



MALVERN
COLLEGE

Transform their world

SURNAME:

FIRST NAME:

PREP SCHOOL:

Malvern College Academic Scholarship Examinations 2023

SCIENCE

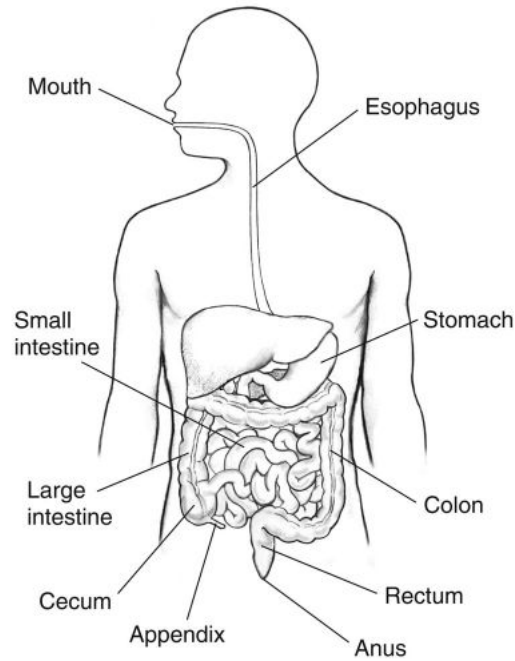
Please read this information before the examination starts:

- This booklet contains the test papers for Biology, Chemistry and Physics
- You have 60-minutes
- It is recommended you spend 20-minutes on each paper

BIOLOGY

Questions

Q1. The diagram shows the digestive system of a human.



(a) Describe the role of the mouth in digestion.

(2)

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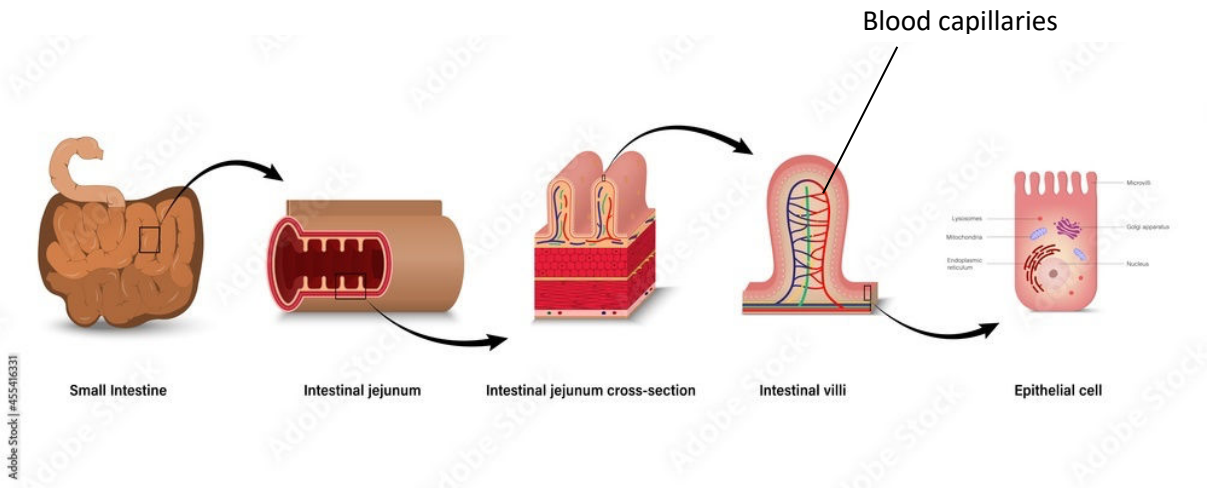


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(b) Villi are structures in the small intestine (singular villus). The main roles of the small intestine is digestion and absorption. Using the diagram above explain 3 ways in which the small intestine is adapted to these functions.

