

TASK 2

OCEAN

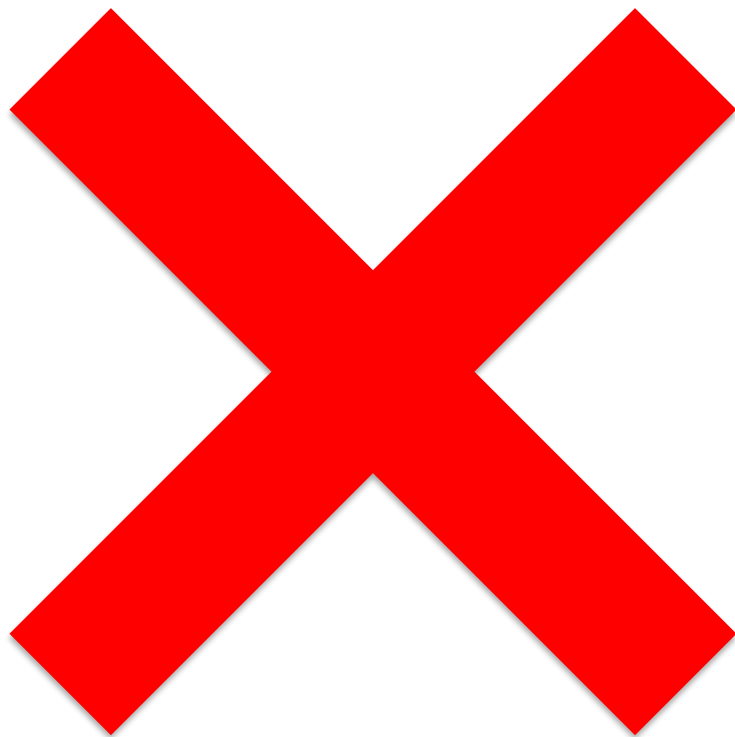
ANSWERSHEET



COUNTRY:

Team:

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Part 1: Algae production and wastewater treatment measurements using spectrophotometry

34 marks

A. How much algae am I producing?

1.1

1 mark

Given Freja collected 21.5 L/hour of effluent and the reactor has a volume of 400 L what is the dilution rate (in unit: day^{-1})?

Dilution rate =

1.2

5 marks

Initial effluent algae absorbance (optical density) at 750 nm	
Dry weight (g/L) calculated from formula	

1.3

2 marks

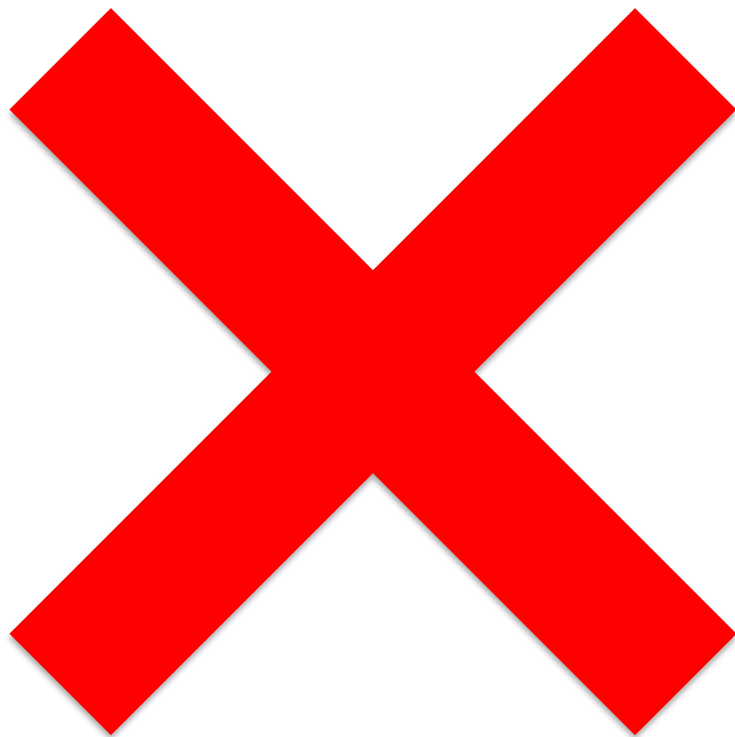
What is the volumetric productivity (in $\text{g L}^{-1} \text{day}^{-1}$)?

