

Candidate Name

Candidate Number

Centre Name

Centre Number

Paper 2: Biology
(2 hours)**For Examination December 2023**

It is necessary to respond on the answer sheets provided alongside this question paper. Additionally, you must have a soft pencil (preferably of type B or HB), a clean eraser and a dark blue or black pen.

INSTRUCTIONS:

- You must write your name, candidate number, centre name and centre number on the answer sheets in the designated spaces.
- Objective section consists of 25 questions, and it is essential that you attempt all of them.
- Each question has four options labelled A, B, C, and D. Select the option that you think is correct. Mark it on the multiple-choice answer sheet using a soft pencil.
- Attempt all the questions from subjective section using a dark blue or black pen.
- It is important to follow the instructions provided on the answer sheets.
- Do not use correction fluid.
- Avoid writing on any bar codes.

INFORMATION:

- This paper has a total of 100 marks.
- In objective section there are 25 questions, each carries one mark. There is no negative marking for incorrect responses.
- In subjective section, 45 marks are for extended theory and 30 marks for practical component.
- The number of marks assigned for every question or its parts is indicated within brackets [].

Section 1 MCQ:

- 1) Which enzyme is responsible for the conversion of pyruvate to acetyl-CoA during aerobic respiration?

A: Pyruvate kinase
B: Pyruvate dehydrogenase
C: Acetyl-CoA synthase
D: Acetyl-CoA carboxylase
- 2) What is the net gain of ATP from glycolysis?

A: 2
B: 4
C: 32
D: 36
- 3) Which organelles found in eukaryotic cells are once thought to be independent organisms that were engulfed and integrated into cells?

A: Golgi body
B: Endoplasmic reticulum
C: Vesicles
D: Mitochondria
- 4) In which part of the chloroplast does the light-dependent reaction take place?

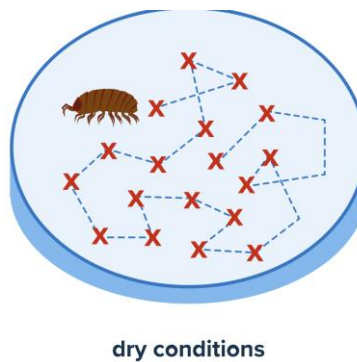
A: Grana
B: Stroma
C: Thylakoid membrane
D: Chlorophyll
- 5) What is the role of NADP⁺ in photosynthesis?

A) Involved in splitting of water molecules into H⁺ ions.
B) Transfers electrons during light dependent reactions.
C) Involved in H⁺ ion formation during photosystem II.
D) Supplies electrons for ADP + Pi → ATP reaction.

6) Triose phosphate (TP) is a product of the Calvin cycle. What is the majority of the produced TP through the Calvin cycle used for?

- A: Starch
- B: ATP
- C: Hexose phosphates
- D: RuBP

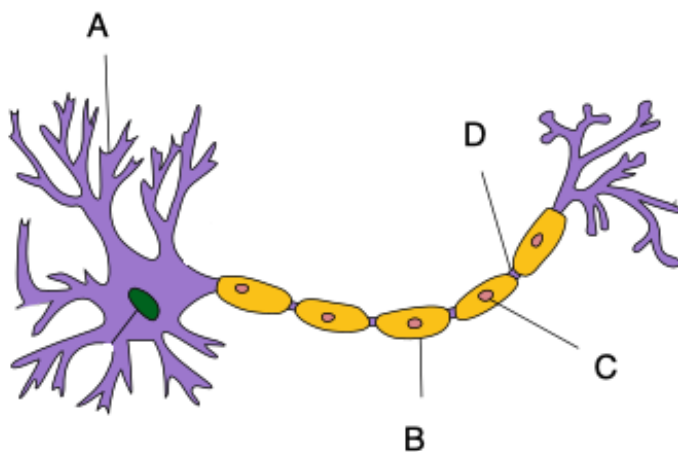
7) Woodlice are found in damp conditions under logs or bark, water vapour can evaporate and diffuse out of their exoskeleton, leading to the risk of drying out. When woodlice were placed in dry conditions the image below represents the behaviour and track that a singular woodlouse took during a 20-minute period.



