Question 1 (9 marks)

Athletes need to exercise daily and follow a strict dietary regime to perform at the highest levels. As a result of their exercise and dietary routines, athletes have increased muscle mass compared to people who do not exercise. An image of the body can be seen below:

Scroll down to continue

Question 1a (1 mark)

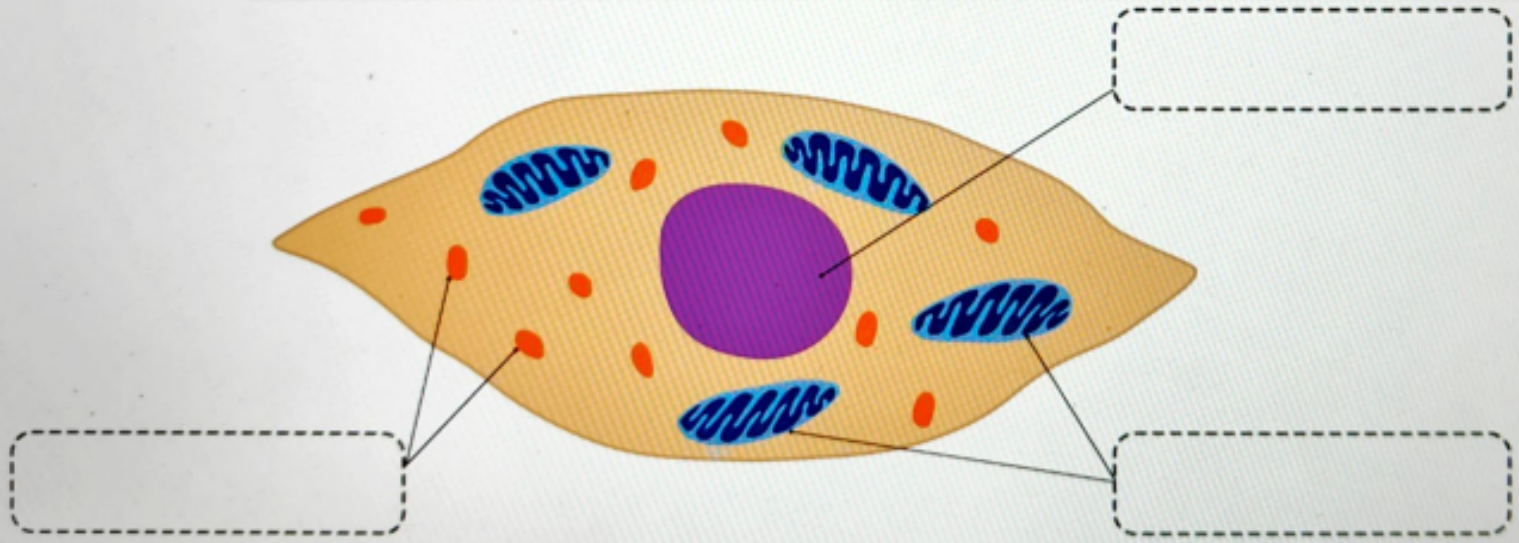
Select the correct term to describe the level of organization shown in the image:

- ○ Vacuole
- ○ Organelle
- ○ Molecule
- ○ Organ system

Question 1b (2 marks)

The diagram below shows a single muscle cell. **Label** the structures found in the muscle cell below:

Draggable items: Cell membrane | Mitochondria | Chloroplast | Ribosomes | Nucleus | Cytoplasm



Question 1c (4 marks)

The number of mitochondria differs from one cell type to another. The table below shows the mean number of mitochondria per cell in different types of cells.

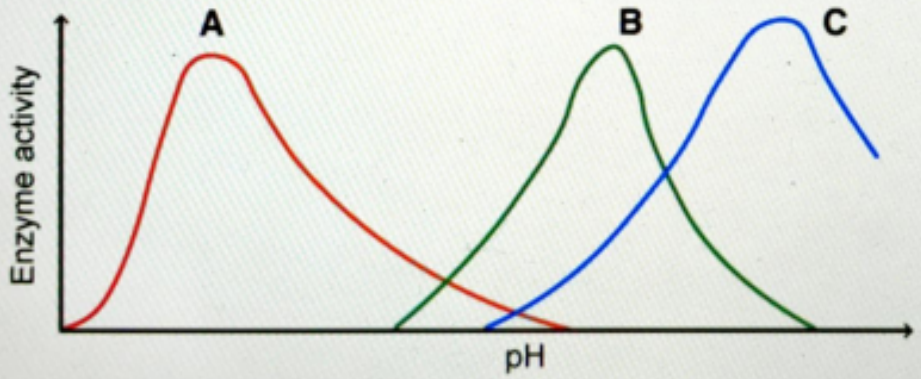
Cell type	Mean number of mitochondria
Fat cell	100
Skin cell	200
Muscle cell	1700

Suggest and **justify** a reason for the difference in the mean number of mitochondria found in muscle cells compared to fat and skin cells. You should use scientific terminology in your answer.

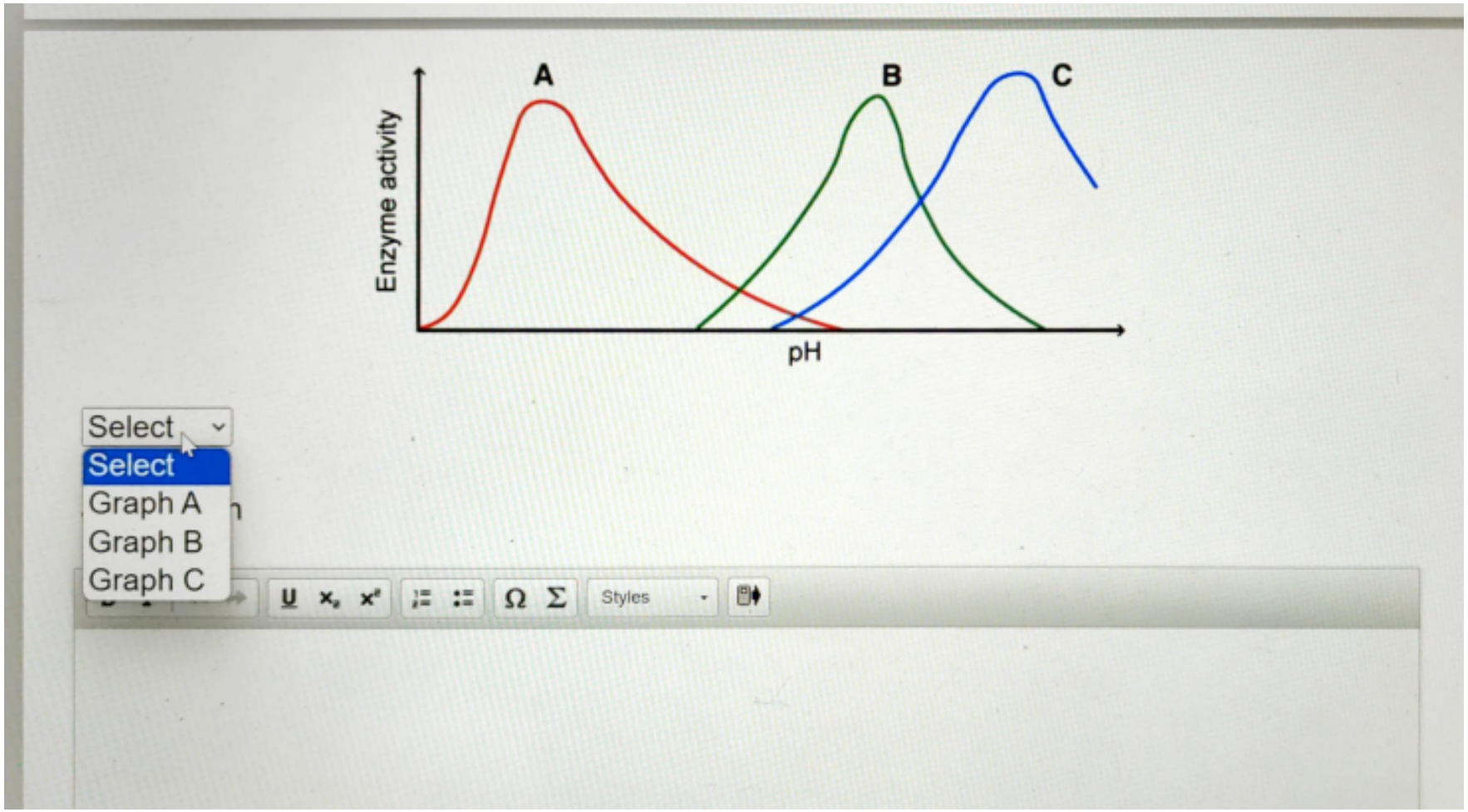
Reason

Question 1d (2 marks)

It is recommended that athletes consume large amounts of protein to maintain their muscle mass. Digestion of protein starts in the stomach. The graph below shows the activity of different digestive enzymes at different pH levels. **Select** the graph that represents the enzyme responsible for the initial digestion of protein. **Justify** your answer.



Select


A
B
C
Enzyme activity
pH
Select
Select
Graph A
Graph B
Graph C
Styles

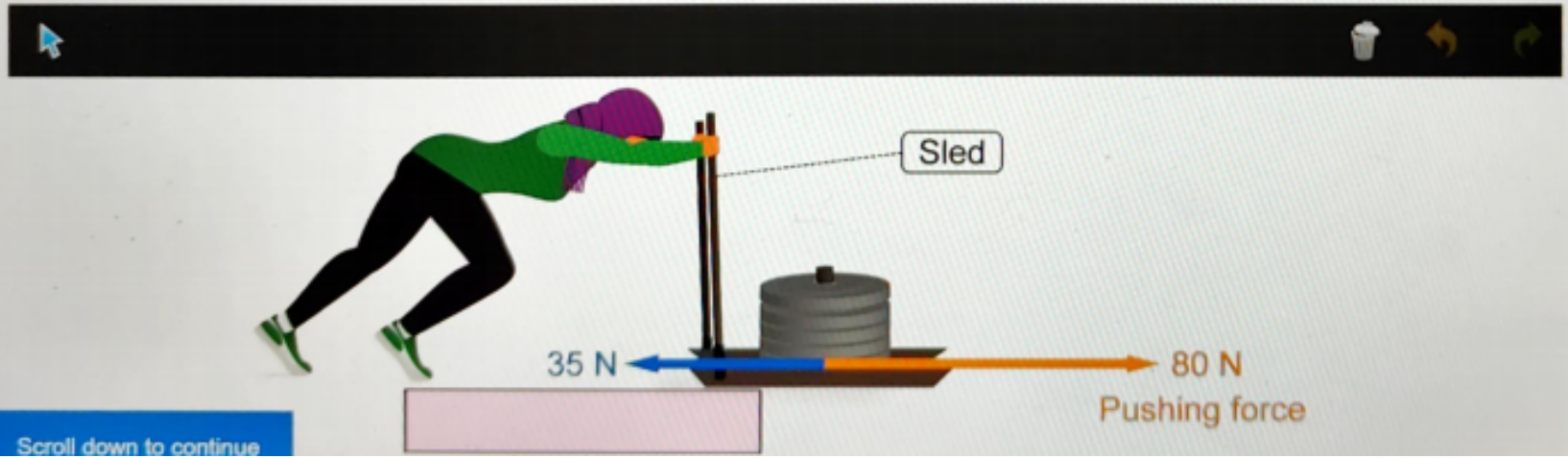
Question 2 (11 marks)

Athletes do many different types of resistance exercises in the gym.

