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COMBINED SCIENCE

0653/42

Paper 4 Theory (Extended)

May/June 2026

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen. Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m/s^2).

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Any blank pages are indicated.

- 1 (a) Figure 1.1 is a diagram of the human breathing system.

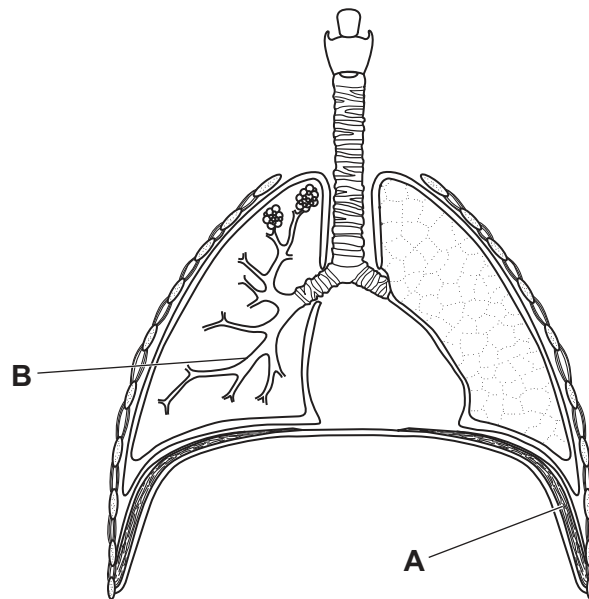


Figure 1.1

- (i) Identify the parts labelled **A** and **B** on Figure 1.1.

A

B [2]

- (ii) Draw a label line and the letter **L** on Figure 1.1 to identify the larynx. [1]

- (b) Oxygen diffuses into the blood across the gas exchange surface of the lungs.

- (i) Gas exchange surfaces in humans have a large surface area.

State **two** other features of the gas exchange surface in humans.

1

2 [2]

- (ii) Surface area and temperature influence the rate of diffusion.

Describe **two** other factors that influence the rate of diffusion.

1

2 [2]



- (c) Oxygen is transported in the blood.
Figure 1.2 is a photomicrograph showing two blood vessels.

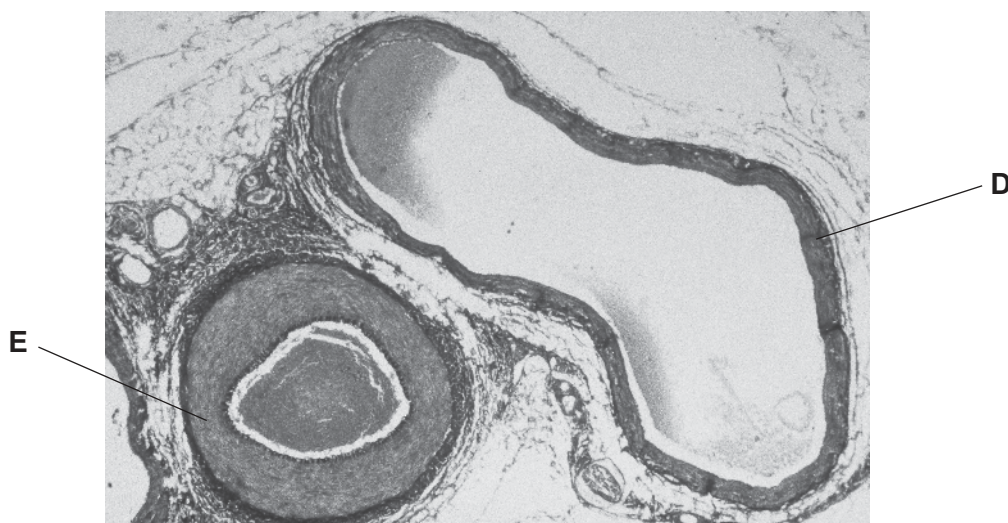


Figure 1.2

- (i) State the letter in Figure 1.2 that identifies a vein.
Use Figure 1.2 to give reasons for your answer.

letter

reasons
.....
.....
.....

[2]

- (ii) Describe the role of blood in defending the body from pathogens.

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

[Total: 11]



2 (a) The pancreas produces the enzyme lipase.

(i) State **one** other enzyme produced by the pancreas.