(4)

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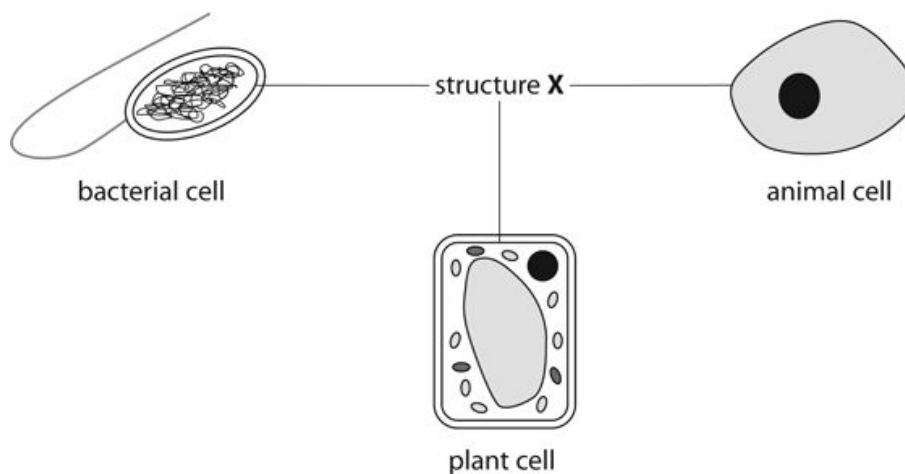
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(Total for Question = 6)

Q2. (a) The diagrams show a bacterial cell, a plant cell and an animal cell.
Structure **X** is found in all three cells.



(i) Complete the sentence by putting a cross (☒) in the box next to your answer.
Structure **X** is the

(1)

- A** cell membrane
- B** cell wall
- C** cytoplasm
- D** nucleus

(ii) Many bacteria have one or more flagella whereas most animal cells have no flagella.

State **one** other difference between a bacterial cell and an animal cell.

(1)

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b) Scientists use microscopes to magnify cells.

(ii) The diagram shows a sperm cell that has been magnified 100 000 times.



Calculate the actual length of the sperm cell.

(2)

length of sperm cell = mm

(Total for Question = 4)

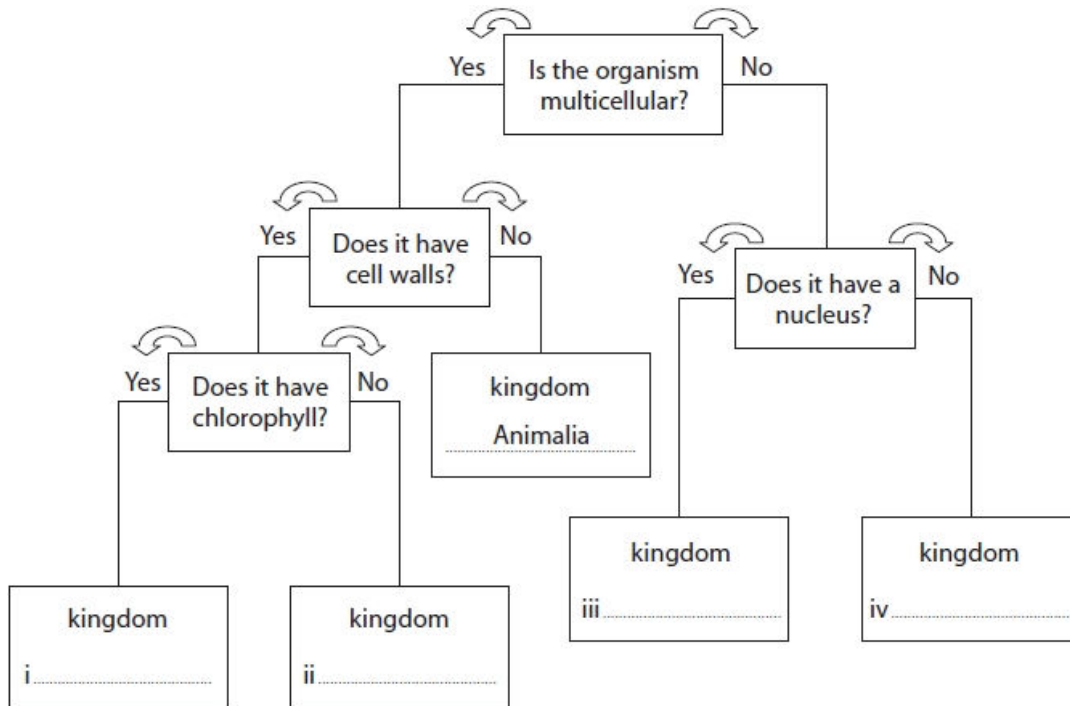
Q3. John produced a key to classify organisms into their kingdoms.

