



**OUNDLE**

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School

2018 Academic Scholarship

**Science**

Theory Paper

Time Allowed: **1 hour**

Name: .....

**Biology Section**

- 1. Brine shrimp (sea monkeys) are crustaceans that are easily kept in an aquarium. They live in water and eat algae (microscopic single-celled plants).



*A male (right) and female (left) brine shrimp.*

- a. Brine shrimp are multicellular organisms that need to respire at all times. Where do they get their oxygen?

.....  
.....  
.....  
.....  
..... [2]

- b. What are the differences between 'respiration' and 'breathing'?

.....  
.....  
.....  
.....  
..... [2]

An aquarium was set up as shown below. There is a lamp that is kept on for 10 hours every day that provides artificial sunlight. There is also a heater that keeps the water at a steady temperature. The aquarium was set up with the algae 2 weeks before the shrimp eggs were added. The picture was taken 24 hours after the shrimp hatched.



c. Why is the water green?

.....  
.....  
..... [2]

d. What will an image of the aquarium look like in a month? Explain any differences.

.....  
.....  
.....  
.....  
.....  
..... [3]

e. What process does the lamp allow?

..... [1]

**[Total: 10 marks]**

2. There are two images below – one is a cactus (left - a desert plant), the other is a conifer (right - lives in the high Arctic where it is very cold for much of the year).



- a. What is the equation for photosynthesis?

[1]

- b. Both the cactus and the conifer show similar adaptations in their leaves. Both have narrow, small leaves with thick waterproof layers on them. Explain as fully as you can:

- i. Why both have small leaves with a reduced surface area

.....  
.....  
.....  
.....  
.....  
.....  
..... [2]

ii. Why both have evolved leaves with thick, waxy layers covering them.

.....

.....

.....

.....

.....

.....

..... [2]

[Total: 5 marks]

3. Each question has a single word or short phrase as the answer. Write it in the space provided.

a. Which single word links together milk teeth and a type of tree found in the UK?

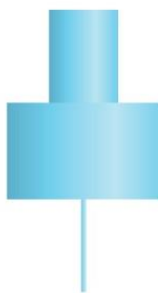
..... [1]

b. There are 1 000 000 microns ( $\mu\text{m}$ ) in a metre. A pin head is 0.8mm in diameter. A single red blood cell is 150  $\mu\text{m}$  across at its widest point. Approximately how many red blood cells can fit across a pin head? Show your working.

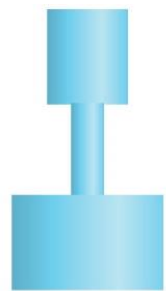
[1]

c. The images show two different pyramids of numbers. For each, can you think of a food chain that would match the shape? Write down the food chain that would fit each in the space next to the image.

Pyramid 1



Pyramid 2



Pyramid 1 .....

Pyramid 2 ..... [2]

[Total: 4 marks]

## Chemistry Section

4. Antoine Lavoisier was a pioneering Chemist. During the 1700s Lavoisier carried out many experiments to advance our understanding of the then fledgling subject. Some scientist point to Lavoisier as the father of modern Chemistry. In one experiment Lavoisier heated a red-orange solid called *red calx*. This substance decomposed to give pure mercury and a gas. The gas proved 'five or six times better than common air for the purpose of respiration'.



a.

- i. Suggest the identity of the gas made in this experiment

..... [1]

- ii. Suggest the chemical name of *red calx*.

..... [2]

- b. Lavoisier also noted that the mass of the *red calx* started with, was the same as the combined mass of the products made. What principle, which all chemical reactions obey, does this illustrate?

..... [1]

In a separate series of experiments Lavoisier repeated work by a Scottish Chemist: Joseph Black. Black had studied a mild alkali,  $\text{CaCO}_3$ , and a strong alkali  $\text{CaO}$ . Lavoisier made solutions of these two compounds.

c.

- i. How could you determine the pH of each solution?

..... [1]

- ii. Which of the two solutions would you expect to have a higher pH?