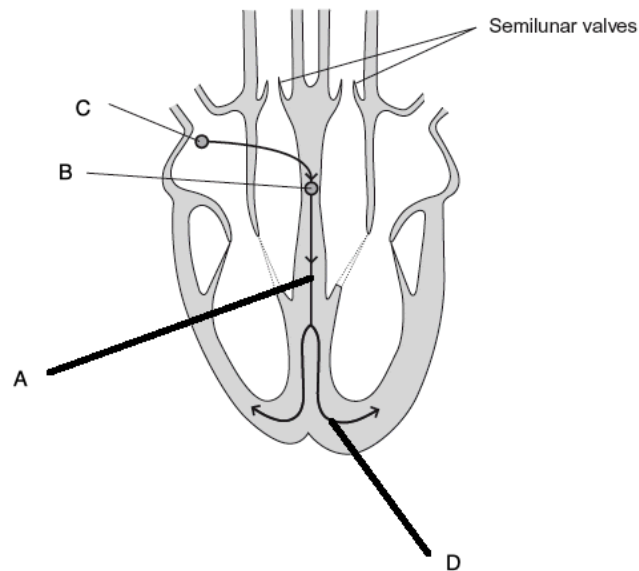
What type of response is being observed from this image?

- A: Hydro taxis
- B: Tropisms
- C: Thigmotaxis
- D: Kinesis

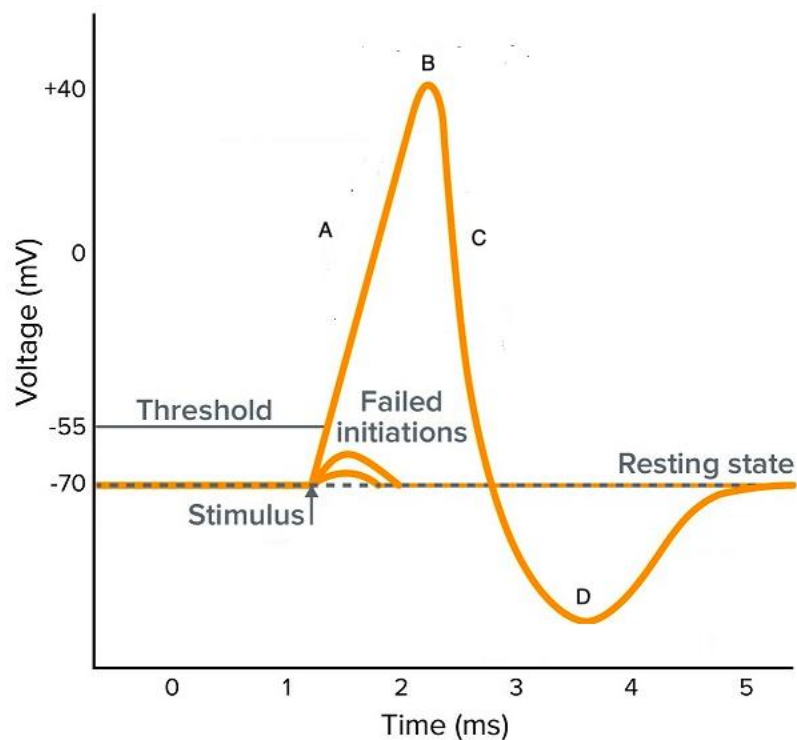
8) Which section of the motor neurones represents the location of the sodium-gated channels, allowing for saltatory conduction to occur.



- 9) The bundle of His is an essential role in electrical conduction of impulses within the heart. Correctly identify the location of the bundle of His.