1.4

2 marks

How much would the reactor produce if operated at the same rate for one year?

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B. How much carotenoids are the algae producing?

1.5

3 marks

What values did you measure for A_{470} , A_{649} , A_{664} ?

A_{470}	
A_{649}	
A_{664}	

1.6

3 marks

What did you calculate for c_a , c_b , $c_{(x+c)}$?

c_a (mg/L)	
c_b (mg/L)	
$c_{(x+c)}$ (mg/L)	

1.7

2 marks

How much chlorophyll (a+b) and carotenoids do the algae contain in mg per gram dry weight?

Chlorophyll (a+b) (mg/g algae)	
Carotenoids (x+c) (mg/g algae)	

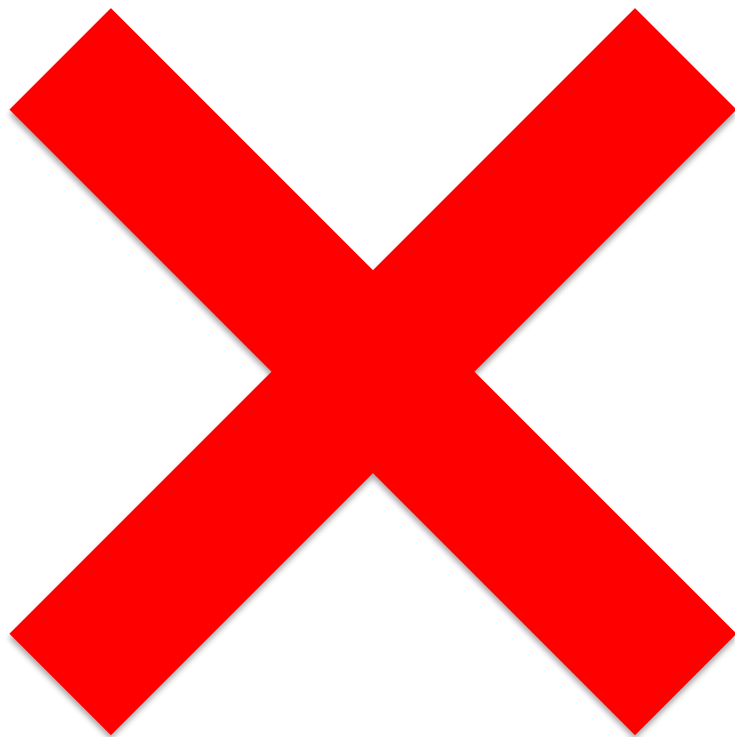
1.8

2 marks

What are the production rates of these molecules?

Chlorophyll (a+b) (mg/L day)	
Carotenoids (x+c) (mg/L day)	

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C. How much nutrients are the algae removing from the wastewater?

1.9

4 marks

	NH_4^+ for influent	NH_4^+ for effluent
Measured absorbance		
Dilution factor		
Concentration (mg/L)		
NH_4^+ removal (%)		
NH_4^+ removal rate (mg/(L d))		

1.10

4 marks

	PO_4^{3-} for influent	PO_4^{3-} for effluent
Measured absorbance		
Dilution factor		
Concentration (mg/L)		
PO_4^{3-} removal (%)		
PO_4^{3-} removal rate (mg/(L d))		

1.11

3 marks

Use nutrient removal and growth rate to estimate the N and P content of the algae.

N content (mg/g algae)	
P content (mg/g algae)	

1.12

3 marks

What is the annual saving in DKK/litter of reactor volume, given the Danish tax of 5 DKK per kg N and 110 DKK per kg PO_4^{3-} ?