..... [1]



Lavoisier was able to convert  $\text{CaO}$  into  $\text{CaCO}_3$  by reacting the  $\text{CaO}$  with a gas he called 'Black's air'.

d.

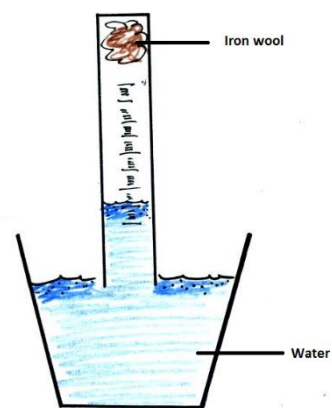
i. Give the chemical formula of 'Black's air'

..... [1]

ii. If you were to dissolve 'Black's air' in a beaker of water, would the solution be acidic or neutral or alkaline?

..... [1]

e. Lavoisier was a man interested in the components of the air around us. An experiment to investigate the composition of air is shown on the right. Describe what would occur if this experiment was left for a week. In your answer include the names of any chemical processes happening, and also how you could use this experiment to make a measurement of the composition of air.



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.....  
.....  
.....  
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.....  
.....  
..... [5]

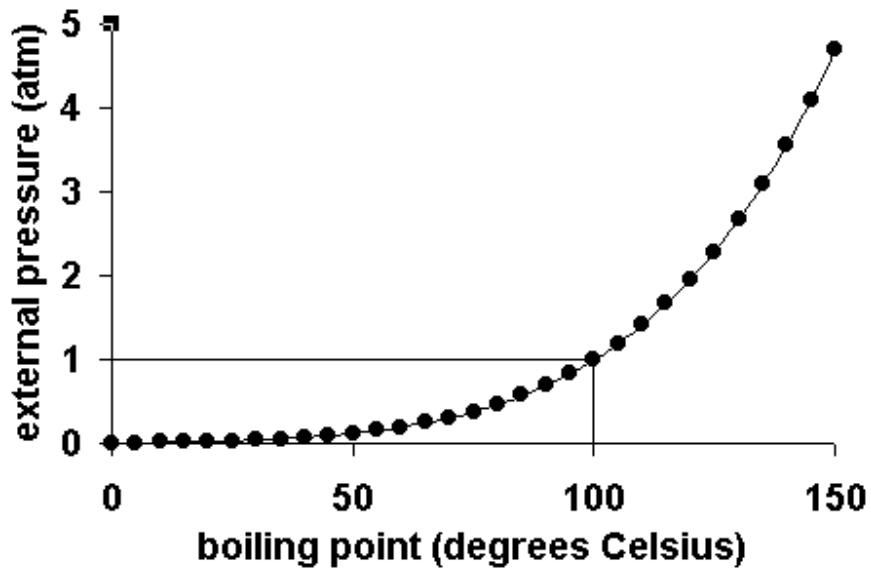
[Total: 13 marks]

5.

- a. Water boils at 100°C. The temperature in Oundle rarely gets above 30 °C, certainly nowhere near 100°C, and yet if the sun is shining on a puddle of water it takes only a few hours for it to disappear. Why is this?

.....  
.....  
.....  
.....  
..... [2]

- b. If the pressure of the atmosphere is decreased the temperature at which water boils also decreases. This is shown in the graph below. The pressure at sea level is 1 atm (standing for 1 atmosphere).



The pressure at top of Mt. Everest is approximately a third of that at sea level. Draw lines on the graph to help you estimate what temperature water would boil at when at the top of Mt. Everest.

Estimated temperature: ..... [2]

- c. Even at the same altitude there are relatively small and transient differences in the atmospheric pressure around the world. These pressure differences drive the world's weather systems.

One complicating issue is that people in different countries measure pressure in different units. Given the relevant conversion factors (in bold) place the measurements of pressure in the correct order.

$$\mathbf{1 \text{ bar} = 100,000 \text{ Pa} = 0.987 \text{ atm} = 14.5 \text{ PSI}}$$

2.2 atm, 2.2 bar, 35.0 PSI, 242,121 Pa

Highest pressure .....

