Lab 2: Miscellaneous Calculations

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Table of contents

ℹ Date

- **Lab Date:** 23 September 2024 (Monday)
- **Due Date:** 7:00, 30 September 2024 (Monday)

Students will work as individuals; assignments are per individual. This lab is due on Monday 30 September 2024 at 7:00 on iKamva.

0.1 Pre-Lab

Read this lab and contextualise within the pertinent material in your text.

0.2 Post-Lab

Upon completion of this lab:

- transcribe all tables and questions (Exercises A-E) to an electronic document and submit on iKamva. To submit online on Monday 30 September 2024 at 7:00.

0.3 Question 1: Dilutions (10 marks)

A 1.5% (mass:volume) carrageenan gel consists of 0.75g of carrageenan dissolved in 50 ml of 1% KCl. You accidentally added 0.87g to the 50 ml.

i. What percentage of gel have you accidentally created?
ii. How much extra water do you need to add to the 50 ml to achieve the 1.5% gel we initially desired?

iii. What is carrageenan, and in which photoautotrophs is it found?
iv. What role does it play in plants?
v. How do people use it?

0.4 Question 2: Quantum Light Measurements (4 marks)

A blue light source (420 nm) provides an illumination of 120 μmol photons.m^{-2}.s^{-1}. How many photons of light would fall within an area of 25 cm^2 within the period of 2 hours?

0.5 Question 3: Plant Growth Rates (9 marks)

For Scenarios i) and ii), write down the following:

- The process that the sets of measurements represent;
- Suitable equations for calculating the process;
- The calculated rates; and
- The resulting units for the process as determined by your calculation.

Scenario i (4 marks)	Scenario ii (5 marks)
• Day 1: Plant biomass of 99 g	• Time, 0 minutes: 7.95 mg/L O_2
• Day 100: Plant biomass of 149 g	• Time, 20 minutes: 11.39 mg/L O_2
	• Algal biomass: 2.3 g fresh mass

0.6 Question 4: Light Attenuation (15 marks)

You are a marine scientist wanting to determine the light penetration into the water column off the coast of Richards Bay, KZN. You want to collect the first set of measurements at a distance of 1 km from the shoreline at 5 m depth increments from the water's surface down to a depth of 50 m. The second set of matching measurements that you want to collect is at a distance of 20 km from the shoreline.

Unfortunately, you discover that you left the submersible light meter back in the lab and you only have an instrument suitable for taking light measurements above the water's surface. So, being a scientist, you make a plan… this involves applying some basic knowledge that you acquired during your 2nd year BSc studies. You go back to the lab with the following measurements:

- at 8:00 when you were closest to the shoreline you took a measurement of the incident radiation at the water's surface, which was 1213 μmol photons.m^{-2}.s^{-1};
- at 9:35 when you arrived at the station 20 km from the shore you measured an incident radiation of 2166 μmol photons.m^{-2}.s^{-1}.

1. Draw light penetration curves that describe the vertical light intensity as a function of depth for each of the two sites (i.e. graphs of light intensity as a function of depth from the surface down to 50 m).
2. Describe the rationale behind this theoretical approach in an attempt to convince us that your curves are a decent approximation of the real situation.

3. Of course your approximation is not going to be perfect. What factors will contribute towards the deviation from the actual situation?

0.7 Question 5: Photosynthetic Rate Calculation (10 marks)

A leaf in full sunlight absorbs 10 mol of photons per square meter per second (mol m^{-2} s^{-1}). The leaf has a quantum yield of 0.05 moles of CO_2 fixed per mole of photons absorbed.

Calculate the photosynthetic rate (in μmol CO_2 m^{-2} s^{-1}) of the leaf under these conditions.

0.8 Question 6: Relative Growth Rate (RGR) (5 marks)

The biomass of a plant at time t_0 is 50 g, and after 10 days (time t_1), the biomass increases to 80 g.

Calculate the relative growth rate (RGR) in g g^{-1} day^{-1} using the equation:

$$RGR = \frac{\ln(W_1) - \ln(W_0)}{t_1 - t_0}$$

Where:

- (W_1) is the biomass at time (t_1)
- (W_0) is the biomass at time (t_0)

1 Question 7: Respiration Rate and Plant Carbon Balance (5 marks)

A plant in darkness consumes 5 mg CO_2 per hour for respiration. During the day, its photosynthetic rate is 15 mg CO_2 per hour.

Calculate the net carbon balance of the plant over a 24-hour period, assuming 12 hours of light and 12 hours of darkness. Is the plant in a positive or negative carbon balance?

1.1 Question 8: Additive Light Intensity at Different Depths in Water (7 marks)

In an aquatic research setup, light at different depths is a combination of direct surface sunlight and diffuse underwater light. At a depth of 2 meters, the following photon flux densities are measured:

- Direct sunlight: 400 μmol photons m^{-2} s^{-1}
- Diffuse underwater light from reflections: 120 μmol photons m^{-2} s^{-1}
- Scattered light from particles in the water: 50 μmol photons m^{-2} s^{-1}

1. Calculate the total photon flux density at a depth of 2 meters.
2. If an aquatic plant requires a minimum of 500 μmol photons m^{-2} s^{-1} for photosynthesis, does this plant receive sufficient light at this depth?

Bibliography