..... [1]

(ii) Name the large molecule lipase digests and the products of this digestion.

large molecule

products

[2]

(b) Figure 2.1 is a graph showing the effect of pH on lipase activity.

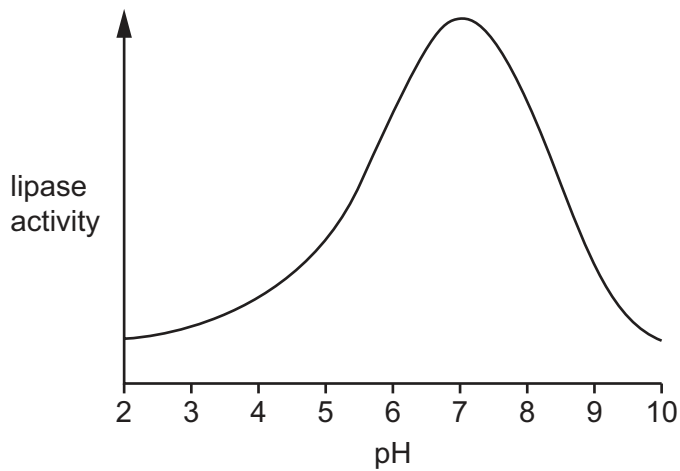


Figure 2.1

Explain the effect of pH7 on the lipase activity shown in Figure 2.1.

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



- (c) Enzymes are used in the process of photosynthesis in plants.

A student measures the rate of photosynthesis by counting the number of gas bubbles produced by an aquatic plant.

Figure 2.2 shows the apparatus the student uses.

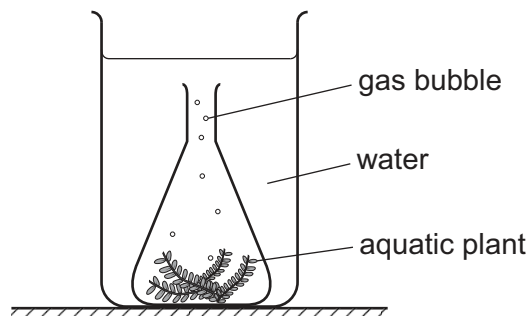


Figure 2.2

Table 2.1 shows the number of gas bubbles produced in 3 minutes for different concentrations of carbon dioxide in the water.

Table 2.1

percentage concentration of carbon dioxide	number of gas bubbles in 3 minutes	rate of photosynthesis / gas bubbles per minute
0.1	9	3
0.2	13	4
0.3	17	6
0.4	20	7
0.5	22	

- (i) Calculate the rate of photosynthesis for the 0.5 percentage concentration of carbon dioxide shown in Table 2.1.

Give your answer to the nearest whole number.

rate of photosynthesis = gas bubbles per minute [2]

- (ii) Describe the effect of changing the percentage concentration of carbon dioxide on the rate of photosynthesis shown in Table 2.1.

.....
 [1]

[Total: 9]

3 (a) Figure 3.1 shows a photograph of a flower.



Figure 3.1

(i) Identify the part labelled **G** in Figure 3.1.

..... [1]

(ii) Complete the sentences about the flower in Figure 3.1.

The flower is pollinated when pollen from another flower is carried by

..... to this flower.

The pollen lands on the of the flower.

[2]

(b) After pollination, fertilisation occurs.

Compare fertilisation in humans and plants.

similarities

.....

.....

.....

differences

.....

.....

.....

[4]

[Total: 7]



- 4 (a) Table 4.1 shows information about some ions of Group I and Group VII elements.

Table 4.1

formula of ion	number of protons	number of neutrons	number of electrons
Li^+			2
	9	10	10
	11		

Use the Periodic Table to complete Table 4.1.

[4]

- (b) Bromine, chlorine and iodine are elements in Group VII.

- (i) Identify the least dense of these three elements.

..... [1]

- (ii) Identify the least reactive of these three elements.

..... [1]

- (c) A test-tube contains aqueous sodium bromide.

Aqueous chlorine is added to the test-tube and a reaction occurs.

- (i) Identify this type of chemical reaction.

..... [1]

- (ii) State the colour change of the solution in the test-tube.

from to [2]

[Total: 9]

5 Methanol, CH_3OH , is an organic compound.

(a) Explain why methanol is **not** a hydrocarbon.