.....

.....

Lowest pressure .....

[3]

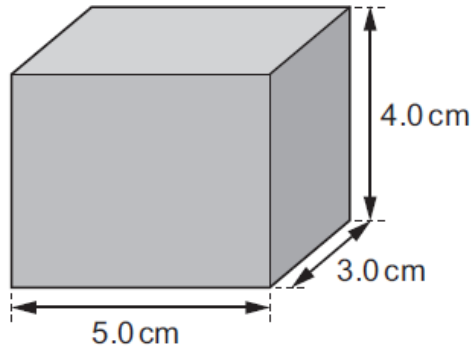
[Total: 7 marks]

**Physics Section**

6.

a.

The block of metal shown has a mass of 240 g.



What is the density of the metal?

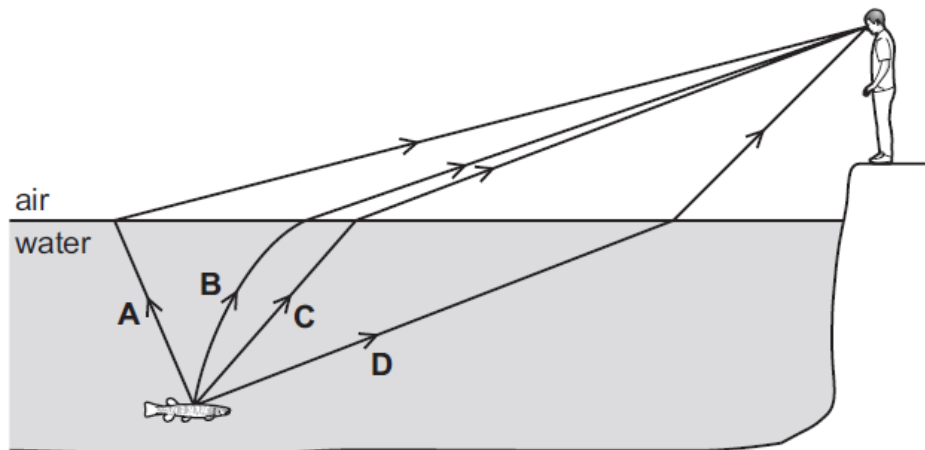
- A** 0.25g/cm<sup>3</sup>    **B** 4.0g/cm<sup>3</sup>    **C** 16g/cm<sup>3</sup>    **D** 14400g/cm<sup>3</sup>

Answer: ..... [1]

b.

A boy sees a fish in a lake.

Which labelled path is taken by the light travelling from the fish to the boy's eye?

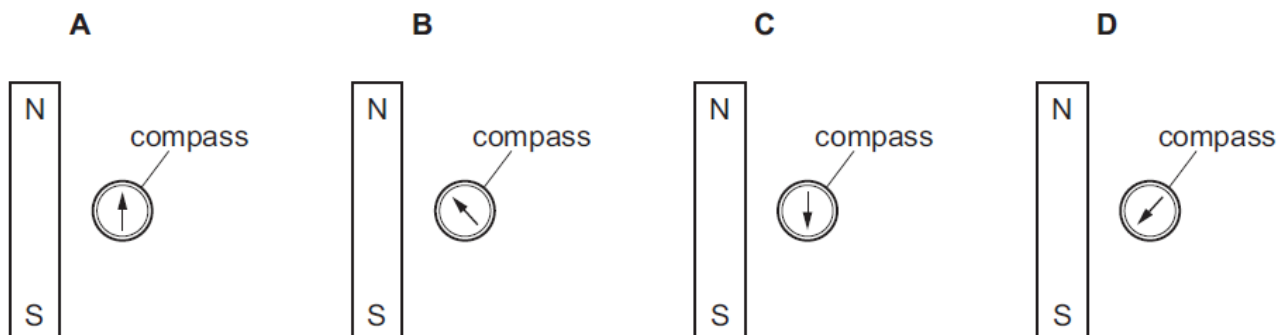


Answer: ..... [1]

c.

A small compass is placed close to a strong bar magnet, the same distance from each end.

