 10) and answer Question 11 on answer sheet.*

Task C: Conductivity as a measure of Salinity

Resistance (R) for any material is the ratio of voltage (V) across that material to current (I) through it.

$$R = \frac{V}{I}$$ [V] = Volts, (V) [I] = Amperes, (A) [R] = Ohms, (Ω)

(Note: [ ] indicate 'the units of ' whatever quantity is within brackets)

The **conductance** (G) of a sample is the reciprocal of the resistance (R).

$$G = \frac{1}{R}$$ [G] = Ω^{-1} = Siemens (S)

The value of conductance (as of resistance) for a particular sample depends on how big the sample is.

We will be measuring the conductance of a volume of water between the plates of a cell as in Figure 3 on the following page.

To compare different samples we must convert conductance measurements into **conductivity** values, which are always the same for a given sample independent of its size.

This is approximated by employing a cell constant (K) and the relationship:

Conductivity (σ) = Conductance (G) x Cell constant (K)

The **cell constant** depends on the dimensions of the measuring cell.

$$K = \frac{l}{A}$$ l = length of cell [l] = cm A = area of electrodes [A] = cm^2

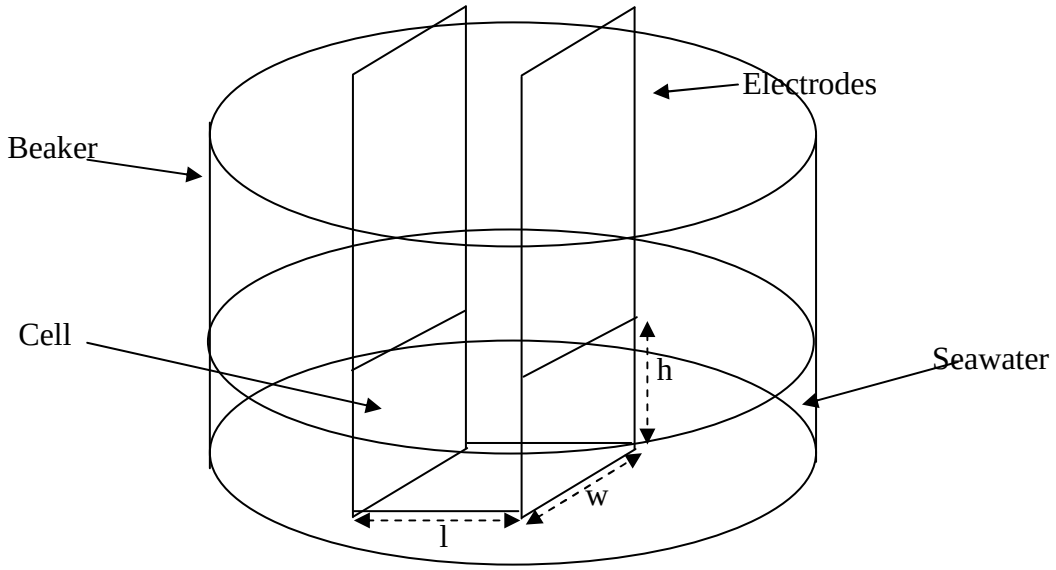
Thus [K] = cm^{-1} [σ] = $\Omega^{-1}cm^{-1}$ or [σ] = $S.cm^{-1}$

To measure conductivity of a solution

In seawater the dissolved salts act as charge carriers. The conductivity of the water depends on the concentration of the salt dissolved – the salinity. Conductivity is used as a sensitive measure of salinity.

To measure conductivity - two plates (electrodes) are placed in the sample, forming a conductivity cell.

Figure 3: Conductivity cell



An **AC** potential is applied across the plates using an **ac power supply**.

Current through and **voltage** across the cell are measured simultaneously.

Thus cell **resistance** is determined.

Conductance and **conductivity** are then calculated.

Experimental

You are asked to build a simple conductivity meter and to measure the conductivity of 6 solutions – A, B, C, D, E of known salinity and X of unknown salinity.

1. Measure the dimensions of the conductivity cell and enter the values on the answer sheet (Answers 12, 13, 14)

   To determine effective height of the cell pour 50ml of water (measured with graduated cylinder) into the beaker.

   Insert the cell.

   *(**Note:** Be consistent with orientation of electrodes, the top of the electrodes is clearly indicated with a '***T***'. The bottom must be inserted into the solution.)*

   Measure the height of the water as accurately as possible.

2. Determine the cell constant and enter value on answer sheet. (Answer 15)

3. Draw a circuit diagram on the separate answer sheet (Answer 16) showing clearly connections to the oscillator, ammeter and voltmeter to measure current and voltage.

Hand your circuit diagram to supervisor who will provide you with a definitive version

4. Connect the circuit as follows and in accordance with the circuit diagram provided by the supervisor.

    a. **Do not switch on the ac power supply** until the supervisor has checked circuit. The oscillator is already set – **do not adjust** (sine wave output, frequency 2kHz)

    b. Use the mains operated meter as the ammeter and the battery operated meter as the voltmeter.

    c. Connect to the appropriate terminals:

    (COM and V terminals for voltage measurements,

    COM and mA terminals for current measurements).

    d. Switch the voltmeter to measure AC voltage.

    e. Switch on the ammeter and press the AC/DC button until AC appears in the display. Turn centre dial to 20mA range.

Call supervisor to check your circuit (Answer 17)

(If your circuit is not connected correctly the supervisor will make the appropriate corrections and you may proceed without further penalty.)

5. To measure conductivity of solution A:
    a. Rinse the electrodes using wash bottle of distilled water.
    b. Dry the electrodes with paper provided.
    c. Rinse the beaker marked **'Measuring Beaker**' with distilled water.
    d. Place approximately 50ml of solution A in beaker.
    e. Swirl solution around electrodes and discard the solution.
    f. Carefully measure 50ml of solution A (using graduated cylinder) into the beaker.
6. Switch on the ac power supply. **Do not adjust its settings**.
7. Adjust the current and voltage ranges on the meters if and as necessary to obtain the most sensitive readings.

    *(**Note:** The voltmeter may switch off automatically to conserve battery. Press any button to switch back on.)*
8. Record current and voltage on the answer sheet (Answer 18).

    *(**Note:** Record results in **units** given in table heading.)*
9. Determine the resistance of the cell to **3 significant figures** and record on the answer sheet. (Answer18 - No estimate of error necessary.)
10. Determine the conductance of the cell to **3 significant figures** and record on the result sheet. (Answer 18 - No estimate of error necessary.)

11. Determine the conductivity of the cell to **3 significant figures** and record on the answer sheet. (Answer 18 - No estimate of error necessary.)
12. Repeat the process from steps 5 to 11 above to determine the conductivity of solutions B, C, D E and X, entering results as appropriate on answer sheet.
13. The salinity values for solutions A, B, C, D and E have been determined in Task A by your team. Enter these values into Table 5.
14. Draw a suitable graph of conductivity as a function of salinity. Assume a linear relationship between conductivity and salinity in the region plotted and draw a 'best fit' straight line between the data points.
15. For the unknown solution, X, use the calibration graph to determine its salinity. Clearly indicate on the graph the coordinates for solution X. Enter the result on the answer sheets (Answer 20).