MJSO

Malta Junior Science Olympiad

2021 Biology

SCIENCE CENTRE
PEMBROKE MALTA

MINISTRY FOR EDUCATION
Directorate for Learning and Assessment Programmes

Acknowledgements

The examination questions included in this Malta Junior Science Olympiad set of booklets are the result of a team effort and reflect the contributions by Ms Penelope Fitzgerald (EO Biology), Mr Michael Mercieca (EO Chemistry) and Ms Audrey Vella Bondin (EO Physics).

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Special thanks are due to Mr Michael Mercieca for his technical support, design and compilation of the final version of the booklets.

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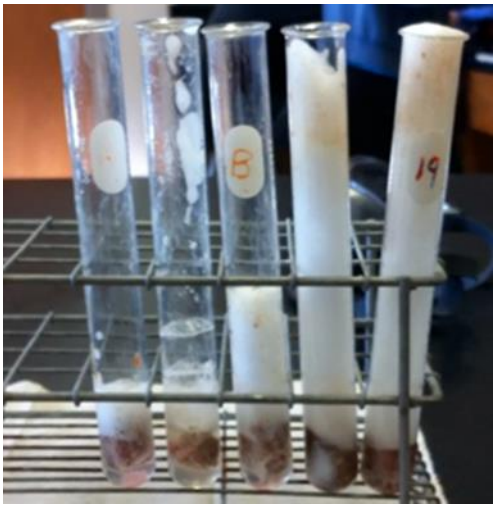
Instructions

- You are asked to attempt all questions within the four sections and write your answers clearly in the spaces provided. Whenever necessary indicate the question number to your answer.
- Show all steps in your working.
- The use of a calculator is permitted.
- You are also reminded of the necessity of good English and orderly presentation of your answers.
- No extra foolscaps will be provided.

Section A: Short answer questions (20 marks)

1. Catalase is an enzyme present in different animal and plant tissues. It has an important role of breaking down hydrogen peroxide, a toxic by-product of several cellular metabolic reactions. The following equation shows the breakdown of hydrogen peroxide.

$$2H_2O_2 \xrightarrow{catalase} O_2 + 2H_2O$$



A group of students investigated the concentration of the enzyme catalase in different parts of a broad bean plant. The students placed hydrogen peroxide into five test tubes, added a different part of the bean seedling to each tube and recorded the results after half a minute. If any catalase is present in part of the seedling, oxygen gas is given off. When oxygen gas is given off, froth is produced in the test tubes as shown in the adjacent photograph.

The table below lists the results obtained from this investigation.

Part of broad bean seedling	Height of froth (cm)
Leaf	1.8
Stem	2.6
Root	2.2
Seed	8.1
Seed coat	0.0

a. What conclusion can be drawn from the results above?

_____

_____ (2)

b. Describe the action of an enzyme on a substrate.

_____

_____

_____

_____

_____ (4)

c. Taking in consideration the concentration of catalase and metabolism of each part of the broad bean seedling, name the part of the broad bean seedling that has the highest metabolic rate and give ONE reason for your answer.

_____

_____

_____ (1, 2)

d. Describe the role of the seed coat within the seed.

_____

_____ (1)

Total: 10 marks

2. Soil is a mixture of minerals, water, air, organic matter and organisms. A student decided to find the percentage of water in different soils. The student weighed the exact quantity of the two types of soil (soil A and soil B) and put each in an evaporating dish. Both soils were placed in an oven at 105 °C for 24 hours.

	Initial quantity of soil (g)	**Final quantity of soil (g)**	**% of water in soil**
Soil A	100.0	82.5	
Soil B	100.0	96.8	

a. Calculate the percentage of water in soil A and soil B, respectively. Write your answer in the appropriate box in the table above.

Working Space

(2)

b. Explain how you would modify the experiment to check that all the water has been removed from the soil samples.

_____

_____ (1)

c. Which soil sample comprises sandy soil? Describe the soil structure and water retention properties in relation to your answer.

Soil sample: _____ (1)

_____

_____

_____ (2)

d. Explain how the presence of high percentage of organic matter in one of the samples would affect the final results.