Question 2a (1 mark)

The sled push is one type of resistance exercise that can improve strength. The diagram below shows an athlete doing a sled push.

Label the missing horizontal force acting upon the sled.



Scroll down to continue

Question 2a (1 mark)

The sled push is one type of resistance exercise that can improve strength. The diagram below shows an athlete doing a sled push.

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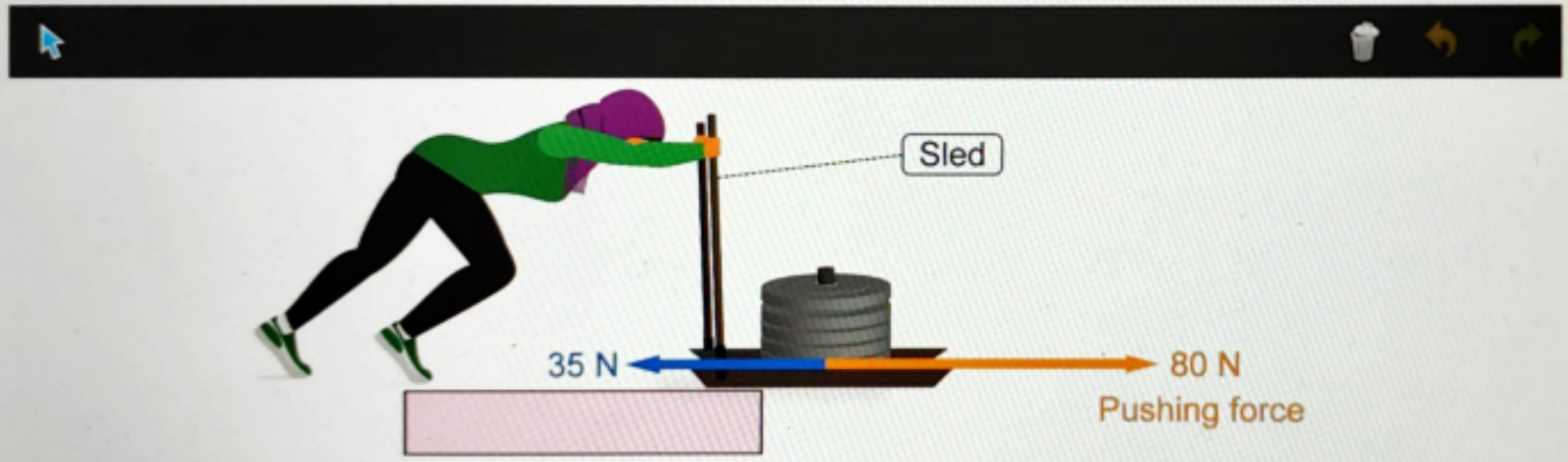


Question 2b (2 marks)

Calculate the resultant (net) force acting on the sled and **state** the direction of this force.

Question 2c (1 mark)

Select the option that describes the motion of the sled after the athlete starts pushing from rest.

- ○ Moves to the right at constant speed
- ○ Moves to the right with increasing speed
- ○ Moves to the right with decreasing speed
- ○ Remains at rest
- ○ Moves to the left at constant speed
- ○ Moves to the left with increasing speed
- ○ Moves to the left with decreasing speed

Question 2d (1 mark)

Another way athletes train is by weightlifting. The diagram below shows the athlete lifting a barbell to a height of 1.8m.

Total mass of barbell = 50 kg

Select the type of energy stored in the barbell when it is held above the athlete's head.

Select

Question 2d (1 mark)

Another way athletes train is by weightlifting. The diagram below shows the athlete lifting a barbell to a height of 1.8m.

Total mass of barbell = 50 kg

Select
Chemical
Elastic potential
Gravitational potential
Kinetic

Select

y stored in the barbell when it is held above the athlete's head.

Question 2e (3 marks)

Calculate the work done by the athlete to lift the barbell from the ground above her head once.
You should assume that gravitational field strength is 10 Nkg^{-1}.

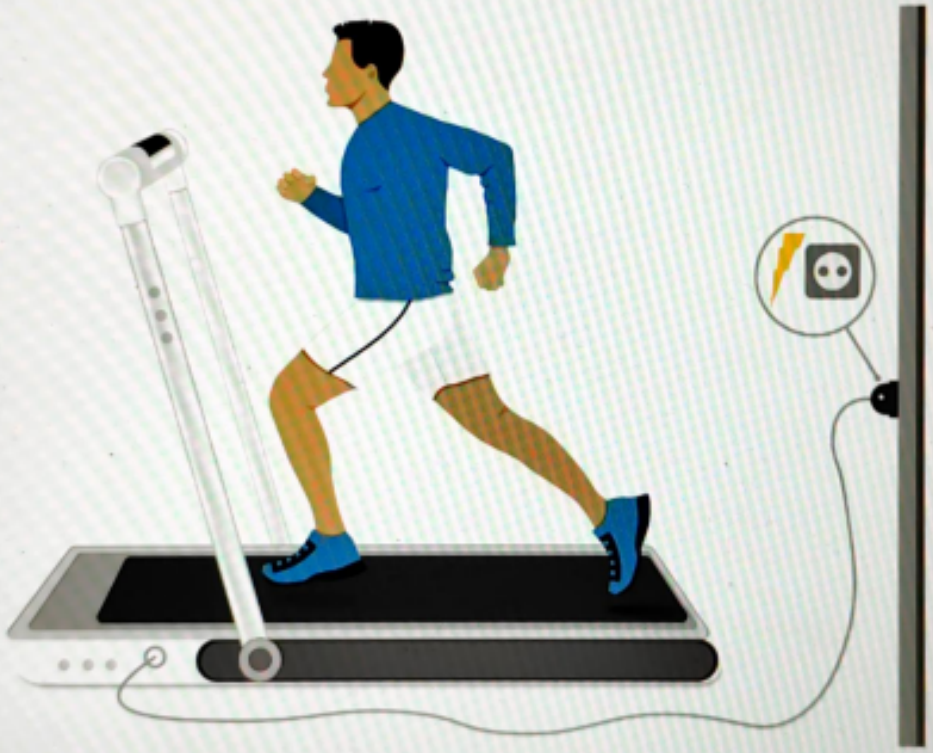
Question 2f (3 marks)

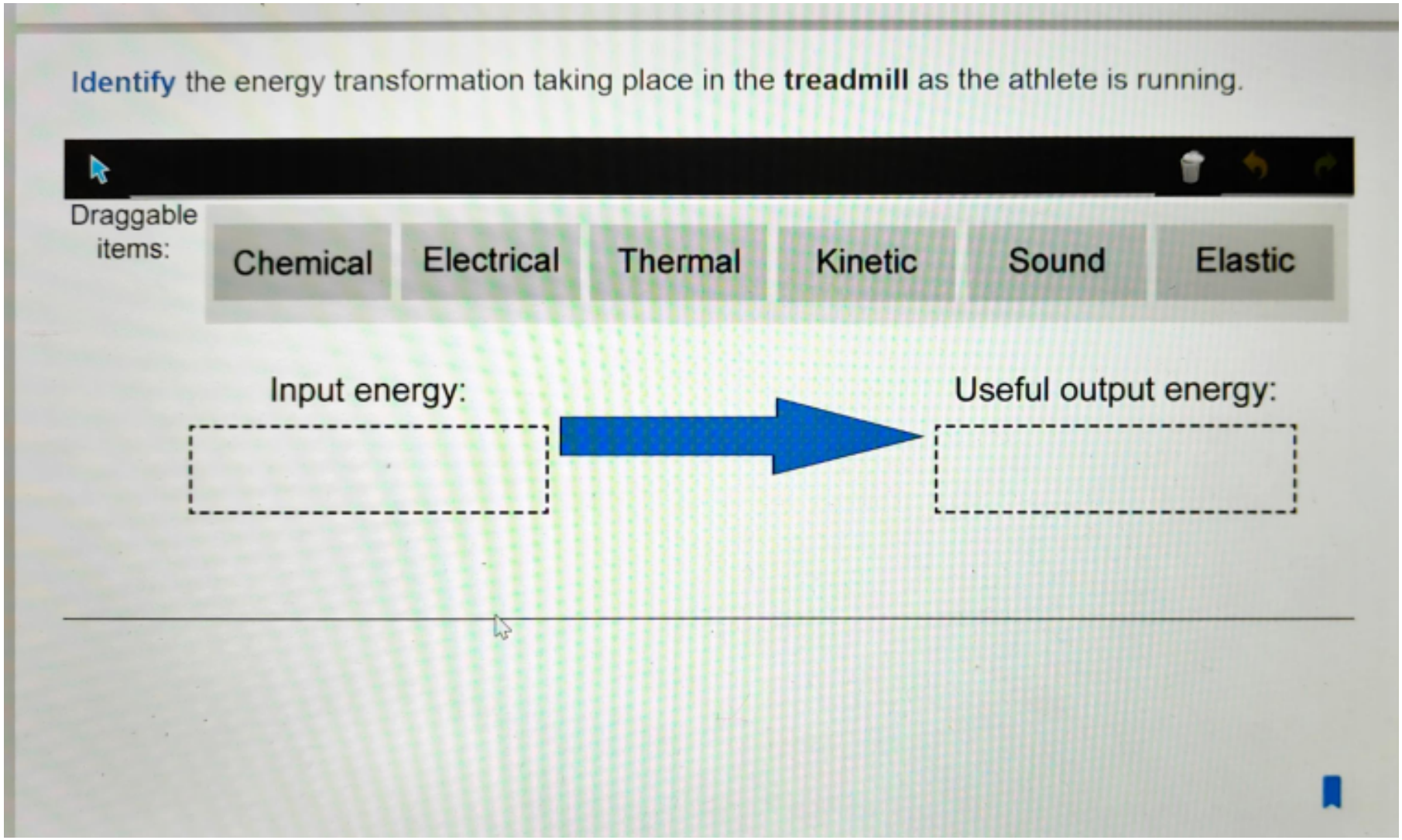
Finally, the athlete uses a resistance band to exercise. A resistance band is a large, elastic band made of rubber. The image below demonstrates this exercise.