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Part 2: Designing an illumination system for algae production using LEDs

32 marks

2.1

2 marks

Which wavelength intervals did Freja identify as relevant for chlorophyll a?

2.2

1 mark

Which spectra does Freja have to compare for her example?

	Tick your answer(s)
Chlorophyll a blue and red absorption.	
Chlorophyll a red absorption and blue diode emission.	
Chlorophyll a red absorption and red diode emission.	

2.3

2 marks

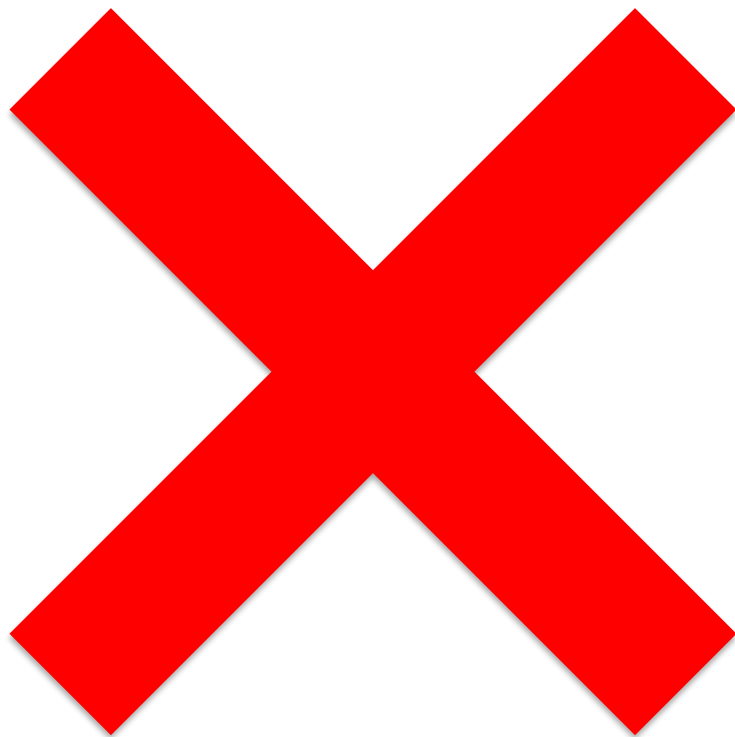
➤ Attach your print of the graph. Remember to check your group number on the print.

2.4

2 marks

How many nanometres should the red diode light be shifted to match the red absorption peak for the algae? Show your readings of the necessary numbers on the print.

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2.5

2 marks

What process in the plant does the consumption of CO₂ signify?