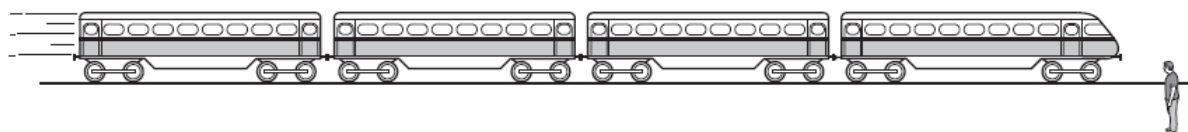
Which diagram shows the direction in which the compass needle points?



Answer: ..... [1]

d.

A man stands by a railway track.



A train travelling at 40 m/s takes 2.0 s to pass the man.

What is the length of the train?

- A** 20 m      **B** 38 m      **C** 40 m      **D** 80 m

Answer: ..... [1]

e.

A car moves along a level road.

The diagram shows all of the horizontal forces acting on the car.



Which statement is correct?

- A The car is slowing down.
- B The car is speeding up.
- C The car is moving at a constant speed.
- D The car is moving backwards.

Answer: ..... [1]

f.

Which situation is an example of a force acting over a large area to produce a small pressure?

- A a builder hammering a nail into a piece of wood
- B a cook using a sharp knife to cut vegetables
- C a nurse pushing a needle into a patient's arm
- D a soldier marching in flat-soled boots

Answer: ..... [1]

[Total: 6 marks]

7. A family goes on holiday in a car. To stop the journey being boring for the children, every half an hour they note down the distance they have travelled since they left home. They then plot the graph shown in Fig. 7