Explain how the exercise shown demonstrates Newton's third law of motion.

Question 3 (8 marks)

Cardio-based exercise is important for athletes to maintain cardiovascular health. One effective cardio exercise is running on a treadmill.



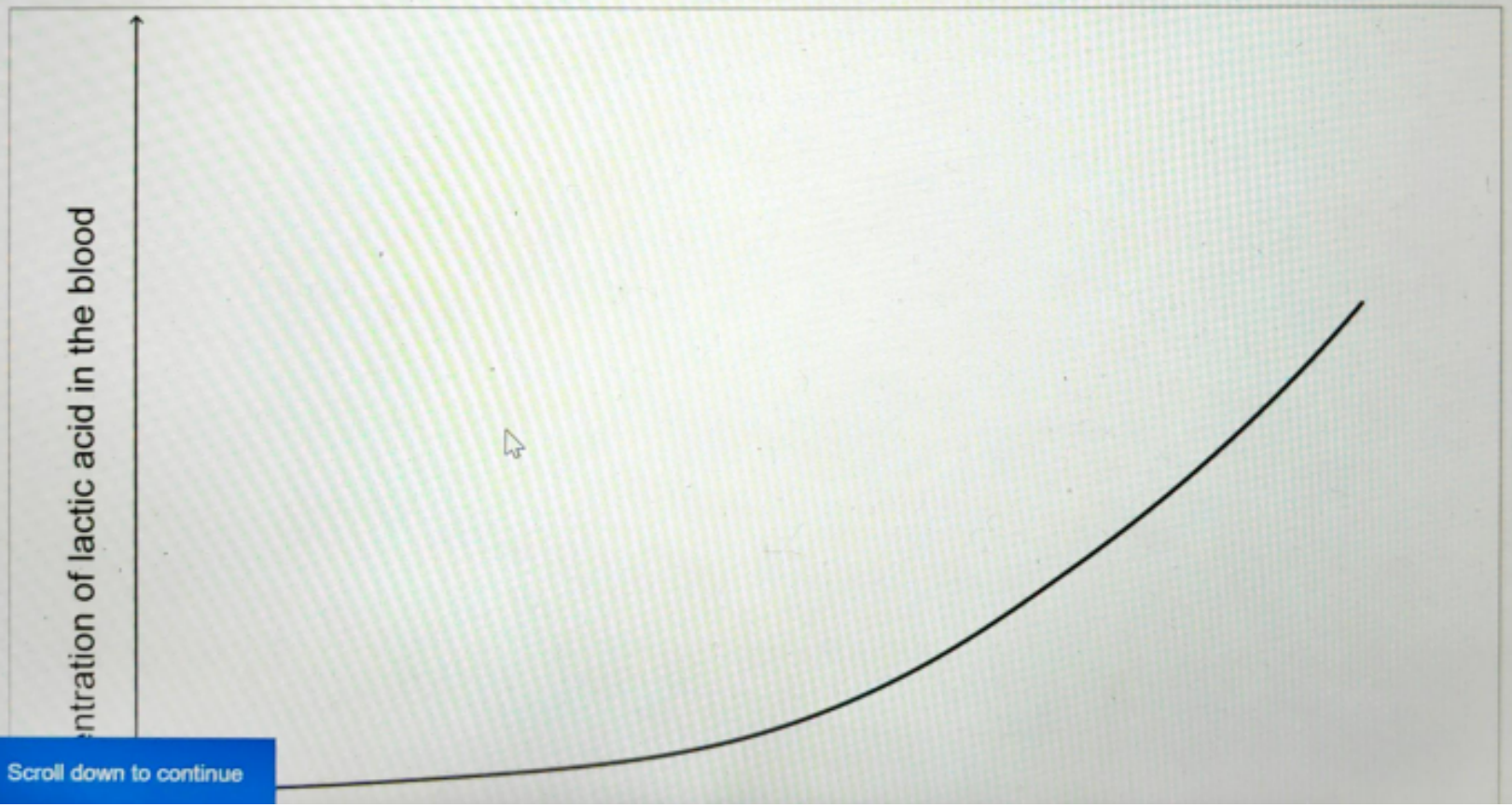

Identify the energy transformation taking place in the **treadmill** as the athlete is running.
Draggable items:
Chemical
Electrical
Thermal
Kinetic
Sound
Elastic
Input energy:
Useful output energy:

Question 3b (3 marks)

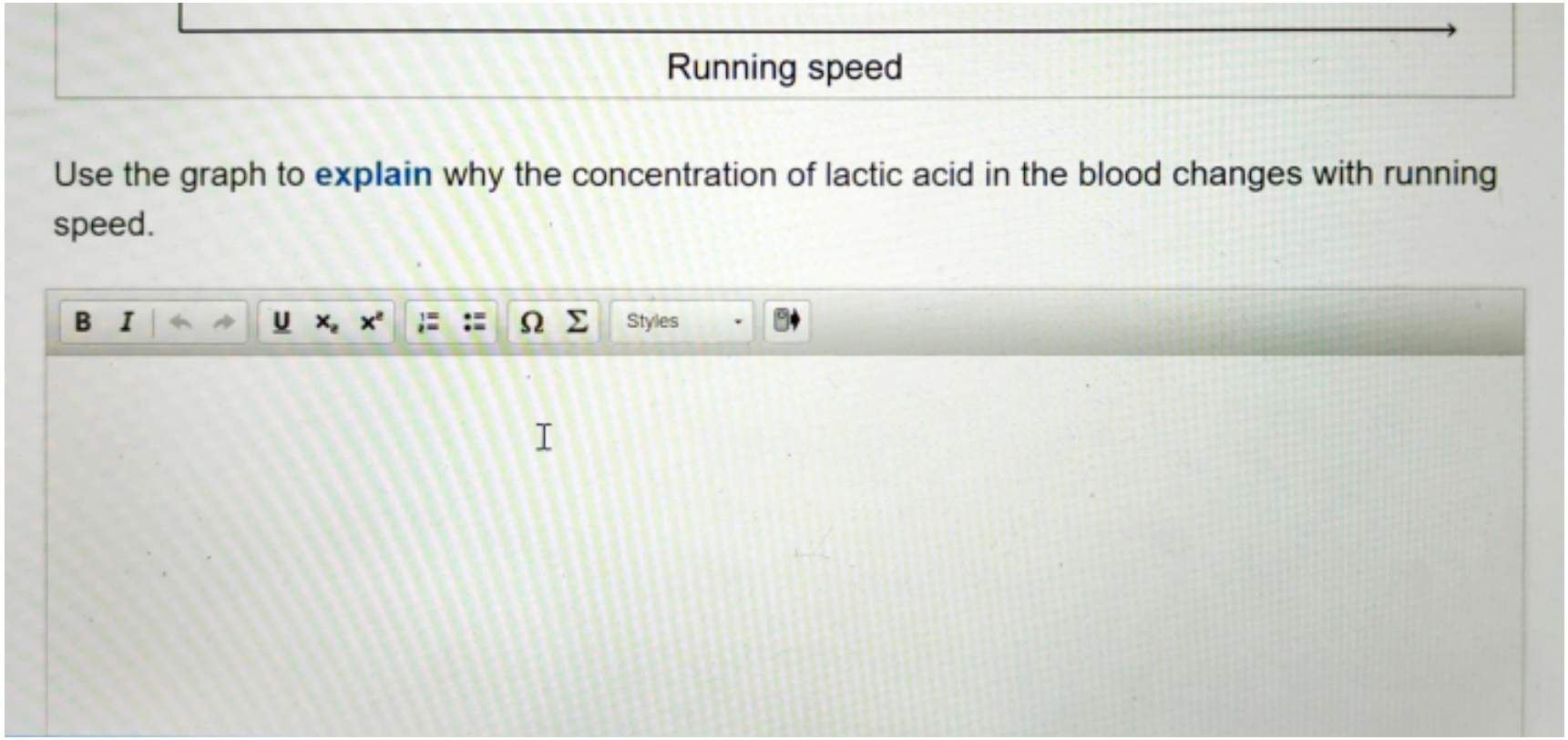
The current generated by the treadmill motor is 2.8A and the treadmill runs on 120V. **Calculate** the resistance generated by the motor. Give your answer to two significant figures.

Question 3c (3 marks)

The athlete runs on the treadmill at different speeds. The graph below shows the concentration of lactic acid in the blood as the running speed increases.



Scroll down to continue

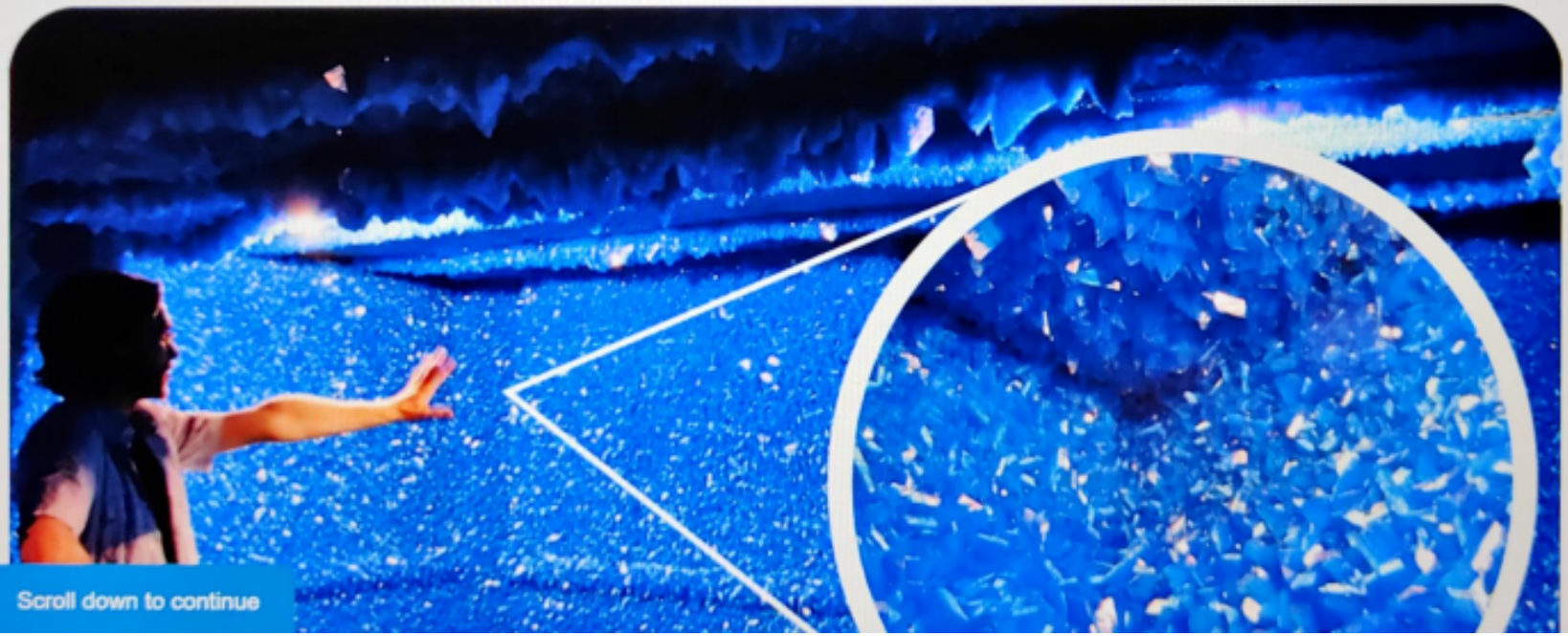


Use the graph to **explain** why the concentration of lactic acid in the blood changes with running speed.