- 10) Transmission of electrical impulses is essential in the coordination of complex organisms. At which point on the graph does voltage gated Na^+ channels close and the K^+ ions open, allowing K^+ ions to leave the cell.



11) How do cholinergic synapses and neuromuscular junctions differ in terms of their function?

A: Cholinergic synapses transmit impulses to the central nervous system, while neuromuscular junctions transmit within the peripheral nerves.

B: Cholinergic synapses play a role in the autonomic nervous system, whilst neuromuscular junctions involved in the somatic nervous system

C: Cholinergic synapses transmit impulses between neurones, while neuromuscular transmit between neurones and muscles.

D: Cholinergic synapses regulate the release of hormones, whilst neuromuscular junctions control sensory perception.

12) Correctly identify the chemicals involved with a functional role in muscle movement.

1. Myosin
2. Actin
3. Troponin – tropomyosin
4. Thrombin = thrombomyosin
5. ATP
6. Sodium ions

A: 1,2,3 and 5

B: 1, 2, 4 and 5

C: 1, 4, 5 and 6

D: 1,2,3, 5 and 6

13) Which row correctly describes the changes in chemical concentrations causing muscle fatigue?

	Lactate	pH	ATP	Ca ²⁺ released
A	Increases	Increases	Decrease	Increase
B	Decreases	Decreases	Increase	Increase
C	Increases	Decreases	Decrease	Decrease
D	Decreases	Increases	Increase	Decrease

14) Which one of the following statements correctly describes an example of positive feedback?

A: An increased secretion of insulin in response to higher blood glucose levels.

B: Increased sweat production in response to increased body temperature.

C: Secretion of oxytocin during childbirth to increase muscle contractions of the uterus.

D: Increased breathing rate due to increased physical activity.

15) What is the purpose of gluconeogenesis in the body?

- A: To synthesis glucose from non-carbohydrate sources.
- B: To convert excess glucose into glycogen in muscle cells and the liver.
- C: To facilitate the breakdown of fatty acids for energy production in the liver.
- D: To breakdown glucose into pyruvate

16) Which term best describes the efficiency of energy conversion from GPP to NPP?

- A: Trophic efficiency
- B: Photosynthetic efficiency
- C: Respiratory quotient
- D: Ecology efficiency

17) How do saprobionts contribute to the availability of nutrients in an ecosystem?

- A: They absorb nutrients from the soil and release them into the atmosphere
- B: They convert nitrogen form the atmosphere into nitrates in the soil.
- C: They decompose dead organic matter, releasing nutrients back into the soil.
- D: They help convert inorganic minerals into organic compounds.

18) What is a primary limiting factor for primary produces in marine ecosystems?

- A: Availability of phosphorus
- B: Availability of carbon dioxide
- C: Availability of sunlight
- D: Availability of nitrogen

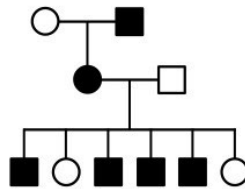
19) In 1995 gray wolves were reintroduced to Yellowstone to help control the elk population.
How does the predator-prey of the grey wolf and elk effect the carrying capacity
Yellowstone park ecosystem as a whole?

- A: The predator prey relationship increases the overall carrying capacity of the ecosystem.
- B: The predator-prey relationship has no impact on the overall carrying capacity of the ecosystem.
- C: The predator-prey relationship decreases the overall carrying capacity of the ecosystem
- D: The predator-prey relationship solely determines the carrying capacity of the ecosystem,

20) What role does conservation play in facilitating secondary succession?

- A: Conservation promotes primary succession over secondary succession.
- B: Conservation hinders secondary succession by maintaining disturbed habitats
- C: Conservation provides a stable environment for secondary succession to occur.
- D: Conservation accelerates secondary succession by introducing pioneer species.

21) Below is a pedigree diagram of an inherited disorder individuals shaded black suffer with the condition.



Which letter best describes the pattern of inheritance observed above?