_____

_____

_____ (2)

e. Describe the importance of beneficial organisms such as earthworm, in soils.

_____

_____

_____ (2)

Total: 10 marks

Section B: Comprehension (20 marks)

3. Read the following edited article entitled **Staghorn Ferns forming communities** accessed online at *https://tinyurl.com/3fusuyej* on 7/10/2021. Then answer the questions that follow.

A mass of strange ferns grips an angiosperm trunk high among the treetops. They look like a giant tangle of floppy, green antlers. Below their fork-shaped fronds and closer into the core of this lush knot of greenery are brown, disc-shaped plants. These, too, are ferns. They are even the same species. Together these individuals form a society. This type of society has only ever been observed in animals, especially bees, termites and ants.

Staghorn ferns appear to work together. Each takes on different tasks that together aid their society. The biologist Kevin Burns likens the fern colonies to an upside-down umbrella. Some with long, green, waxy "strap" fronds appeared to direct rainwater to the centre of the clump. Their spongey disc-shaped, brown "nest" fronds soaked up this moisture.

Scientists call such cooperative groups eusocial. Overlapping generations live together in groups, with each performing different roles. The term eusocial has been used to describe certain societies of insects and crustaceans, along with two species of mole rats. Burns wondered if ferns, too, might be eusocial.

Ferns reproduce via spores. These form on the underside of leaf-like fronds. Some four in every ten fronds of the studied communities of staghorn ferns could not reproduce. They mostly served as nests for others. Another fern has what is known as "strap" fronds. It did develop fertile spores. This suggests a division of labour between fronds that do or do not form nests.

Tests also showed that nest fronds take up more water than strap fronds do. Earlier research by other scientists had found networks of roots running throughout the

colony. Using them, nest fronds can share their water, slaking the thirst of neighbouring strap fronds.

Burns sustains that the staghorns' newfound traits tick many of the boxes needed to support a claim that they too, are eusocial. Looking at epiphytes (a non-parasitic plant that grows on another plant) as eusocial is "really cool," says the ecologist, Michelle Spicer. To Burns, the division of labour to build communal resources "appears to be a key feature that sets staghorn ferns apart from other colonial plants." A stressful life in the treetops, far from the soil, may have helped the ferns evolve eusocial traits, Burns says. The society these plants create allows all members to share the scarce supplies of water and nutrients.

The evolutionary biologist, Brian Whyte, is fascinated by how staghorns form colonies in the wild, where members perform different, individual tasks. However, he notes that, when grown in soil as ornamental plants, these ferns do not need a community. They now form individual strap fronds. Such variability is not typical of eusocial species, he says.

Burns and his colleagues are currently studying whether strap fronds can become nest fronds when they are moved to another part of a colony. Burns also wants to study a second staghorn fern species that appears to grow in colonies, found in Madagascar.

a. From the text name ONE:

i. structure that contains vascular tissue _____ (1)

ii. endothermic organism _____ (1)

b. Define the term species. (line 4)

_____

_____ (2)

c. Write ONE similarity between angiosperms and ferns.

_____

_____ (1)

d. List TWO differences between angiosperms and ferns.

_____

_____

_____

_____ (2)

e. State the importance of the different roles of ferns within a community. (line 13)

_____

_____

_____ (2)

f. Explain why growth away from the soil is a problem for ferns. (line 29)

_____

_____ (2)

g. Give the importance of some individual ferns channelling water to other ferns of the community. (line 22)

_____

_____

_____ (2)

h. The term community (line 17) mentioned in the text does not reflect the biological definition of this term. Explain why.

_____

_____ (2)

i. Insects and crustaceans are found in the same phylum.
   i. Name the phylum that includes insects and crustaceans.

_____ (1)

   ii. Give ONE characteristic feature of this phylum.

_____ (1)

   iii. Write ONE other group that forms part of this phylum.

_____ (1)

   iv. Distinguish between insects and crustaceans.