The names of the kingdoms are shown in the box.

Animalia	Fungi	Plantae
Prokaryotes	Protoctista	

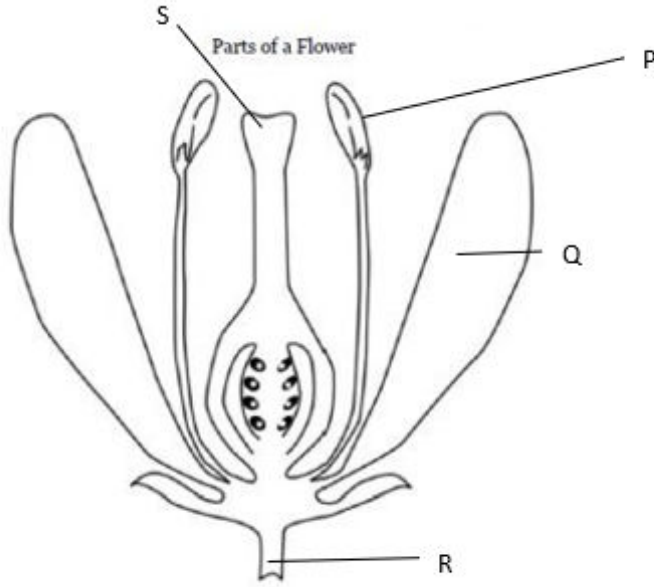
Use words from the box to complete the key. One has been done for you.

(4)



(Total for question = 4 marks)

Q4. The diagram shows an insect-pollinated flower called a lily.



(a) (i) Name structure P?

(1)

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(b) Describe how the structures of P, Q and S would differ in a wind-pollinated flower.

(3)

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(c) State the difference between pollination and fertilisation.

(2)

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(Total for question = 6 marks)

CHEMISTRY

1. This question is about ammonium chloride (NH_4Cl), which is formed in the reaction of hydrochloric acid (HCl) with a base called ammonia (NH_3).

(a)

(i) State the number of atoms in ammonium chloride.

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[1]

(ii) State the number of elements in ammonium chloride.

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[1]

(iii) What type of reaction is this?

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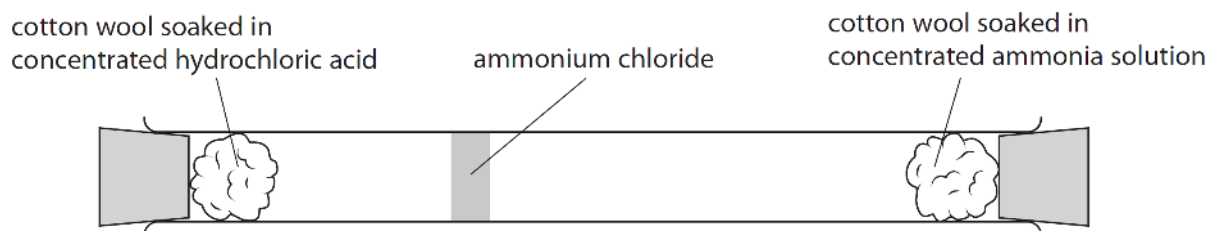
[1]

(iv) Complete the table with the colours that hydrochloric acid and ammonia would make with universal indicator.