- A: Y – linked
- B: Autosomal linkage
- C: X – linked dominant
- D: X – linked recessive

22) In a lake a population of fish shows distinct variations in body size and feeding habits based on available resources. This diversification leads to the emergence of several new species within the population. This is an example of:

- A: Allopatric speciation
- B: Sympatric speciation
- C: Adaptive radiation
- D: Convergent evolution

23) Which statement best describes how this activation of oncogenes can occur?

- A: Gene amplification, resulting in increased gene dosage.
- B: Loss of one copy of the gene through deletion.
- C: Mutation of the tumour suppressor gene.
- D: Inhibition of transcription and translation process.

24) Synthetic DNA is used in the development of a new vaccine for a virus. Which statement best describes how the synthesis DNA is utilized?

- A: Encode and produce viral proteins for the vaccine
- B: Replace the patients damaged DNA with synthetic DNA
- C: Create a transgenic organism for the vaccine production
- D: Genetically modifying bacteria to manufacture antibodies for passive immunization.

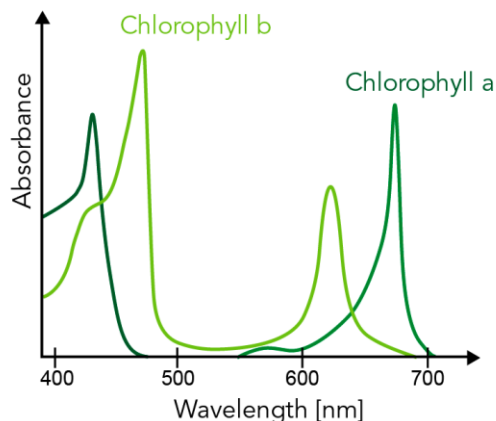
25) Which technique is commonly used to amplify specific DNA regions for DNA profiling?

- A: Western blotting
- B: Polymerase chain reaction
- C: Gel Electrophoresis
- D: South blotting

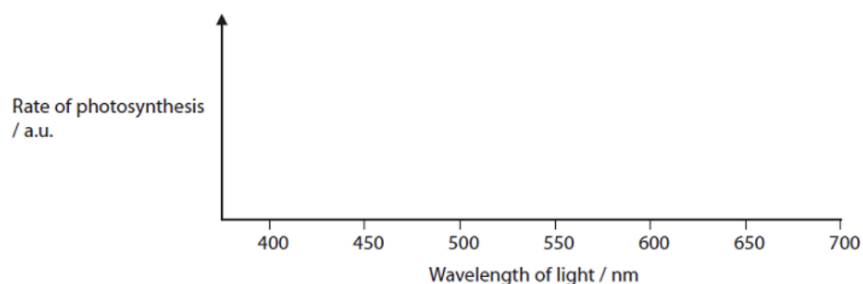
End of Multiple Choice 25 marks

Extended theory:

1. Chloroplasts are involved both light dependent and light independent reactions of photosynthesis.
 - a) Draw the labelled diagram of the ultrastructure of a chloroplast, do not include labels for thylakoid membrane, cell membrane or stroma. [3 marks]
 - b) Chlorophyll has a range of pigments that can absorb different wavelengths of light to excite electrons. Below is a graph of absorbed of light of a green plant.



- bi) Draw a line on the graph above of the expected absorbance of pigments of a purple leafed plant. [1 mark]
 - bii) Draw the action spectrum for the purple leafed plant below. [2 marks]



- c) Describe the light independent reaction in photosynthesis? [6 marks]
 - d) Purple bacteria use hydrogen sulfide, H_2S , to produce organic compounds. The hydrogen sulfide chemosynthesis has a similar role to that of water in photosynthesis.