	Tick your answer(s)
Respiration	
Photosynthesis	
Respiration and photosynthesis	

2.6

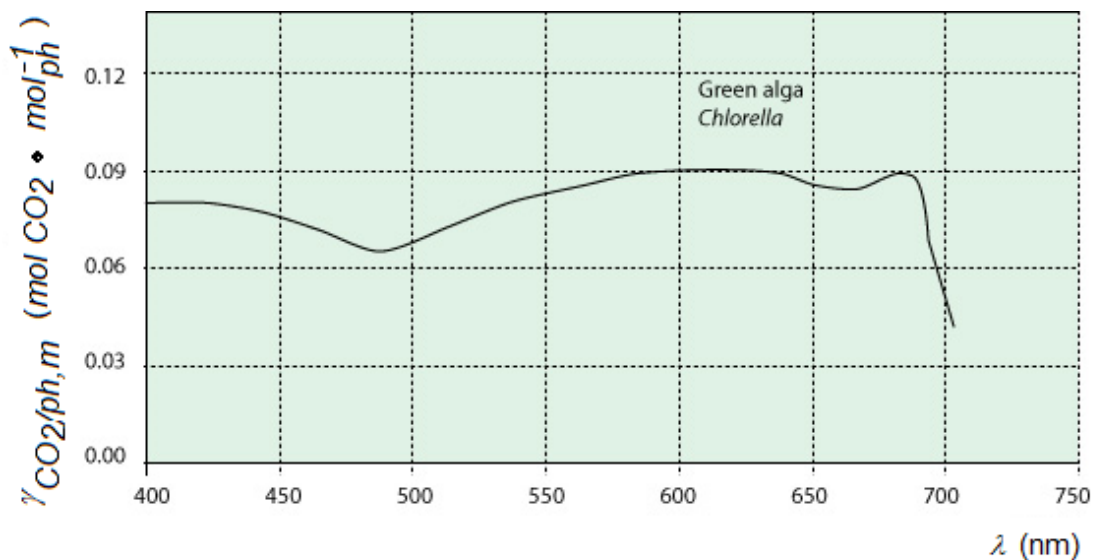
4 marks

Write down the green diode peak wavelength.

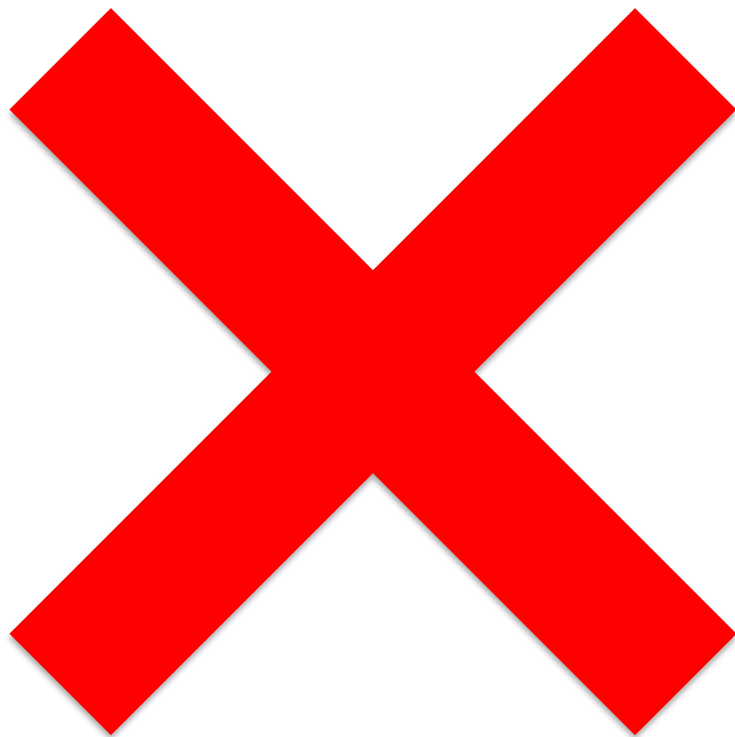
How many percent is the quantum efficiency lower there for Chlorella than at the wavelength of the red diode peak? (Show your calculations.)

➤ Print your graph for the green diode light (mark it clearly "graph 2.6" and with your group number).

Show on the print and on the copy of fig. 2.3 below how you read off the necessary numbers.



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2.7

4 marks

- *Measure the spectrum of the white light diode bulb and compare it with the spectrum of algae. Print the comparison and check your group number on the print.*

Which one of the following statements is correct?

	Tick your answer(s)
The white light is the most energy efficient possibility for these algae.	
Light of higher wavelengths could improve the energy efficiency for use on these algae.	