Question 4 (6 marks)

Artists use many different ways to express their creativity. Artists sometimes use their understanding of science to express their ideas and feelings. Crystallization is a method of isolating and purifying compounds. However, recently, crystallization found its way into modern art.

The image below shows a work of art created by the artist Roger Hiorns. He grew copper sulfate crystals on the ceilings and walls of a small apartment.



Scroll down to continue

©

Crystals can form in different ways to produce complex structures.

Crystals can form in different ways to produce complex structures.

Question 4a (3 marks)

A student wants to investigate how to make crystals using table salt: sodium chloride (NaCl). In order to form NaCl crystals, the student must first make a saturated solution; to do this they dissolve a sample of NaCl in a beaker of hot water. The student keeps adding NaCl until no more can dissolve.

The student leaves the solution in the room for a few days and comes back to find crystals have formed at the bottom of the beaker. **Describe** why crystals have formed.

Question 4b (3 marks)

The student wants to investigate the size of the crystals formed by dissolving different compounds instead of NaCl. **Identify** the variables for this investigation. The dependent variable is given to you.

Independent variable	Dependent variable
	Size of crystals formed

Question 5 (20 marks)

Question 5a (4 marks)

Another student carries out a different investigation using sugar. This student wants to investigate the effect of changing the initial temperature of the water on the mass of sugar crystals formed.

Formulate a testable hypothesis for this student's investigation.

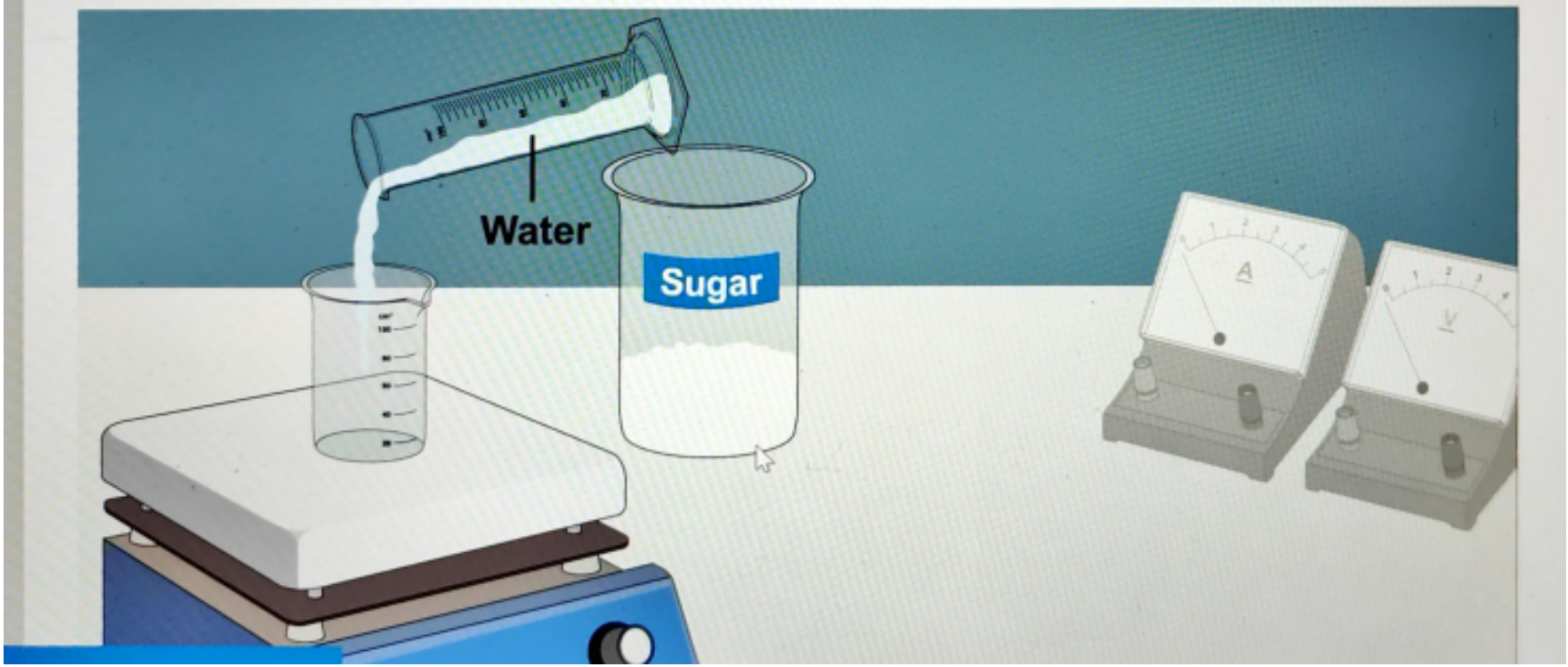
If

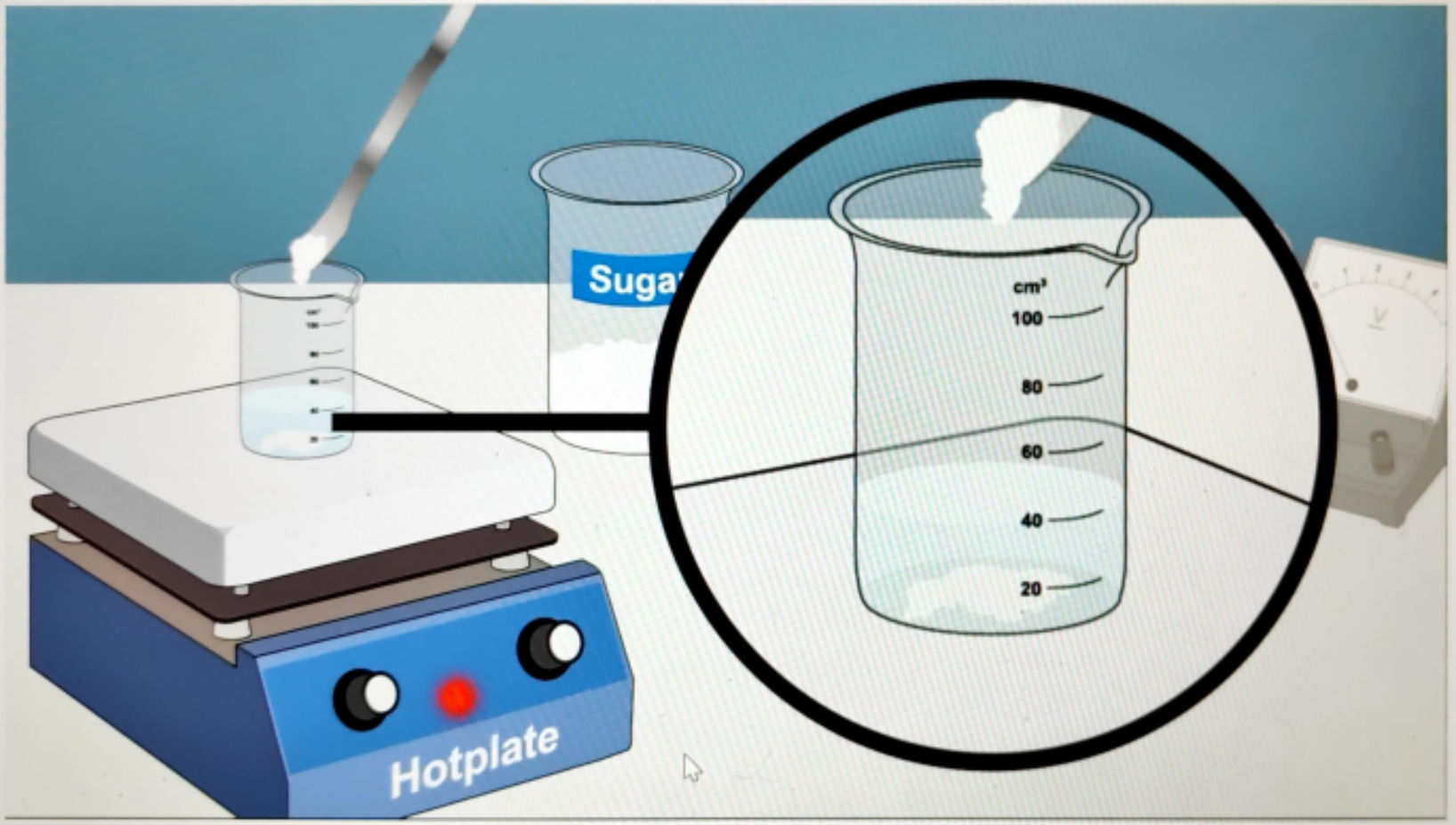
Then

Question 5b (16 marks)