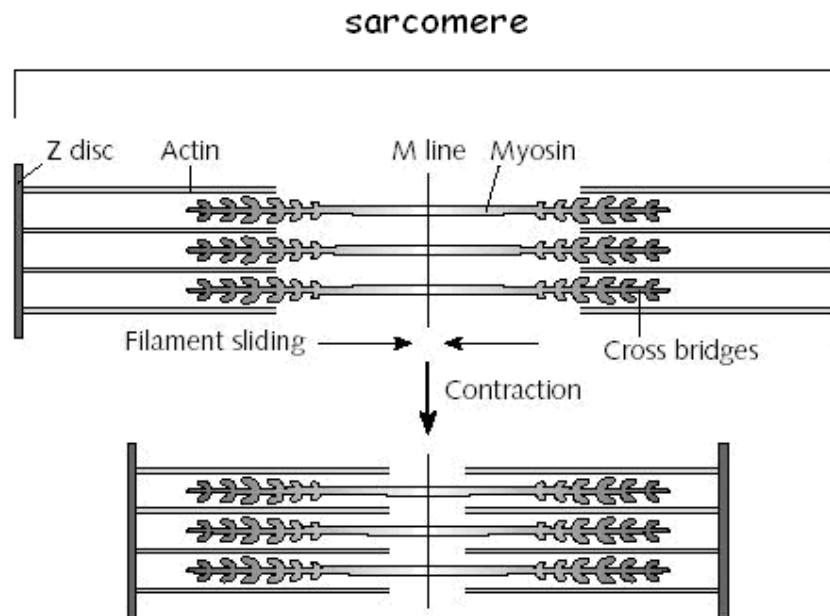
A simple equation for this process in bacteria is shown below:

Hydrogen sulfide + carbon dioxide \rightarrow glucose + sulfur + water

Suggest what the hydrogen sulfide is used for in these bacteria? [2 marks]

[Total 13 marks]

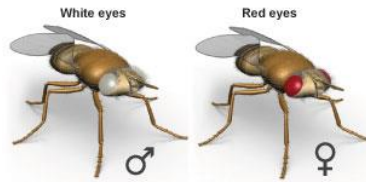
Q2) A sarcomere is the basic contractile unit of a muscle fiber, consisting of thin and thick filaments. An example of a single sarcomere of a skeletal muscle during contraction of the sliding filament theory is observed below.



- a) Describe the role of following in myofibril contraction?
 - Ai) Myosin [2 marks]
 - Aii) Tropomyosin [2 marks]
 - Aiii) ATP [2 marks]
- b) Triathlon athletes carry out continuous muscle contractions and over a long period of time can deplete calcium stores temporarily. This may lead to muscle fatigue, explain how a lack of Ca^{2+} ions can disrupt the muscle contraction mechanism? [2 marks]
- c) Triathlete will have a higher proportion of slow twitch fibres compared to fast twitch fibres. Explain the benefit of higher proportion of slow twitch fibres for triathletes? [2 marks]
- d) A sprinter will have a higher proportion of fast twitch fibres, the Bohr effect assists in assisting the sprinter meeting their energy demand, explain how? [2 marks]
- e) Muscle contraction resulting in movement is an organism's position or place is voluntary response, as part of the muscle coordination. Describe the sequence of events involved in the transmission of impulse across a cholinergic synapse? [5 marks]

[Total 17 marks]

Q3) *Drosophila* is a genus of small flies commonly known as fruit flies. These flies belong to the family *Drosophilae*, and the most well-known species within this genus is *Drosophila melanogaster*. They are used as a good example to demonstrate sex-linked inheritance.



In an experiment of breeding a homozygous red eye female with long wings was bred with a white eyed male with vestigial wings.

Red eyes is dominant allele located on the X chromosome

Use the symbol X^R

White eye is a recessive allele.