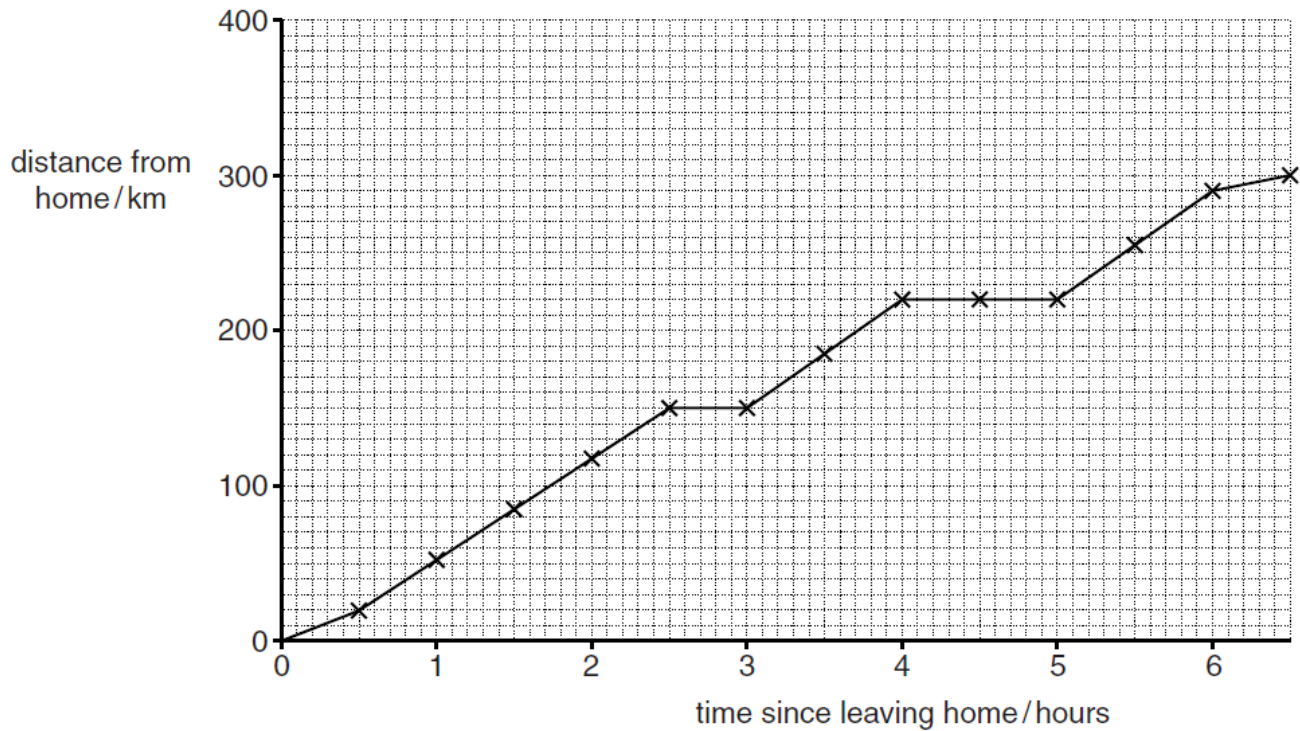


Figure 7

The first half hour and the last half hour of their journey are on small roads. The rest of the journey is on major roads.

Answer the following questions using information from Fig. 7.

- a. For how many hours were they travelling on major roads?

time = ..... hours [1]

b. How far did they travel,

i.in total?

total distance = ..... km [1]

ii.on small roads?

distance on small roads = ..... km [1]

iii.on major roads?

distance on major roads = ..... km [1]

c. They had two refreshment stops whilst on the journey.

On Fig. 7, clearly mark where they had these stops.

[1]

d. Apart from the times when they stopped, during which section of the journey was their speed slowest? Explain your answer.

Section.....

Explanation .....

.....

.....

..... [2]



- e. Calculate the average speed for the whole journey. Your answer must include the unit.

average speed = ..... [4]

**[Total: 11 marks]**

8. Fig. 8.1 shows a beam on a pivot. The beam is balanced at its centre of mass.

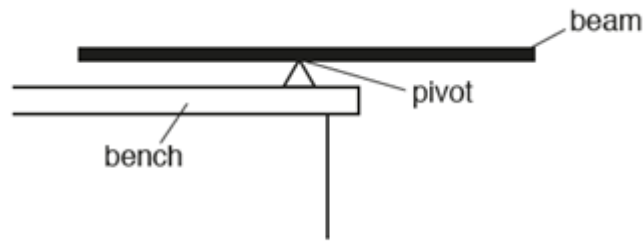


Figure 8.1

a. Fig. 8.2 shows a load of 2.5 N on one side of the beam. The beam is balanced by a load of 1.5 N suspended by a thin string.

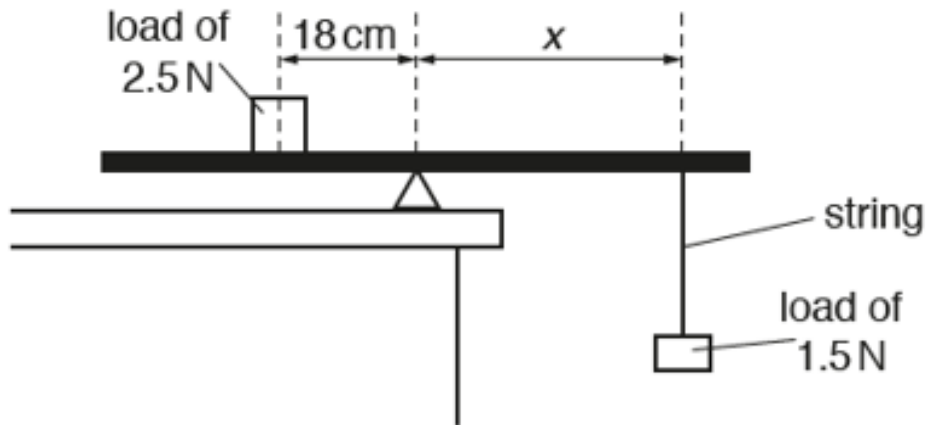


Figure 8.2

(not to scale)

i. Calculate the distance  $x$  from the pivot to the string.

distance from pivot = .....cm [3]

ii. Calculate the mass of the 2.5 N load.

mass = ..... [2]

**[Total: 5 marks]**