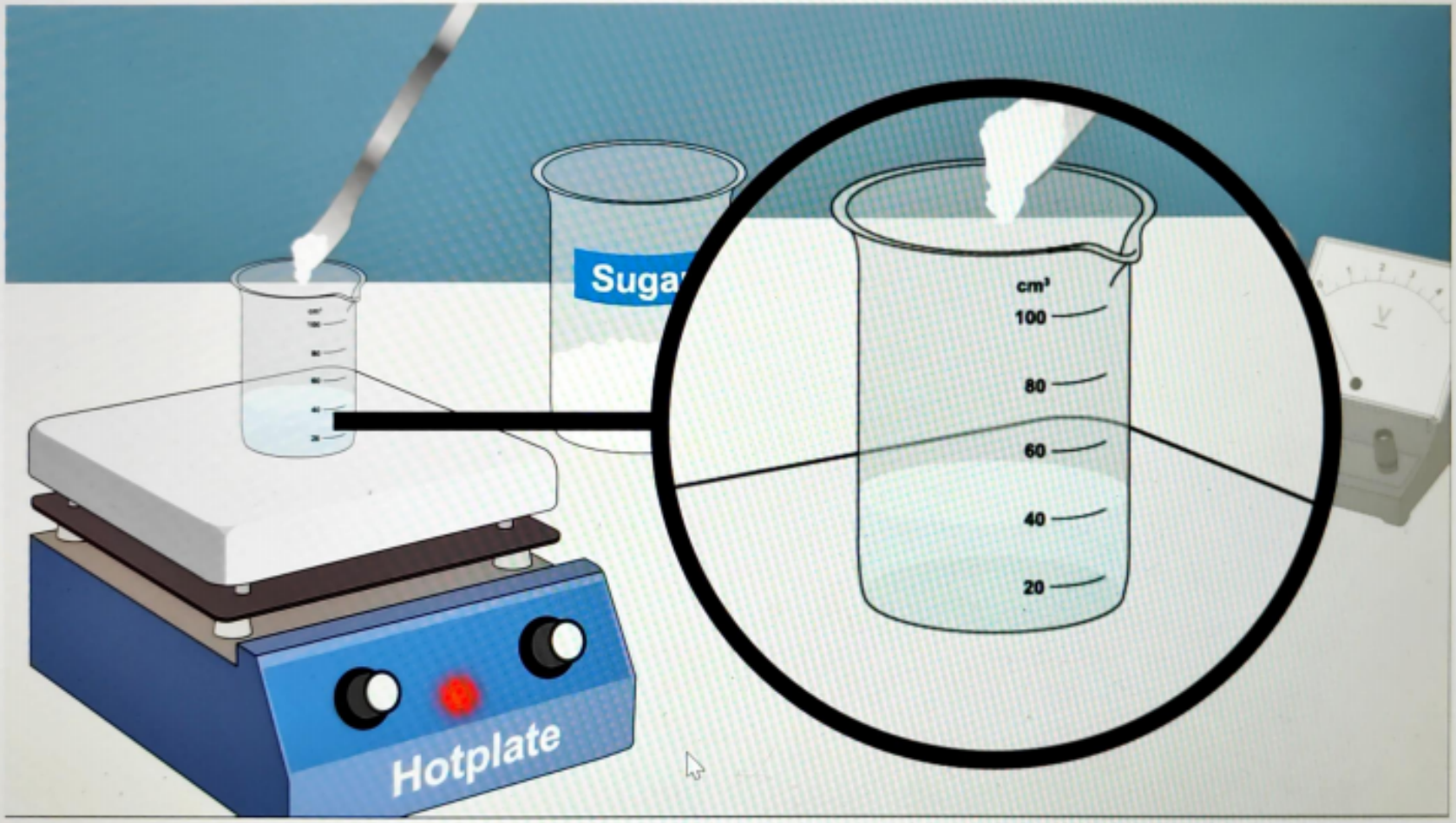
The animation below shows a method that can be used to investigate the effect of changing the initial temperature of the water on the mass of sugar crystals formed.

This media contains no audio





Design a method to test your hypothesis from part (a). In your answer you should include:

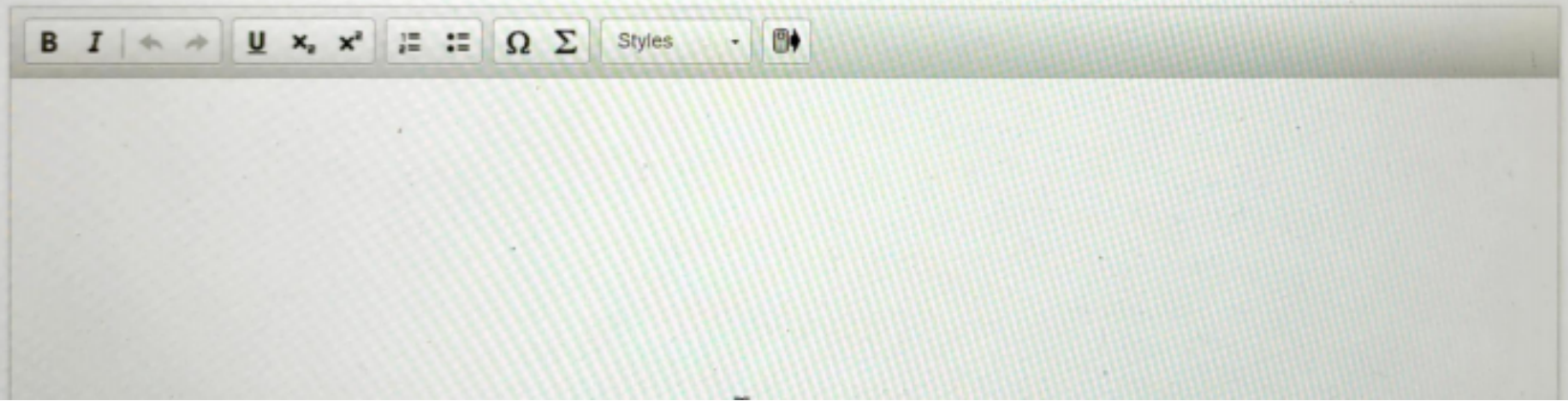


Design a method to test your hypothesis from part (a). In your answer you should include:

- the independent, dependent and control variables

Design a method to test your hypothesis from part (a). In your answer you should include:

- the independent, dependent and control variables
- a list of any equipment needed
- how the variables should be manipulated to collect sufficient data
- a description of the method you will use to make measurements
- any safety precautions that should be taken.



Question 6 (23 marks)

Another way people express their ideas and creativity is by building ornate buildings such as those found in cities all around the world. Different types of air pollution can damage these buildings. One type of pollution is particulate pollution caused by small particles found in black exhaust smoke.

The image below shows particulate pollution on a building in Paris, France. The left-hand side shows a section that has been cleaned.

©

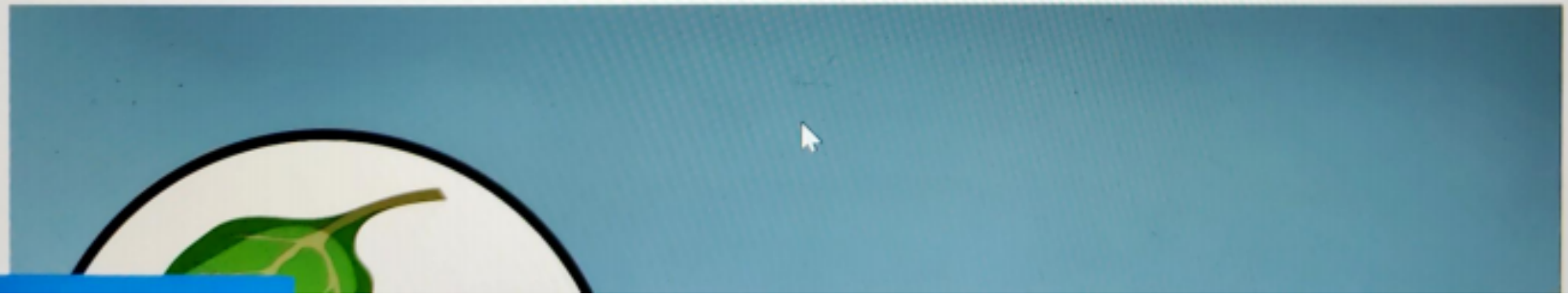
Question 6a (1 mark)

A student wants to investigate particulate pollution in different parts of their city. They design a simple experiment to measure particulate pollution in different locations.

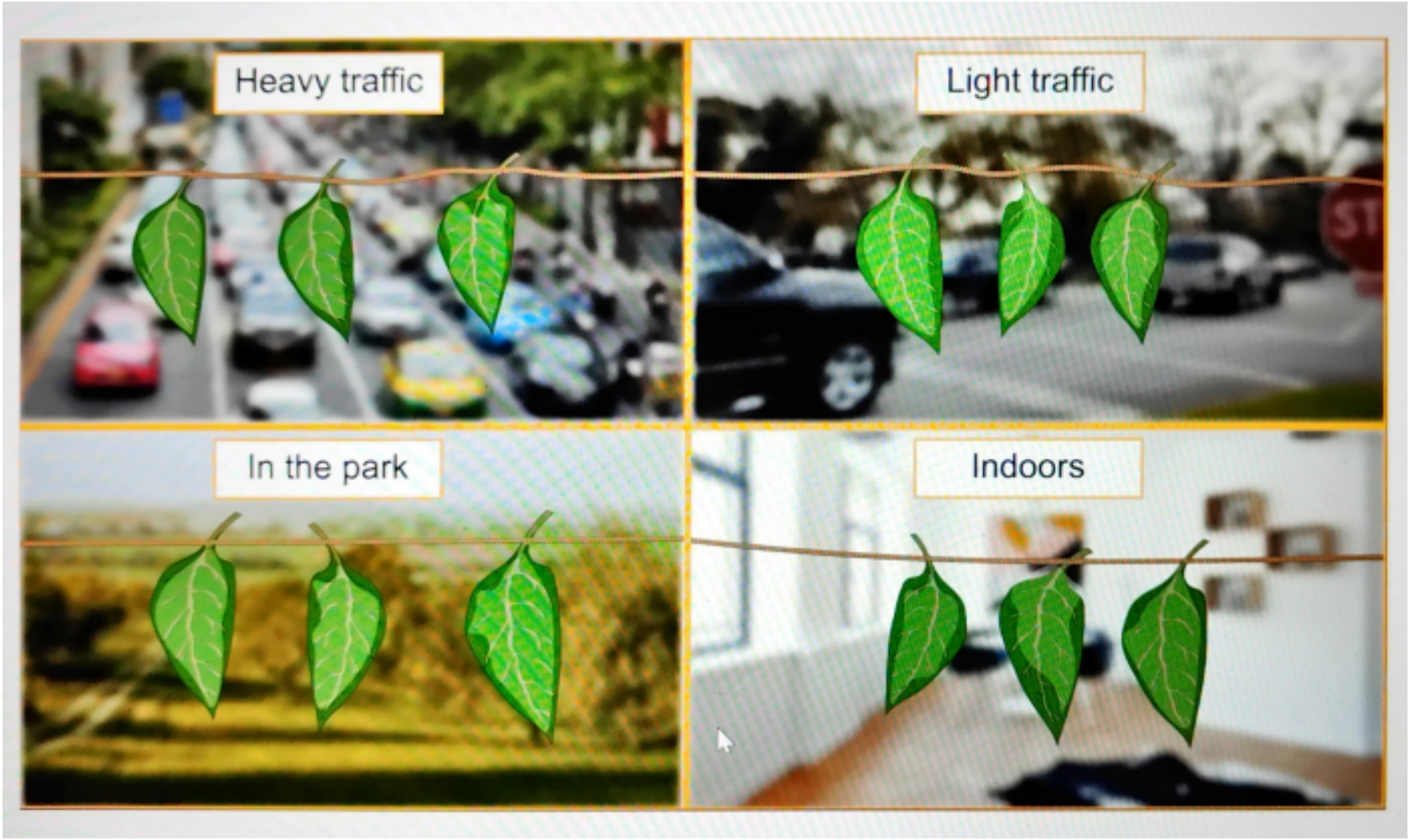
The student collects 12 plant leaves of similar sizes and organizes them into groups of 3. They hang one group of 3 leaves in each of the different locations below:

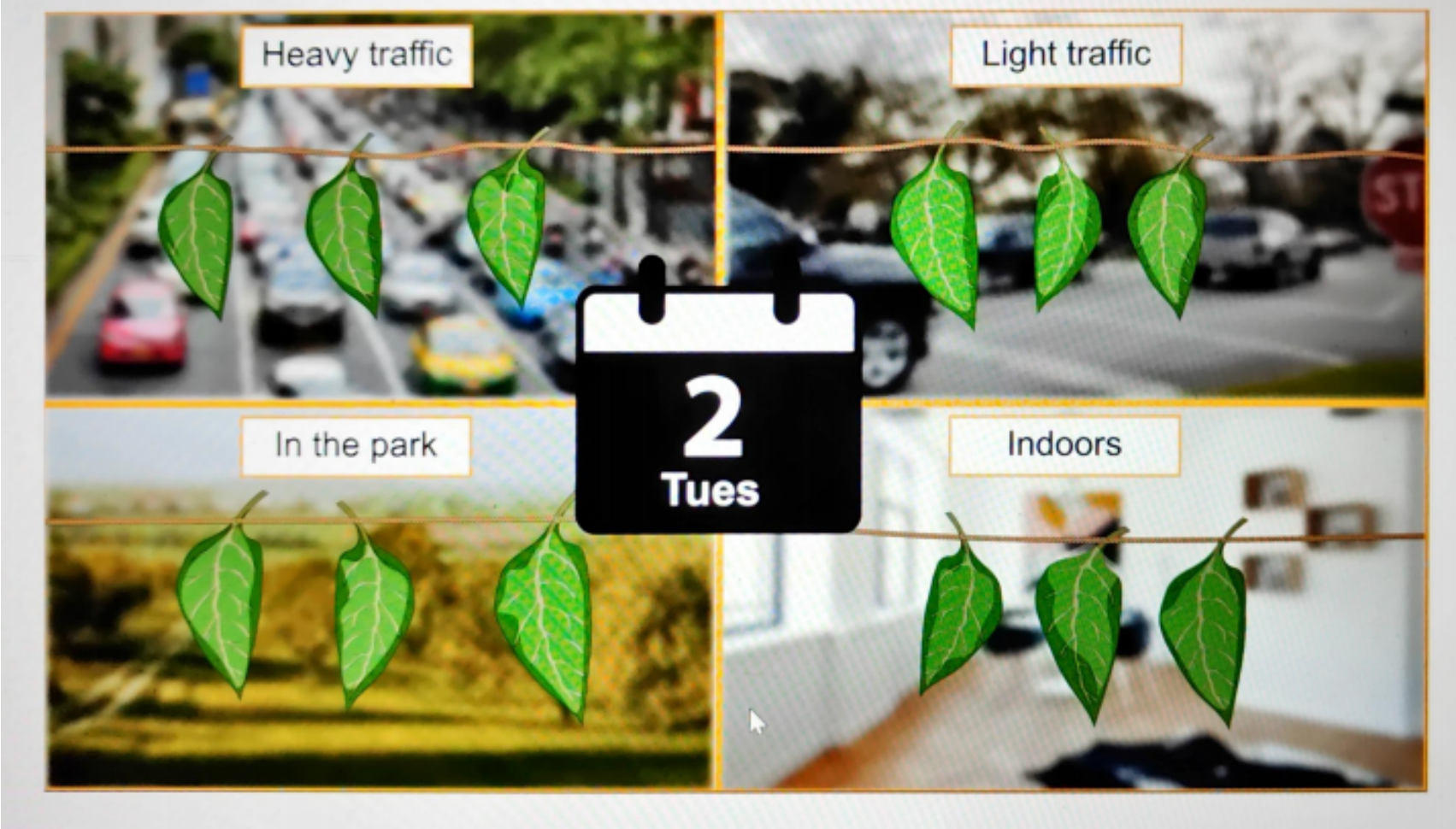
- heavy traffic
- light traffic
- in the park
- indoors.