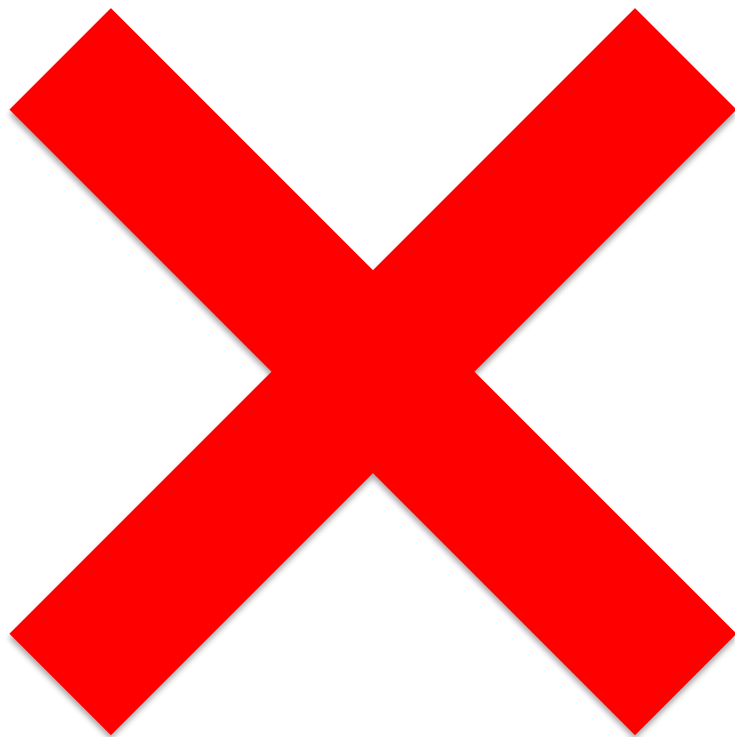
2.8

6 marks

Calculate the energy (in eV) of a photon at the peak wavelength of the green light diode, at the peak wavelength of the red-light diode and at the red absorption peak of your algae sample.

	Peak wavelength (nm)	Frequency (THz)	Energy (eV)
Red LED			
Green LED			
Algae			

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2.9

6 marks

Remember to show the intermediate steps in the next calculations:

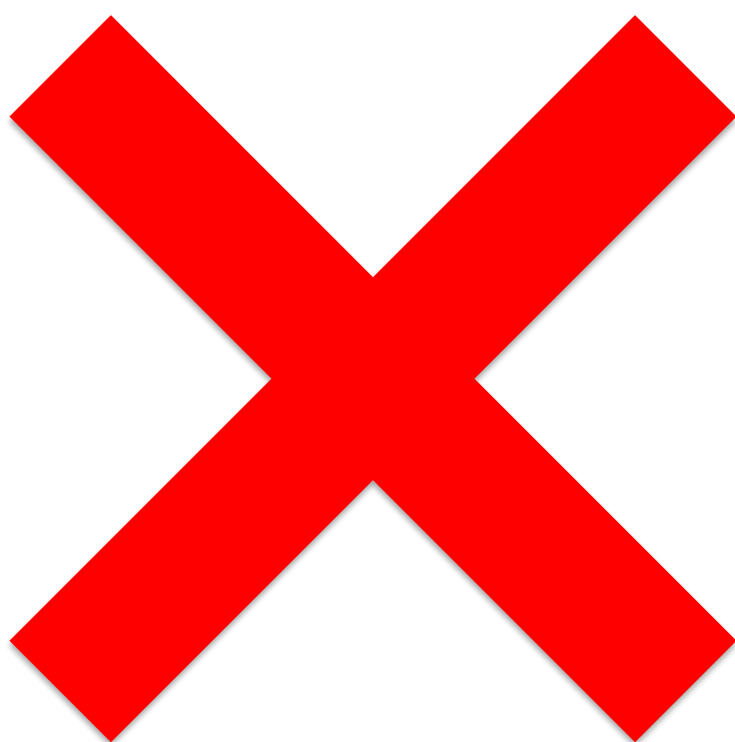
- How much energy (in eV) needs to be absorbed in the red chlorophyll peak for one photon reaction step to take place?
- How many percent of energy is wasted, if this is by a green LED photon transported by carotenoids? By a red LED photon?
- What are the respective efficiencies in energy consumption?

2.10

3 marks

How many percent light energy is lost if Njord uses green LEDs to “feed” the red absorption in the chlorophyll instead of diodes optimized to that absorption?

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Part 3: Predator-Prey interactions.