.....
..... [1]

(b) Complete the dot-and-cross diagram in Figure 5.1 to show the electronic configuration of a molecule of methanol, CH_3OH .

Show **only** the outer-shell electrons.

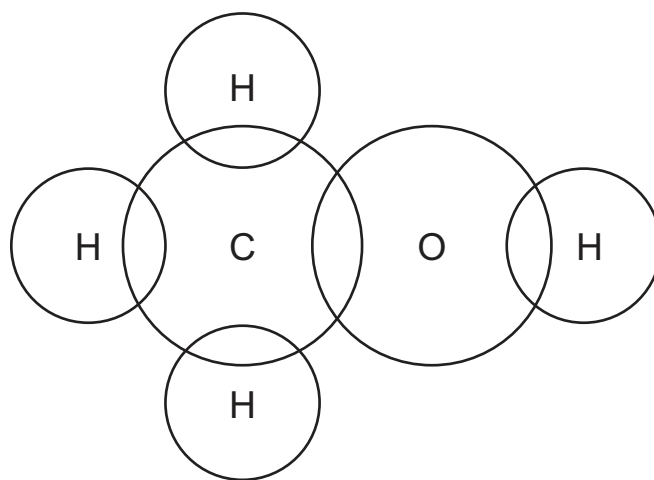


Figure 5.1

[3]



(c) Methanol is used as a fuel for heating.

- (i) A flame is needed to light the methanol so that it starts to burn.
The flame provides activation energy, E_a , for the reaction.

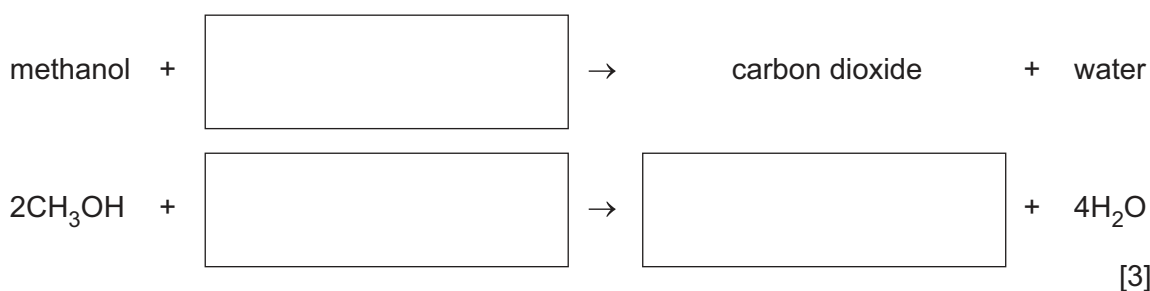
Define activation energy.

.....

 [2]

- (ii) The combustion of methanol produces carbon dioxide and water.

Complete the word equation and the symbol equation for this reaction.



- (iii) State the test for carbon dioxide and the observation for a positive result.

test

observation [1]

[Total: 10]



- 6 (a) Table 6.1 shows the average mass of pollutants in 1 m^3 of air in three cities, **J**, **K** and **L**.

Table 6.1

pollutant	mass of pollutant in 1 m^3 of air / μg		
	city J	city K	city L
particulates	65	51	46
oxides of nitrogen	221	231	211
sulfur dioxide	50	45	55
carbon monoxide	5	4	5

(1 million μg = 1 g)

- (i) State **two** pollutants in Table 6.1 which are formed due to incomplete combustion of hydrocarbons.

1

2 [2]

- (ii) Identify which city, **J**, **K** or **L**, has air with the highest mass in 1 m^3 of gaseous pollutants that cause acid rain.

Explain your answer.

city

explanation [2]

- (iii) Use Table 6.1 to calculate the total mass of **gaseous** pollutants in 1 m^3 of the air of city **L**.

total mass of **gaseous** pollutants = μg [1]



- (b) Two strategies for reducing the effects of climate change are planting trees and reducing livestock farming.

Explain how each strategy reduces the effects of climate change.

planting trees

.....

reducing livestock farming

.....

[2]

[Total: 7]



- 7 (a) A student assembles the electrical circuit shown in Figure 7.1.