Use symbol X^r

Male chromosome Y

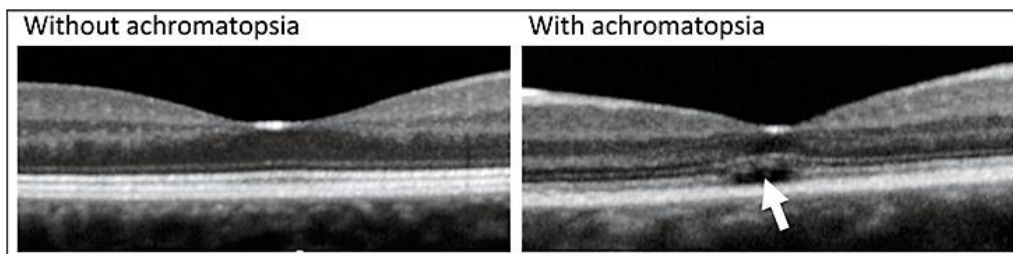
Long wings are dominant.

Use symbol W

Short vestigial wings are recessive.

Use symbol w

- Complete a dihybrid inheritance cross to determine the outcome of the offspring include both phenotypes and sex in the outcome. [5 marks]
- In a different experiment an offspring of red eyed female was collected, deduce all the possible parental genotypes possible combinations to have created this offspring, used similar symbols as part a). [2 marks]
- Achromatopsia is a form of complete colour blindness. Complete achromatopsia is caused by an autosomal recessive allele and is usually rare in populations with only one in 32 000 being affected.



The image above shows optical coherence tomography analysis shows structural abnormalities in the outer fovea of some patients with achromatopsia. The left scan is through the fovea from a person with unaffected vision. The right scan is through the fovea from a person with achromatopsia.

Using Hardy-Weinberg principle deduce the number of heterozygous individuals in a population of 224,000 individuals. [3 marks]

[Total marks 10]

Q4) Insulin, a hormone essential for regulating blood sugar levels, has historically been obtained from animal sources such as pigs or cows. However, advancements in biotechnology have allowed to produce human insulin through the modification of bacteria plasmids.

- a) Describe how modified plasmids are made by genetic engineering and how the use of markers enables bacteria containing these plasmids to be detected. [4 marks]
- b) A modified bacteria can divide every 20 minutes. Starting with one of these cells, how many transgenic will be present after 1 day?
Assume none of these cells will die.

Give your answer in standard form. [1 mark]

Total [5 marks]

End of Extended theory 45 marks

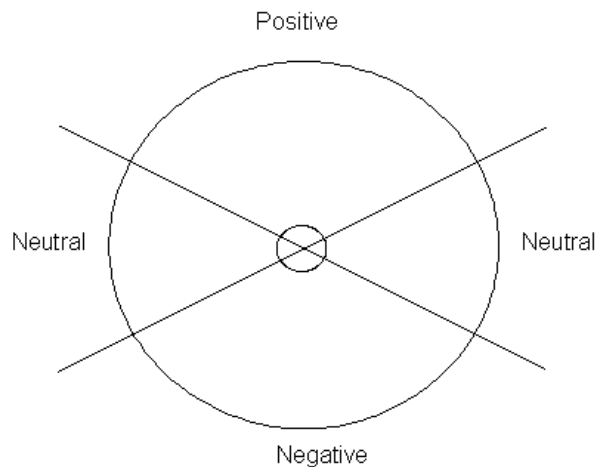
Practical Theory:

Q1) A student investigates the response of an animal to light. *Calliphora* larvae, the maggots of the blowfly (bluebottle).



Method:

Step 1: A piece of marked paper (an example of which is shown below) is put in the plastic dish. Each of the positive and negative sectors should have angles of 120° and each of the neutral sectors should have an angle of 60° . The end marked “positive” is positioned nearest to the light.



Step 2: The plastic tray in front of the lamp. The lamp should be shining at a shallow angle along the tray.

Step 3: A pencil is spun to find a random direction. The maggot is then placed in the centre of the plastic dish facing in the direction of the pencil.

Step 4: The dish's cover is placed on the tray.