35 marks

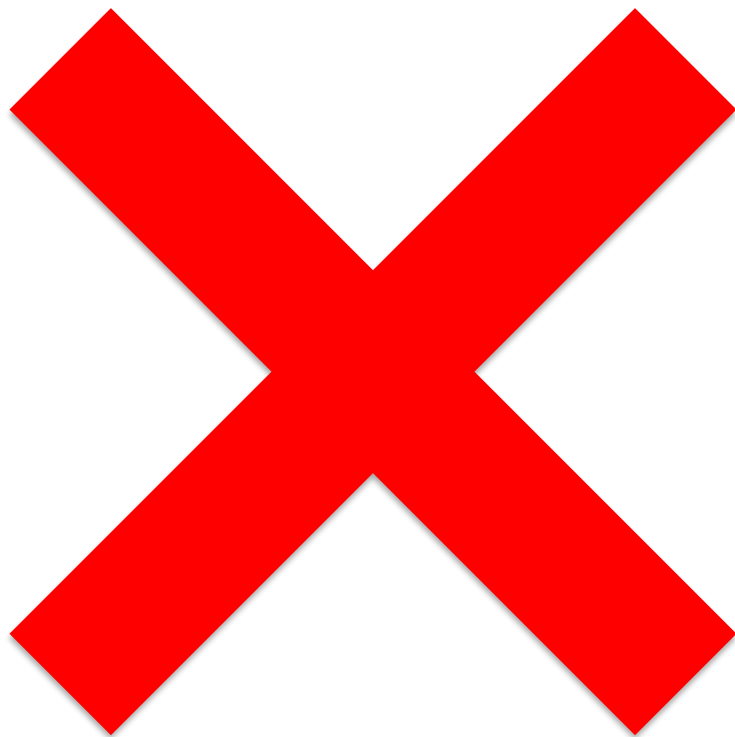
3.1

18 marks

Insert your answers for each of the two copepods in the table below and on the following page.

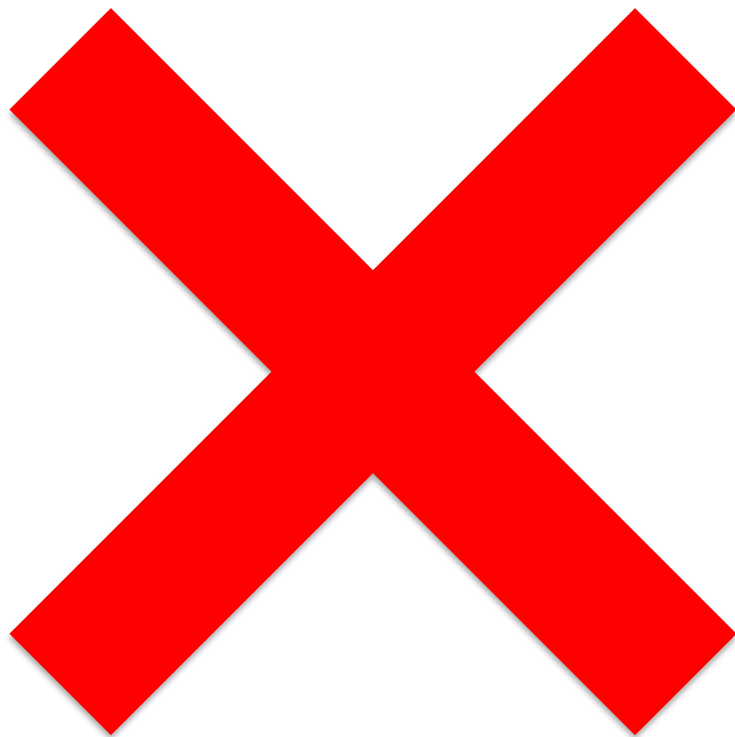
	Copepod Centropages	Copepod Temora	Marks
At what time (in s) does the copepod start the jump?			1
At what time (in s) does the copepod end the jump?			1
What is the position (in mm) in the z direction from pipette tip to the copepod when the copepod starts the jump?			2
What is the position (in mm) in the z direction from pipette tip to the copepod when the copepod ends the jump?			2
Print the graph for the jump in the z-direction, and attach it to the answer sheets.			1
What is the position (in mm) in the x direction from pipette tip to the copepod when the copepod starts the jump?			1
What is the position (in mm) in the x direction from pipette tip to the copepod when the copepod ends the jump?			1