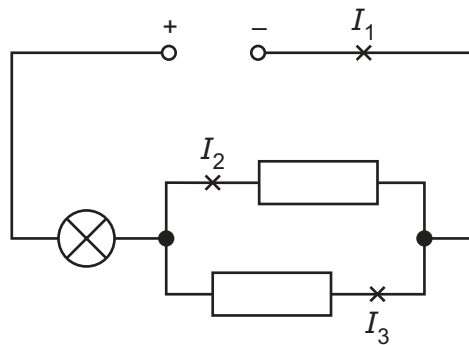


Figure 7.1

- (i) The current in the lamp is 0.26 A.

The potential difference (p.d.) across the lamp is 2.5 V.

Calculate the power of the lamp.

power = W [2]

- (ii) Draw an arrow above the lamp in Figure 7.1 to show the direction of the flow of **electrons** through the lamp.

Give a reason for your answer.

..... [1]

- (iii) The currents at other positions in the circuit are labelled I_1 , I_2 and I_3 .

Write an equation to show the relationship between I_1 , I_2 and I_3 .

..... [1]



- (b) Describe the difference between a direct current (d.c.) and an alternating current (a.c.).

.....
..... [1]

- (c) An electric bell is connected to a battery.

The bell is switched on for 5.0 s.

During this time, 4.7×10^{19} electrons pass through the bell. The charge on each electron is 1.6×10^{-19} C.

Calculate the current in the bell.

current = A [3]

[Total: 8]

8 (a) A sound wave is an example of a longitudinal wave.

(i) Give an example of a transverse wave.

..... [1]

(ii) A sound wave travels through a gas as a series of compressions and rarefactions.

Describe the difference between a compression and a rarefaction in terms of pressure and distance between gas particles.

pressure

.....

distance

.....

[2]

(b) Solids expand less than gases when heated.

Solids contract less than gases when cooled.

Give **two** reasons why.

1

.....

2

.....

[2]

(c) Describe how thermal energy is transferred through a solid metal.

.....

.....

.....

..... [3]

[Total: 8]





Turn over





9 The Sun is the main source of energy for most of our energy resources.

(a) State **two** energy resources that do **not** have the Sun as their main source of energy.

1

2

[2]

(b) Describe how energy is released by reactions in stable stars like the Sun.

.....

.....

..... [2]



(c) A solar cell uses light from the Sun to power the toy car shown in Figure 9.1.

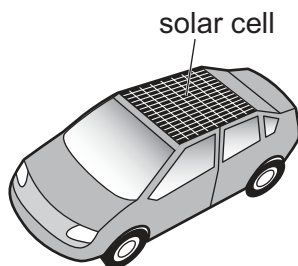


Figure 9.1

The car moves with an initial constant speed of 0.25 m/s .

The car then accelerates with a constant acceleration of 0.40 m/s^2 .

The final constant speed of the car is 1.25 m/s .

(i) The kinetic energy of the car at its initial speed is $1.25 \times 10^{-3} \text{ J}$.

Show that the kinetic energy of the car at its final speed is 0.031 J .

[3]

(ii) Calculate the distance the car moves while it is accelerating.

distance = m [4]

[Total: 11]





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The Periodic Table of Elements

Group											
I	II										
		1 H hydrogen 1									
</											

lanthanoids		57	La	lanthanum	139	58	Ce	cerium	140	59	Pr	praseodymium	141	60	Nd	neodymium	144	61	Pm	promethium	–	62	Sm	samarium	150	63	Eu	eucopium	152	64	Gd	gadolinium	157	65	Tb	terbium	159	66	Dy	dysprosium	163	67	Ho	holmium	165	68	Er	erbium	167	69	Tm	thulium	169	70	Yb	ytterbium	173	71	Lu	lutetium	175
actinoids		89	Ac	actinium	–	90	Th	thorium	232	91	Pa	protactinium	231	92	U	uranium	238	93	Np	neptunium	–	94	Pu	plutonium	–	95	Am	americium	–	96	Cm	curium	–	97	Bk	berkelium	–	98	Cf	californium	–	99	Es	einsteinium	–	100	Fm	fermium	–	101	Md	mendelevium	–	102	No	nobelium	–	103	Lr	lawrencium	–

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