Step 5: As soon as the maggot's head leaves the paper's inner circle the stopwatch is started. The position of the maggot's head is then marked with a small 'a' on the plastic cover every 5 seconds until the maggot leaves the outer circle.

Step 6: The maggot is taken out of the tray and placed in a spare petri dish so that it is not used again.

Step 7: The distance between each 'a' is measured and noted down in a table such as the one below. The sector (positive, negative or neutral) that the maggot left the outer sector is noted in the table. The distance between each of the points and the front of the lamp is then measured and noted in another similar table.

Step 8: A new sheet of paper is then placed in the perspex tray with the 'positive' end pointing towards the light.

Step 9: The experiment is then repeated another 19 times.

Questions:

- a) State 2 control variables that need to be considered for this experiment to increase its fairness. [2 marks]
- b) State 2 safety procedures that should be considered. [2 marks]
- c) State the purpose of spinning the pencil, before placing the maggot. [1 mark]
- d) Explain the purpose of step 6 and step 8? [2 marks]
- e) Write a suitable hypothesis? [1 mark]

The results are as follows:

Distance (cm) From Lamp at each 2 second interval

Maggot	2	4	6	8	10	Overall Direction
1	20.6	22.6	24.4	25.5	26.4	-
2	21.6	23.5	25.0	25.5		-
3	20.6	22.5	24.3	25.9		-
4	22.8	23.5	22.0	23.0		Neutral
5	21.7	23.7	25.8			-
6	22.0	24.4	25.4			-
7	20.9	23.7	25.2	26.1		-
8	22.0	23.5	23.0	23.0	23.5	Neutral
9	21.5	23.0	24.0	25.3	25.9	-
10	22.2	23.7	24.0	24.5	24.8	Neutral
11	21.4	22.9	24.9	25.9	26.5	-
12	21.7	23.5	24.5	26.2	26.0	-
13	21.9	24.4	25.6	25.8		-
14	21.8	23.0	24.6	25.6		-
15	21.5	24.5	26.1			-
16	20.9	22.7	23.7	25.1		-
17	21.7	23.9	26.1			-
18	15.5	14.0	12.0			+
19	21.5	20.5	21.0			Neutral
20	21.3	23.1	25.1	26.5		-

The null hypothesis of this experiment was.

As there is the same angle for each of the three sectors (positive, negative and neutral) an equal amount of maggots should leave each sector.

- f) What would be the expected % of maggots in each sector? [1 mark]

g) Using the Chi² test complete the table: [3 marks]

Direction	Observed	Expected	O - E	(O - E) ²	(O - E) ² / E
Positive					
Negative					
Neutral					
				Total:	

Critical values of chi-square (right tail)



Degrees of freedom (df)	Significance level (α)							
	.99	.975	.95	.9	.1	.05	.025	.01
1	-----	0.001	0.004	0.016	2.706	3.841	5.024	6.635
2	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210
3	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345
4	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277
5	0.554	0.831	1.145	1.610	9.236	11.070	12.833	15.086

- h) Using the Chi² table what is the critical value that should be used for this experiment to be 95% significant? [1 mark]
- i) What can be concluded about this experiment? [2 marks]
- j) What is the correct term used to describe this type of response? [1 mark]
- k) Suggest another possible reason for the behaviour of the maggots other than a response to light, and suggest a method that could be used to reduce the influence of this factor? [2 marks]

[Total 18 marks]

Q2) Students investigated the effect of light wavelength on the rate of dehydrogenase activity in extracts of chloroplasts. Students used the leaves of a tomato plant.



a) Describe how a sample of chloroplasts could be isolated from leaves. [4 marks]

After completing the isolation of chloroplasts, samples were placed in test tubes and a chemical indicator was added.

Samples were then placed in a test-tube rack 20cm from a light source.