Hydrochloric acid (pH = 1)	Ammonia (pH = 10)

[2]

(b) The diagram below shows the formation of ammonium chloride in a glass tube



(i) Use the diagram to explain whether the particles in ammonia or hydrochloric acid have the greatest mean speed.

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[2]

(ii) Explain why it takes some time before the ammonium chloride is observed.

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[2]

(iii) Ammonium chloride is a white solid. Upon heating, it sublimes. State the meaning of the term "sublime".

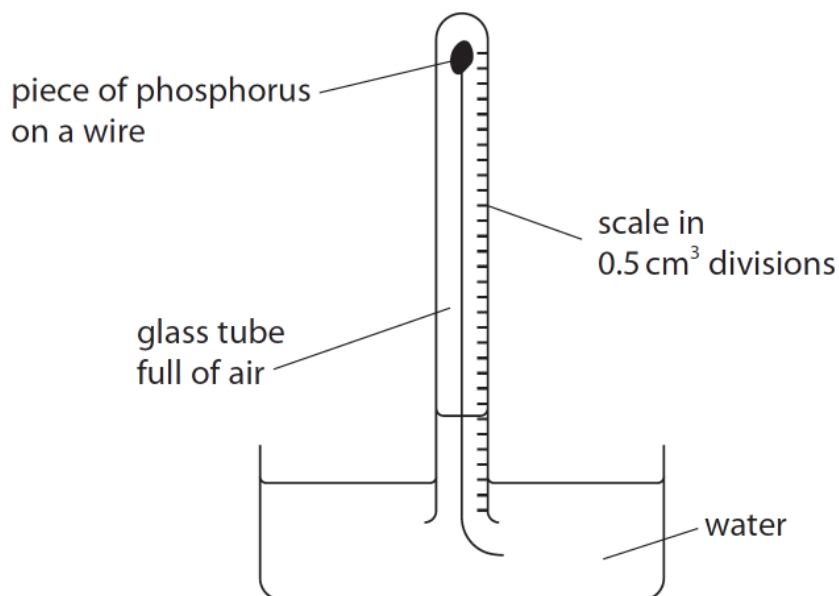
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[1]

2. This question is about oxygen and its reactions.

Oxygen is an important component of the Earth's atmosphere.

A teacher uses the below experiment to measure the amount of oxygen in air.



The oxygen in the tube reacts with the phosphorus, so removing the oxygen from the air inside the tube. As it does so, the water is “sucked” up the tube.

(a) Suggest a word equation for the reaction.

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[2]

(b) The teacher obtains the following results

Time in minutes	Volume of gas in tube in cm ³
0	48.5
1	41.0
2	38.0
4	37.5
5	37.0
6	37.0
7	37.0

(i) State when all the oxygen has reacted. Explain your answer.

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[2]

(ii) Use the teacher's results to work out the % of oxygen in air.
Leave your answer to 1 decimal place.

[3]

(c)
(i) State the name of the process by which plants produce oxygen.

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[1]

(ii) The combustion of fossil fuels leads to the production of CO₂ and SO₂. Outline one environmental impact of each of those substances.

CO₂:

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SO₂:

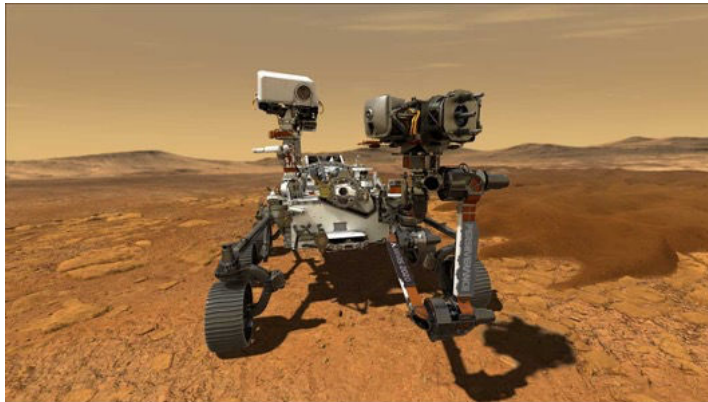
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[2]