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	Copepod Centropages	Copepod Temora	Marks
What is the position (in mm) in the y direction from pipette tip to the copepod when the copepod starts the jump?			1
What is the position (in mm) in the y direction from pipette tip to the copepod when the copepod ends the jump?			1
Print the graph for the jump in the x,y-plane and mark your readings. Attach it to the answer sheets.			1
What is the distance (in mm) from pipette tip to the copepod when the copepod starts the jump \approx 'Predator detection distance'?			2
What is the jump distance (in mm)?			2
What is the escape speed (in mm/s)?			2

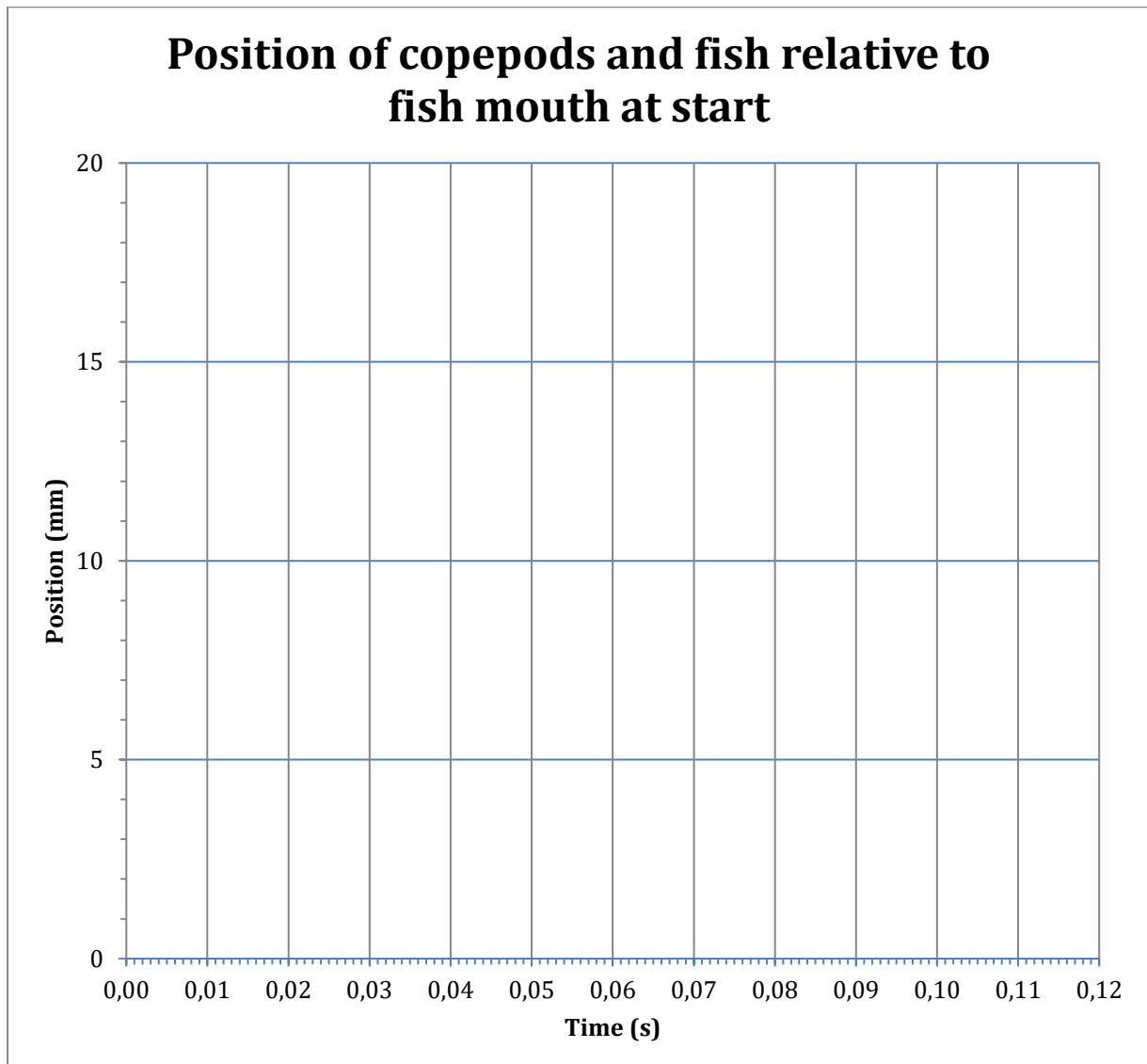
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3.2