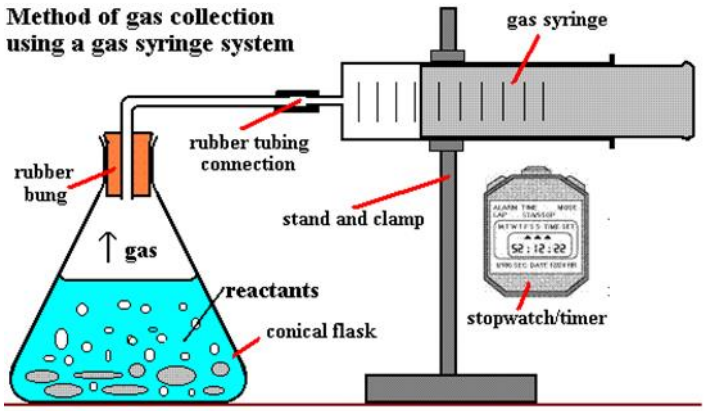
_____

_____ (2)

Total: 20 marks

Section C: Data Analysis (30 marks)

4. In an investigation related to anaerobic respiration by yeast, two scientists decided to test the rate of reaction of two different monosaccharides – glucose and fructose.
The apparatus used in this investigation is shown below.

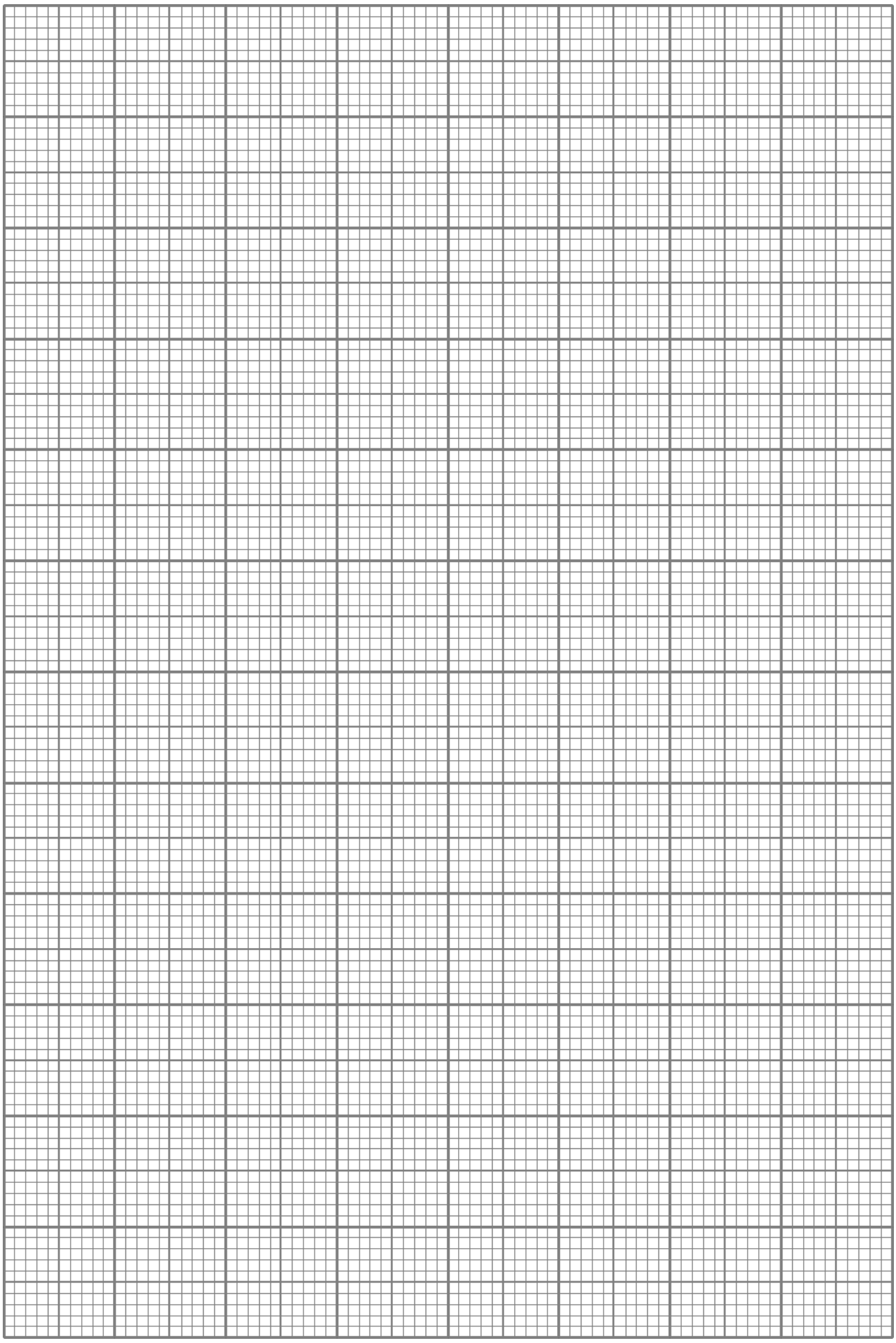


https://docbrown.info/page03/3_31rates3a.htm

The following results were obtained:

Time (min)	Volume of Carbon Dioxide produced (ml)	
	Glucose	Fructose
0	0	0
25	2	0
50	18	0
75	27	4
100	53	10
125	70	16
150	84	19

a. On the graph paper on page 11, draw a graph of volume of carbon dioxide produced in the presence of glucose against time. Join the points of the graph using a ruler. Using the same axes, draw a graph of volume of carbon dioxide produced in the presence of fructose against time. Join the points of the graph using a ruler. (6)



b. State the effect of the presence of glucose and fructose on the volume of carbon dioxide produced.

_____

_____

_____ (2)

c. Write TWO biological reasons for the trends observed in the graphs drawn.

_____

_____

_____

_____ (4)

d. Explain why the two scientists decided to measure the volume of carbon dioxide produced as the dependent variable.

_____

_____ (2)

e. Yeast can perform aerobic and anaerobic respiration depending on the environmental conditions present. List TWO experimental procedures needed to ensure anaerobic conditions and the reasons for these procedures.

_____

_____

_____

_____

_____ (4)

f. The scientists wanted to check if all of the glucose was used up after 150 minutes.
   i. Name the test used to determine the presence of glucose in a solution.

_____ (1)

ii. Describe the experimental procedure of the test to determine the presence of glucose.

_____

_____

_____ (2)

iii. Write the result observed if glucose is still present.

_____ (1)

g. The scientists extended the investigation by using two other substrates, namely, sucrose and maltose. The volume of carbon dioxide produced at 150 minutes for sucrose and maltose respectively were the following:

Substrate name	**Volume of CO_2 produced (ml)**
Maltose	100
Sucrose	9

i. State ONE reason why the volume of CO_2 produced at 150 minutes by maltose is higher than that produced by glucose.

_____

_____ (2)

ii. State ONE reason why the volume of CO_2 produced at 150 minutes by sucrose is lower than that produced by fructose.

_____

_____ (2)

h. During the investigation one of the scientists suggested that the conical flask, where reactants are placed, is put in a water bath at 30 °C. List TWO reasons for this modification.

_____

_____

_____ (2)

i. Explain how the ability of both aerobic and anaerobic respiration in yeast is important for its survival.

_____

_____ (2)

Total: 30 marks

Section D: Design task (30 marks)

5. Gummy bears (or as they were initially called dancing bears) are sweets made up of gelatine, water and sugar. Gummy bears are among the most popular sweets in Europe and the United States.

Two students bought a packet of gummy bears to share. They decided to investigate the effect of water and different salt solutions on the gummy bears.

Answer the following questions to explain how you would design an investigation to determine the effect of different salt solutions and water on gummy bears.

a. Write a hypothesis (prediction) of the investigation.

_____

_____

_____

_____ (2)

b. List the apparatus necessary (including chemicals and their concentrations) for such an investigation.

_____

_____

_____

_____ (4)

c. Describe the experimental procedure for the investigation.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ (6)

d. List TWO precautions related to the experimental investigation and their justification.

_____

_____

_____

_____

_____

_____ (4)

e. Name TWO variables that need to be kept constant during the investigation.

_____

_____ (2)

f. Name the dependent and independent variables of this investigation and include any units if applicable.