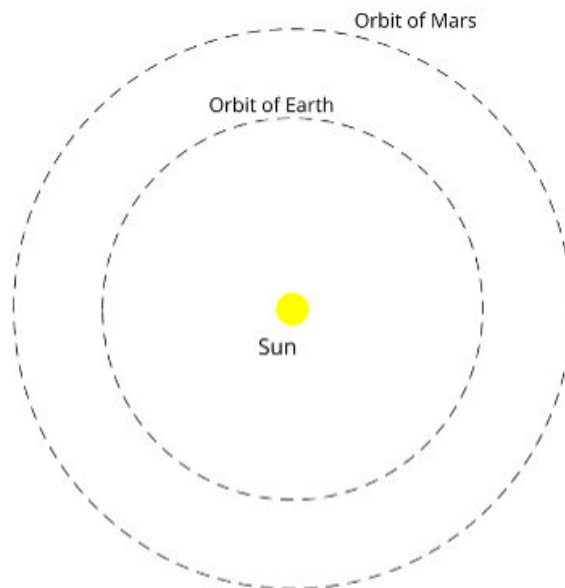
PHYSICS

Questions

Q1. In February 2021 the Perseverance rover landed on Mars, and it has been performing research there ever since.



One of the challenges with operating the rover is the distance between Earth and Mars. The orbits of the Earth and Mars are shown on the diagram below:



- (a) Label on the diagram a possible position of Earth and Mars such that they are the furthest possible distance apart from each other. (1 mark)
- (b) Earth has an orbital radius of 1.5×10^8 km, Mars has an orbital radius of 2.5×10^8 km. What is the maximum possible distance between the two planets? (1 mark)

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(c) Radio signals travels at a speed of 300,000,000 m/s. If a radio signal was sent from the Earth to the perseverance rover on Mars when the two planets were as far apart as possible, how long would it take? (4 marks)

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(d) The scientists have limited the top speed of the rover to just 4.2 cm/s. Explain why they have made it so slow referencing your answer to part c). (2 marks)

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When designing the perseverance rover NASA had to choose between two options for its power supply:

- Solar panels – create electricity from sunlight
- Nuclear power – a small radioactive substance that generates heat which is converted into electricity

In the end they chose the nuclear power option.

(e) What are the disadvantages of using solar panels for a rover on Mars? (2 marks)

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The nuclear power source uses 4.8kg of Plutonium Dioxide to power the rover. The designers at NASA could have increased this mass of radioactive substance.

- (f) Outline 1 advantage and 1 disadvantage to increasing the mass of the power source (2 marks)

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As well as the rover itself, NASA also developed a little helicopter called 'Ingenuity' which was deployed by the rover and used to test whether flight on Mars is possible.



Understanding how a helicopter works can be thought of in terms of Newton's Third Law: When an object exerts a force on another object, it receives an equally sized force in the opposite direction.

- (g) With the aid of a diagram, explain in terms of forces how the Ingenuity helicopter is able to hover in the atmosphere of Mars. (3 marks)

One of the challenges of operating on Mars is that the density of the atmosphere is 0.02kg/m^3 , whereas the density of the atmosphere on the Earth is 1.2kg/m^3 .

- (h) A typical classroom in Malvern college is approximately 400m^3 . What is the volume of Martian atmosphere that would have the same mass as the air inside 400m^3 of Earth atmosphere? (4 marks)

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- (i) Explain what challenges a small density atmosphere causes for the Ingenuity helicopter. (2 marks)

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- (j) Explain one way that the designers of the Ingenuity helicopter might have adapted it to work on Mars. (1 mark)

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