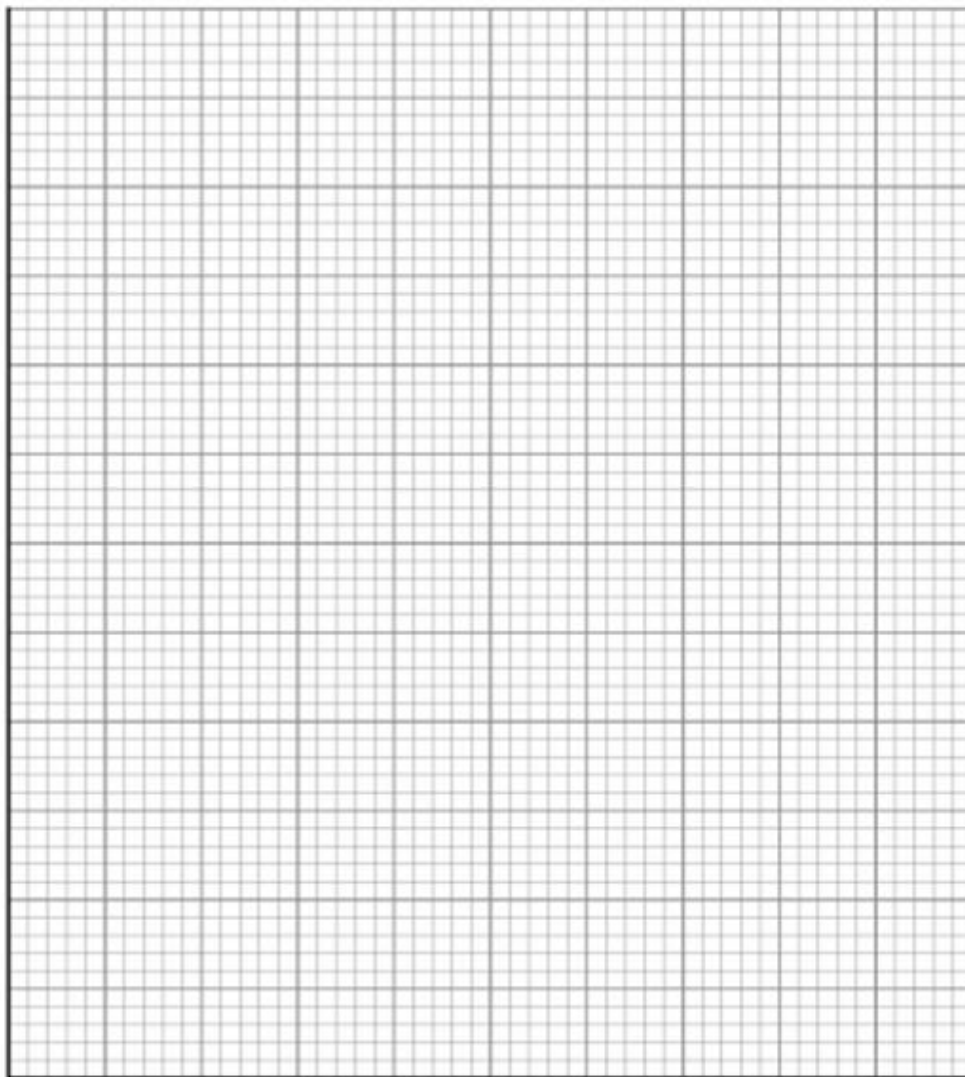
The time taken for the change in colour was noted.

b) State a suitable indicator that was used, describe the expected observed change. [1 mark]

Below are the results for the different wavelengths:

Wavelength/nm	time taken to Change colour (s)	1/t
400	195	
450	150	
500	250	
550	510	
600	400	
650	200	
700	315	

- c) Complete the missing data final column to 2sfg. [1 mark]
- d) Plot a suitable graph between wavelength and $1/t$. [4 marks]



- e) Suggest a limitation of the resolution of results collected and recommend a suitable improvement [2 marks]

[Total 12 marks]

End of Practical Theory 30 marks