Dependent variable: _____

Independent variable: _____ (2)

g. Describe the expected results of the investigation and give a biological explanation for your description.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ (8)

h. List TWO expected conclusions from the investigation.

_____

_____

_____

_____ (2)

Total: 30 marks

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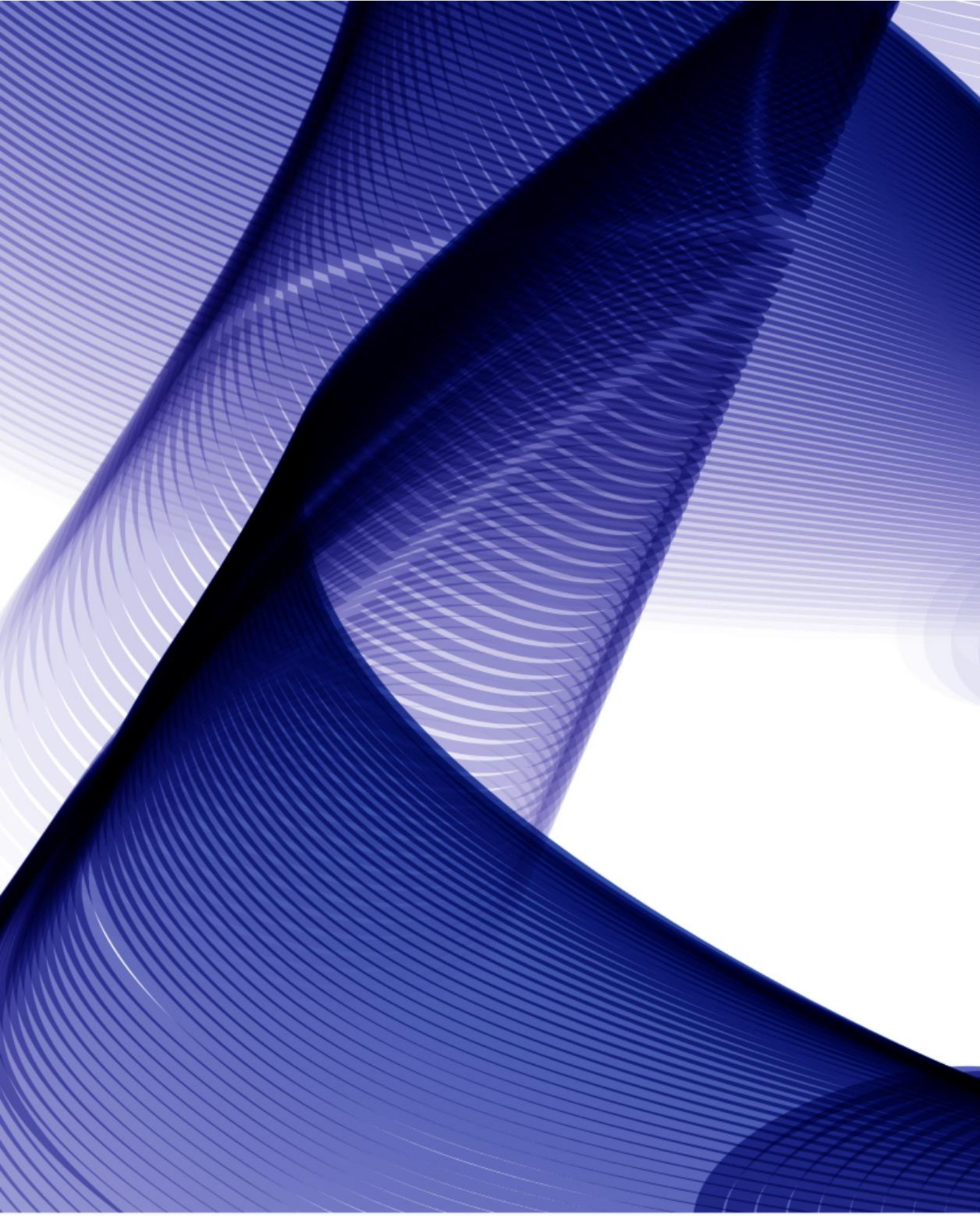

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