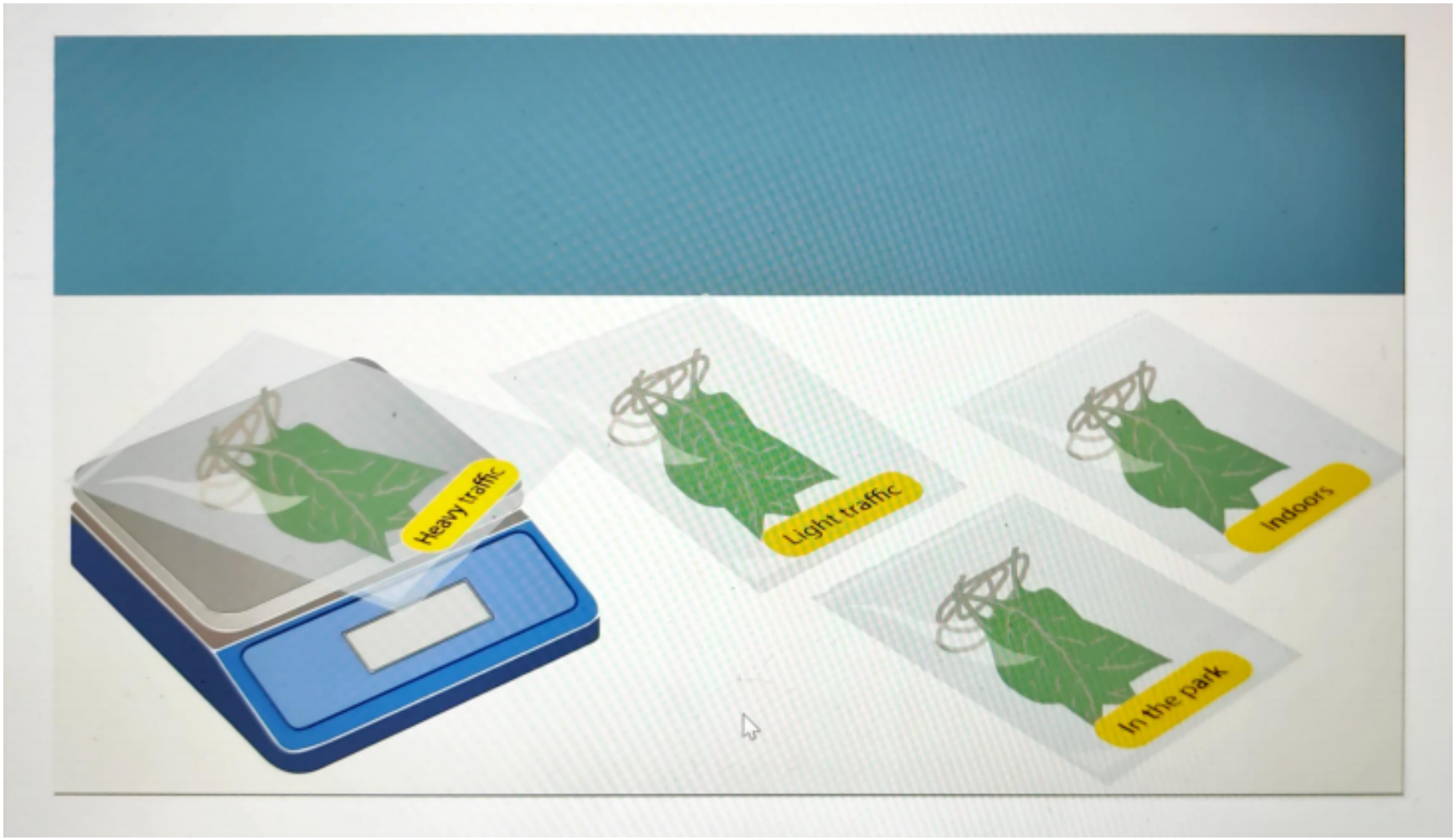
This media contains no audio

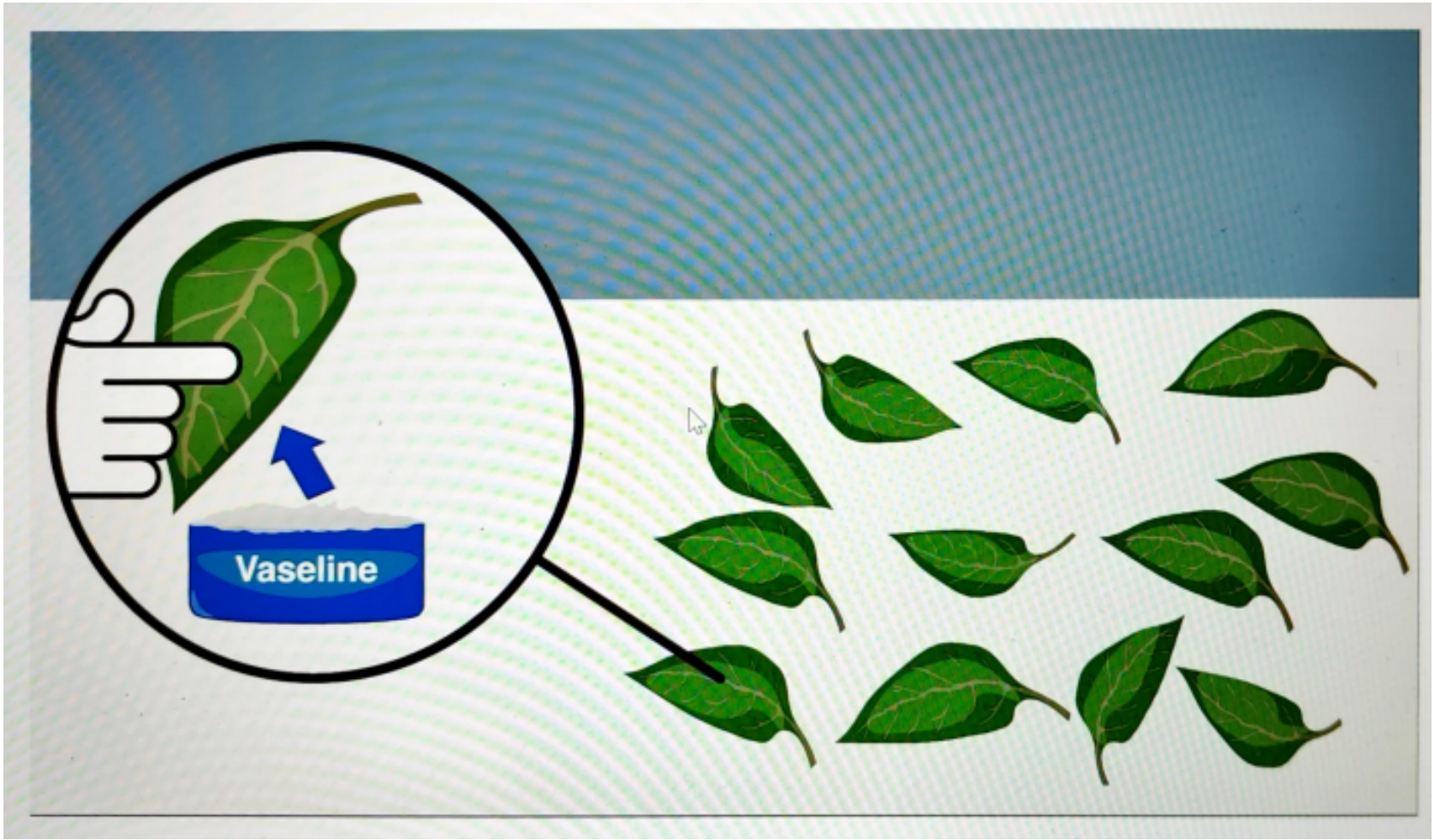


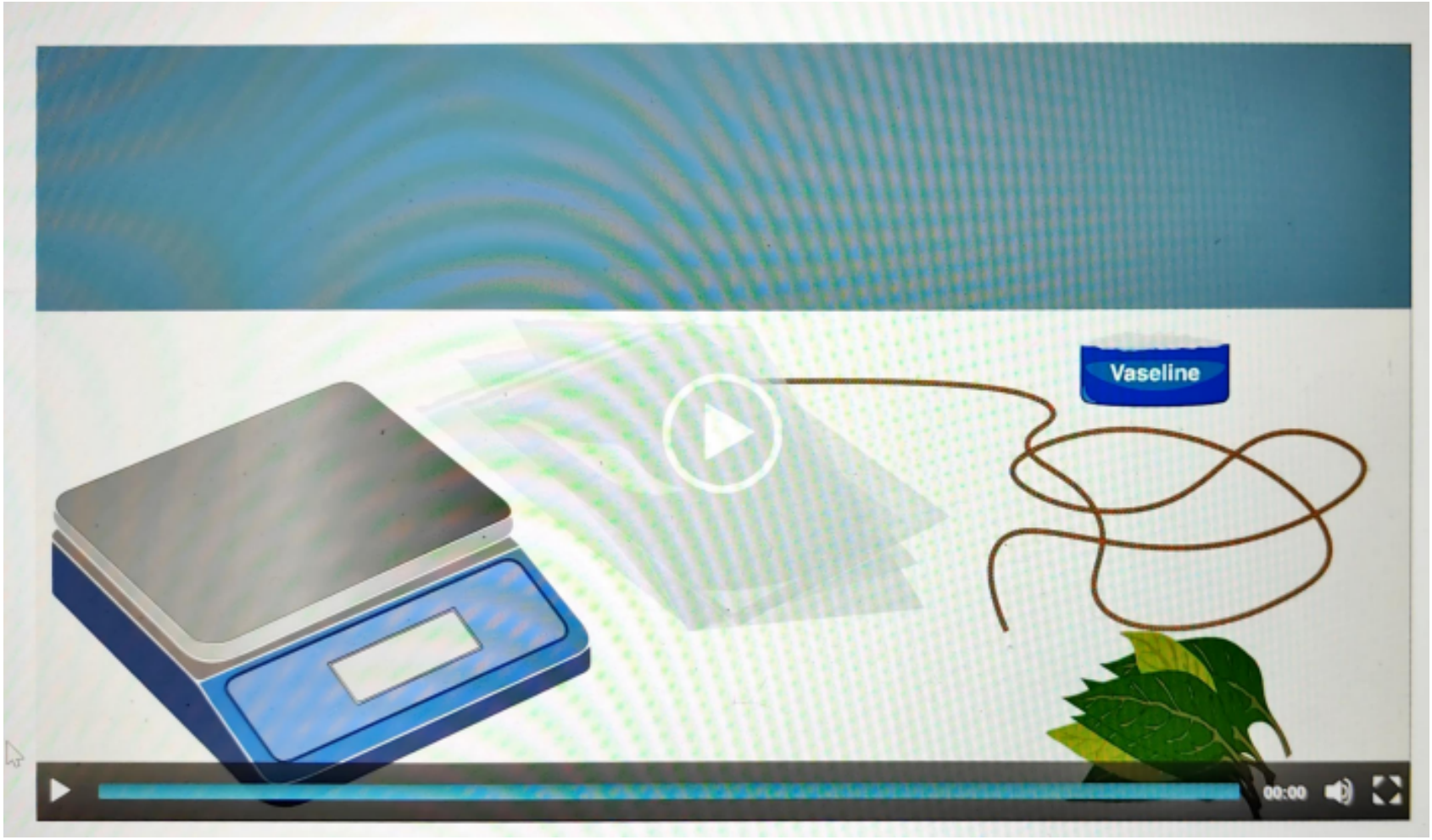

Heavy traffic
Light traffic
Indoors
In the park


Heavy traffic
Light traffic
In the park
Indoors


Heavy traffic
Light traffic
2
Tues
In the park
Indoors


Heavy traffic
Light traffic
Indoors
In the park


Vaseline


Vaseline
00:00

After four days the student collects the leaves and takes them back to the lab. The student then organizes the data in the table shown below:

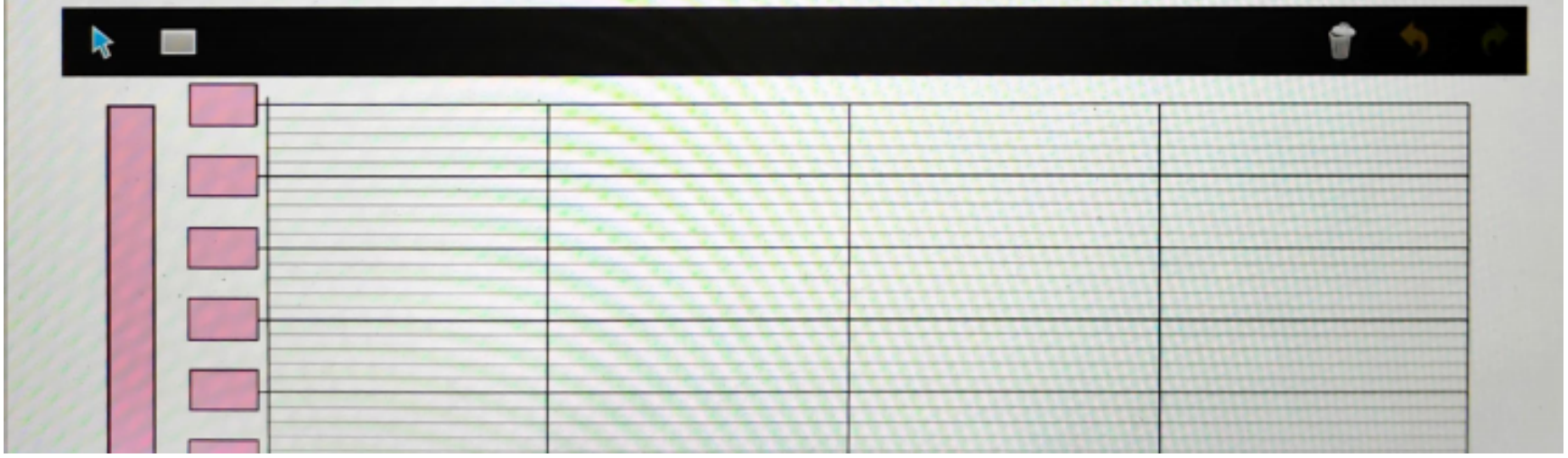
Determine the change in mass for each location and complete the last column of the table.

Location	Total initial mass of 3 leaves / g	Total final mass of 3 leaves / g	Change in mass / g
Heavy traffic	15.0	15.9	
Light traffic	15.7	16.2	
In the park	16.0	16.3	
Indoors	15.1	15.2	

Question 6b (6 marks)

Present the transformed data you calculated in part (a) in a bar chart. You should give your bar chart an appropriate title, add the scale and label the axes.

Title:

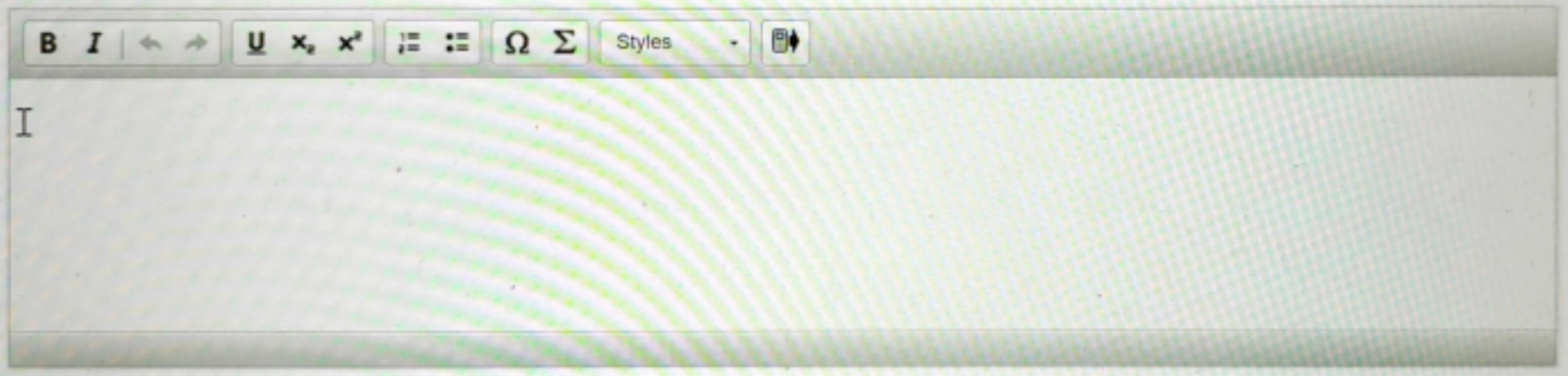


Question 6c (2 marks)

Outline why the mass changed.

