

Name

Current school



WELLINGTON COLLEGE

I3+ SCHOLARSHIP EXAMINATION 2021

SCIENCE

TIME ALLOWED: 60 minutes

Marks for each question are in brackets

- **Equipment required: pen, pencil, rubber, ruler and calculator**
- **Read all the information carefully before you start to answer**
- **Write your answers in the spaces provided**
- **Please write your name and current school at the start of each section**

There will be material in this exam that you will not have learned at school. This is intentional. Try to use the information given to answer the questions.

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Section I:

Sigma-Aldrich is a leading manufacturer of chemicals which are used by many companies around the UK.



They often need to transport large quantities of chemicals such as their best-selling product, hydrochloric acid (HCl).

1. The acid is transported in glass bottles even though glass is very likely to break when dropped on the floor. One of the employees suggests that using a container made from aluminium would be a better alternative. Explain why this would not be a suitable method of transporting the acid.

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[2]

2. The acid needs to be transported from the warehouse to the lorry. As the acid is **corrosive** the company needs to consider the safety of their employees. Suggest two ways in which the company can keep their employees safe when moving the acid to the lorry.

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3. In a recent shipment, some unlabelled bottles have been added. The lorry driver knows this is either sodium hydroxide or hydrochloric acid. How could he confirm the identity of the substance?

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4. The lorry requires fuel, such as diesel, to transport the acid to the customer. One of the hydrocarbons in diesel has the formula $C_{14}H_{30}$. When $C_{14}H_{30}$ reacts with oxygen (O_2), carbon dioxide (CO_2) and water (H_2O) are formed. Write a balanced chemical equation for this reaction.

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[2]

5. How many different elements are present in a molecule of $C_{14}H_{30}$?

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[1]

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Section 2:

Questions 6 and 7 will need to be done using the table of formulae attached at the end of this paper.

- 6. The acid is to be transported in round bottles stored in the back of a lorry. Estimate the total number of bottles that can be transported in one lorry load.

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Answer [6]

7. By how much does the mass of the lorry increase when it is fully loaded with full bottles of acid?
(Remember to use the information in the table to help.)

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Answer [4]

8. The lorry driver has a 100-mile journey along a motorway to deliver the acid. On Saturday when there is less traffic on the road, they can drive the route at a constant speed of 60 mph. However, on Monday the driver often gets caught in traffic jams and then speeds at 80 mph to ensure they get to their destination on time. On which day do they use less fuel? Explain your reasoning.

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[4]

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Section 3:

9. Describe similarities and differences between the combustion of $C_{14}H_{30}$ (Q5) and the process of aerobic respiration, which occurs in all living organisms.

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10. Diesel can contain impurities such as sulfur. Suggest why this is a problem for the environment.

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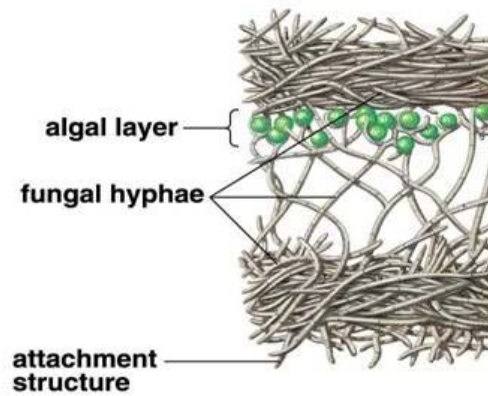
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11. Lichens are a group of organisms that are very sensitive to sulfur pollution. Lichens are not a single organism, but form through a symbiotic relationship between a fungi and an algae, as shown in the image below. These algae are capable of photosynthesising.



Using your own knowledge and the information provided, suggest how these organisms benefit from living together.

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12. Suggest which raw materials the algae need in order to photosynthesise.

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13. The photo below shows different species of lichen growing on a tree bark. Describe an investigation you could conduct, using lichens as an indicator, to investigate the extent to which distance from a major road affects air quality in school playgrounds. Identify your independent, dependent and control variables, and other factors that would need to be taken into account when collecting evidence.



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Answer [6]

Data Sheet

The table below includes some data and formulae that are relevant to Q6 and Q7. It does not give you all of the information that you need.

Bottles	Radius: 19mm Height: 92 mm Mass empty bottle: 25 g	
Lorry	Width: 2.43 m Height: 2.59 m Length: 12.2 m	
Acid	Density: 1.2 g /cm ³	
Volume Cylinder	$\pi r^2 h$	r = radius, h = height
Density	$\rho = \frac{m}{V}$	ρ = density