6 marks

Draw your graph in the graph area beneath.



3.3

2 marks

Which copepod will best serve as food for fish in the production plant?

	Tick your answer(s)
Copepod <i>Centropages hamatus</i>	
Copepod <i>Temora longicornis</i>	

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3.4

2 marks

To which animal group do the copepods belong?

	Tick your answer(s)
Arthropoder, Crustaceer	
Arthropoder, Insecta	
Mollusca, Gastropoda	

3.5

2 marks

From which sides are the copepods in Figure 3.1 depicted?

	Tick your answer(s)
Cranial end	
Dorsal side	
Ventral side	
Lateral side	
Distal side	

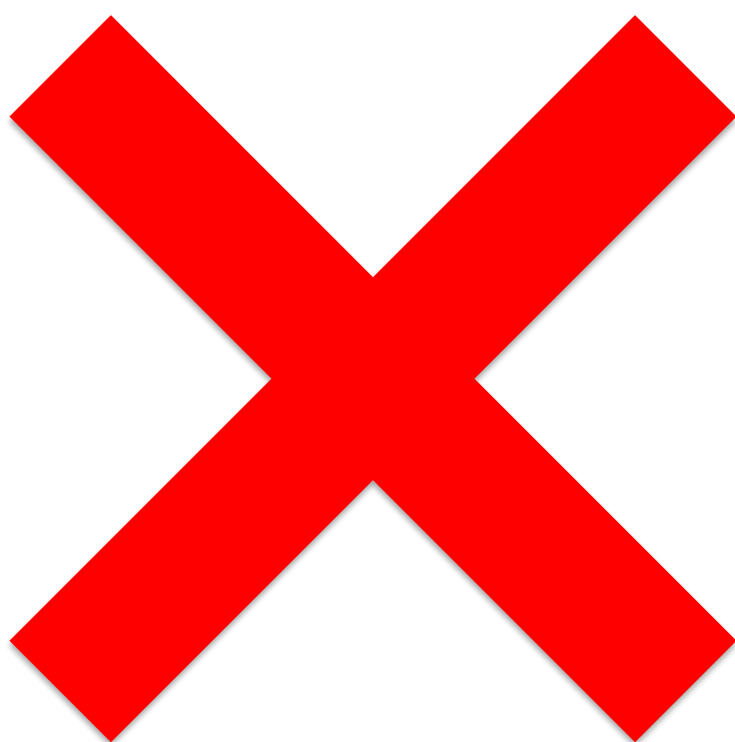
3.6

2 marks

Give the relevant letters (Figure 3.1) to the names.

	Letter
Pereopods (swimming legs)	
Urosome	
Maxillae	
Antennae	
Eyespot	
Prosoma	
Metasoma	

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3.7

3 marks

Many copepods contain oil. Which advantages can it give the copepods to synthesize oil?

Function	Tick your answer(s)
Heat insulation	
Feed reserve	
Improves floatability	
Protection against predators	
Lubricates the joints	

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