Question 6d (2 marks)

Calculate the average change in mass of one leaf that was placed in heavy traffic. You should give your answer in milligrams.

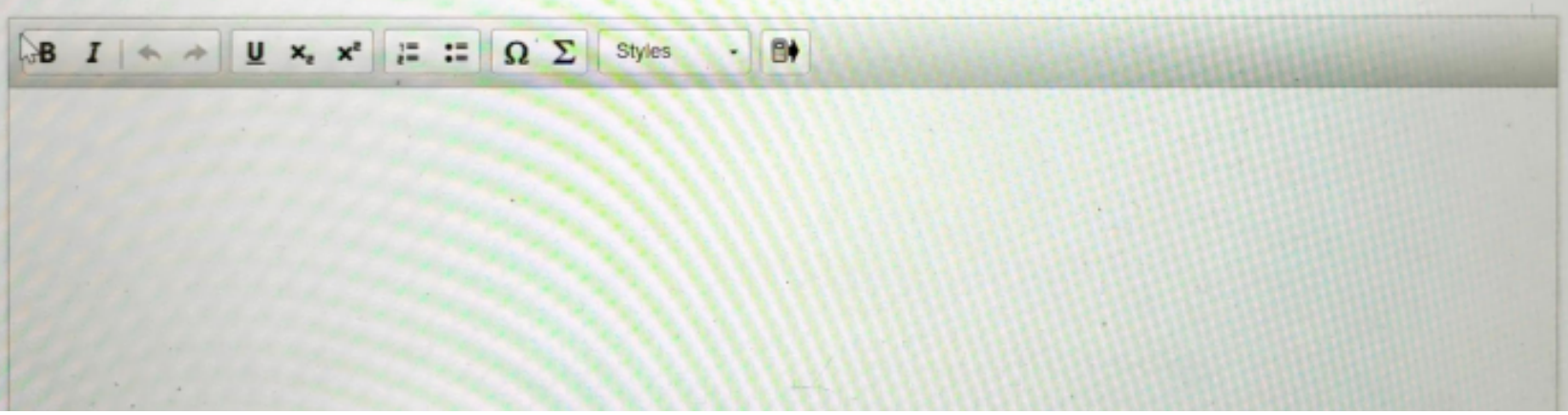


Question 6e (4 marks)

Before the experiment the student made the following hypothesis:

> If the traffic in a location is heavy, then particulate pollution will be five times greater than in locations with lighter traffic because vehicles cause this type of pollution.

Use the data in part (a) to **evaluate** the validity of this hypothesis.



Question 6f (4 marks)

State two weaknesses in this investigation and **suggest** an improvement for each.

Weakness 1 and improvement

Weakness 2 and improvement

Question 6g (1 mark)

Suggest one way in which the student could extend their investigation.

Question 6h (3 marks)

A second student repeated the same experiment but used 2cm x 5cm pieces of plastic rather than leaves. **Outline** the validity of the method using plastic compared to the method using leaves.

Question 7 (7 marks)

Human beings perform multiple activities every day. To carry out these activities, a large amount of energy is required. This energy comes from the food we consume. Food is vital as it provides all the essential nutrients the body needs to function and prevent disease.

Question 7a (1 mark)

Essential nutrients from food can be classified into two categories: macronutrients and micronutrients. Macronutrients are needed in large quantities and micronutrients are needed in very small quantities.

Classify the macronutrients and micronutrients below by dragging them to the correct location.

Draggable items: Vitamins | Carbohydrates | Proteins | Minerals | Fats

Question 7a (1 mark)

Essential nutrients from food can be classified into two categories: macronutrients and micronutrients. Macronutrients are needed in large quantities and micronutrients are needed in very small quantities.

Classify the macronutrients and micronutrients below by dragging them to the correct location.

Draggable items: Vitamins | Carbohydrates | Proteins | Minerals | Fats

Macronutrients	Micronutrients

Question 7b (2 marks)

The table below gives some nutritional data for 100g of two commonly grown grains.

	Corn	Rice
Energy content of food / kJ	1514	1506
Carbohydrates / g	74.5	78.9
Protein / g	9.0	6.8
Fat / g	3.4	0.7
Fibre / g	1.0	0.2
Phosphorus / mg	178	140
Calcium / mg	6.0	6.0
Iron / mg	1.8	0.8
Vitamin C / mg	6.1	0.0

©

Use information from the table to **identify** one nutritional benefit of corn compared to rice.
Justify how this nutritional benefit would improve health.

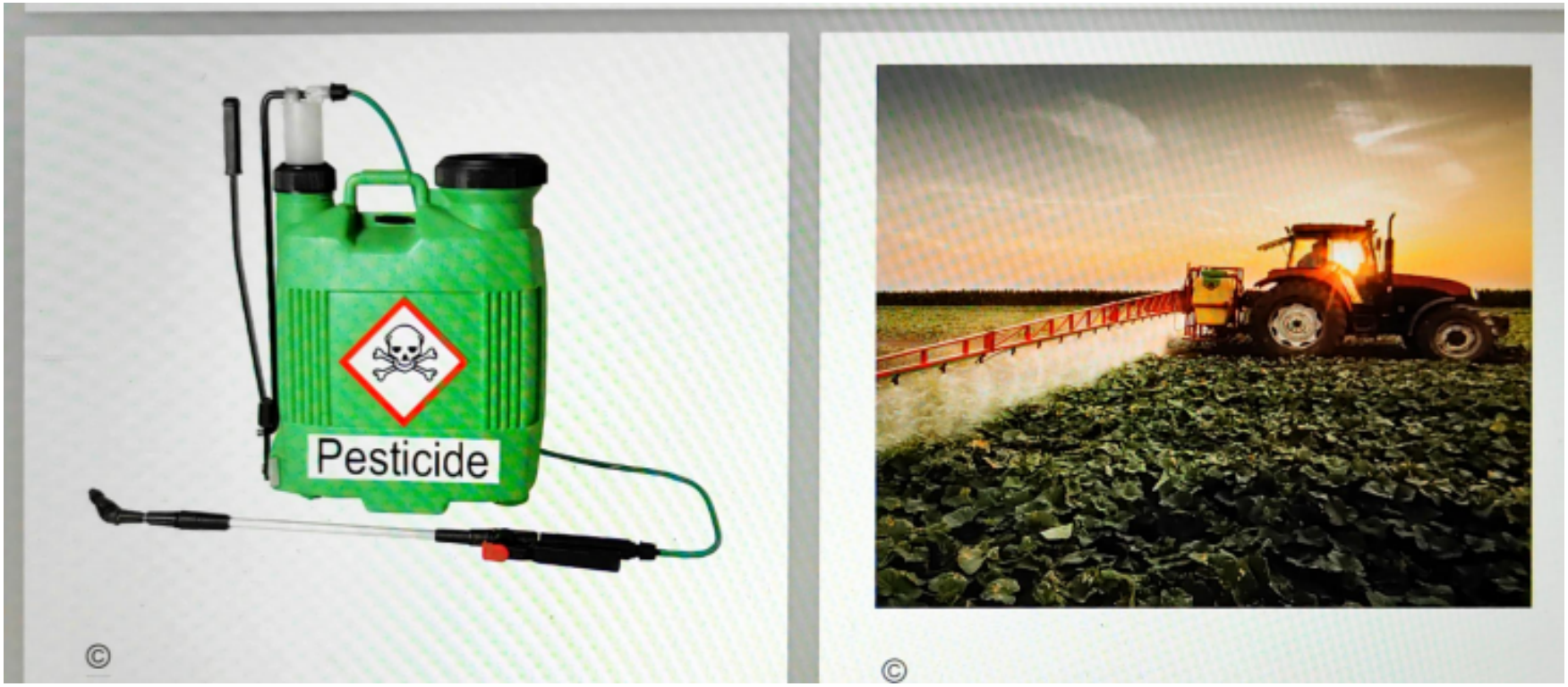
Benefit

Question 7c (2 marks)

Increased production of food crops is needed to address hunger and malnutrition all over the world. Farming may need to increase by an estimated 70 percent to fulfil food requirements of the growing population.

Food crops are at risk of damage from harmful insects called pests. A pesticide is a chemical substance used to kill or repel these insects. Pesticides are used to reduce the amount of damage to crops and increase food production. The images below show a bottle of pesticide and pesticide being applied.

Scroll down to continue


Pesticide
©
©

State the meaning of the hazard symbol on the bottle and one precaution needed when using pesticides.

Hazard	Precaution

Question 7d (2 marks)

Suggest how pesticides could affect the living and non-living parts of the environment.

Living

Non-living

Question 8 (16 marks)

As the world's population increases, the demand for food increases. According to the United Nations, an estimated 821 million people suffered from hunger in 2018 and the problem is only going to get worse.

The video below shows one possible solution to the increased demand for food in the future.

Video Transcript

Technological advances in farming have contributed to a large increase in food crop production since 1970.

For example, corn is one of the most popular food crops around the world. Corn is also called maize in some countries. It can be eaten as it is or ground into cornmeal or corn flour to make tortillas. Corn can also be eaten as popcorn or processed into chips, oil and syrup. Globally, humans get 19.5 % of their calorie intake from corn.

The US is the major producer of corn around the world. According to the Center for Food Safety, 82 % of the corn produced in 2020 had been genetically modified. The remaining 18 % of corn was conventional corn that had not been genetically modified.

Genetic modification is when an organism's genetic material is modified in a way that does not occur naturally. This is done through the introduction of a gene from a different organism.

A variety of corn has been genetically modified by adding a single gene (Bt) from bacteria called: *Bacillus thuringiensis*. The Bt gene, which produces a pesticide, can be inserted into the corn's

A variety of corn has been genetically modified by adding a single gene (Bt) from bacteria called: *Bacillus thuringiensis*. The Bt gene, which produces a pesticide, can be inserted into the corn's DNA.

Bt corn now produces the same pesticide which prevents pests from destroying the corn crop.

However, if only Bt corn is planted all year round, resistant pests will survive and continue to multiply.

Only a few companies have invested in the research to develop Bt corn, which makes the seeds expensive. Many people around the world are against genetic modification and are in favour of conventional corn production as conclusive studies on genetically modified crops have not yet been done.

However, the question remains: will genetically modified food be the solution to the food supply problems of the future?

The government has decided to invest a large budget in farming for the production of corn. As an MYP 5 student you have collected evidence about Bt corn. **Discuss** and **evaluate** whether the government should invest in Bt corn or conventional corn. In your answer, you should include:

- why genetic modification (GM) technology may be considered for future food supply
- the advantages to the environment of producing Bt corn
- the disadvantages to the environment of producing Bt corn
- the economic considerations when producing Bt corn
- a justification of whether you support the use of Bt corn or conventional corn.