

Cambridge International Examinations Cambridge International General Certificate of Secondary Education

	CANDIDATE NAME								
	CENTRE NUMBER		CANDIDATE NUMBER						
* 7 0	PHYSICAL SCIE	INCE		0652/61					
4 υ υ	Paper 6 Alternati	ive to Practical	Oc	tober/November 2018 1 hour					
N	Candidates answer on the Question Paper.								
	No Additional Ma	terials are required.							

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen. You may use an HB pencil for any diagrams or graphs. Do not use staples, paper clips, glue or correction fluid. DO NOT WRITE IN ANY BARCODES.

Answer all questions. Electronic calculators may be used. You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together. The number of marks is given in brackets [] at the end of each question or part question.

This document consists of 26 printed pages and 2 blank pages.



1 Solid **H** is a mixture of element **J** and compound **K**.

Compound K is soluble in water whereas element J is not soluble in water.

A student separates element ${\bf J}$ and compound ${\bf K}$ from the mixture ${\bf H}$ and identifies the two substances.

- (a) She places the solid **H** in a beaker, adds 20 cm³ of distilled water and stirs well.
 - She filters the mixture and keeps the filtrate and the residue for testing in (b) and (c).
 - She records the appearance of the filtrate and residue. Her observations are shown in Fig. 1.1.

	NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
appearance of filtrate:	colourless liquid
appearance of residue:	grey solid



(i) Draw and label the apparatus she uses to filter the mixture.

3

(ii) Explain why she needs to stir well after adding the distilled water.

.....[1]

(b) testing the filtrate

L

- She places 1 cm depth of the filtrate from (a) in a test-tube.
- She slowly adds sodium hydroxide solution until there is no further change.
- She records her observations.

Her observations are shown in Fig. 1.2.

	2222
white ppt. which changes into a colourless	
solution when more sodium hydroxide is add	ded

Fig. 1.2

(i) Use the observations in Fig. 1.2 to identify the cation present in the filtrate.

cation is

[1]

(ii) On the answer lines, outline a plan for the tests the student needs to carry out to determine whether the filtrate contains the carbonate, chloride or sulfate anion.

You also need to plan the order in which she would carry out these tests.

The following reagents are available:

barium nitrate solution dilute nitric acid silver nitrate solution

For each test state the observation which would confirm the presence of the anion.

first test
anion tested for
observation for a positive result
second test
anion tested for
observation for a positive result
third test
anion tested for
observation for a positive result
[3]

(c) testing the residue

- She places the filter paper and residue from (a) in a test-tube.
- She adds dilute hydrochloric acid.
- She holds a lighted splint at the mouth of the test-tube.
- She records her observations.

Her observations are shown in Fig. 1.3.

	5
bubbles are produced	-
pops with a lighted splint	_
there is a colourless solution at the end	-
	-

Fig. 1.3

(i) Use the observations in Fig. 1.3 to deduce the identity of the gas and the nature of the element **J** left in the residue.

gas is

(ii) Suggest one test which she could carry out on the solution produced in (c)(i) in order to identify the element J.

.....[1] [Total: 10] He sets up the circuit shown in Fig. 2.1. The lamps are connected in series.



Fig. 2.1

- He closes the switch.
- He measures the current *I* flowing through lamps **L** and **M**.
- He measures the potential difference *V* across the lamps.
- He opens the switch.

Fig. 2.2 shows the scales of the ammeter and the voltmeter when the measurements are taken.



Fig. 2.2

(a) Read the scales in Fig. 2.2 and record your readings in Table 2.1.

Table 2.1

	I/A	V/V	resistance $R_{\rm S}$ / Ω	power P _S /W
lamps L and M in series				

(b) State why it is important to open the switch after taking readings.

.....[1]

(c) (i) Calculate the combined resistance $R_{\rm S}$ of lamps L and M when connected in series. Use the equation shown.

$$R = \frac{V}{I}$$

Record your answer in Table 2.1.

(ii) Calculate the combined power output $P_{\rm S}$ of lamps L and M when connected in series. Use the equation shown.

$$P = V \times I$$

Record your answer in Table 2.1.

[2]

[1]

[1]

(d) He rearranges the circuit and sets it up as shown in Fig. 2.3. Lamps L and M are now connected in parallel with the power supply.



Fig. 2.3

- He closes the switch.
- He measures the current *I* flowing through lamp L.
- He measures the potential difference *V* across lamp **L**.
- He opens the switch.

He records his readings in Table 2.2.

Table 2.2

	I/A	V/V	resistance <i>R</i> /Ω	power P /W			
lamp L in parallel	0.21	1.3	6.2	0.27			
lamp M in parallel	0.20	1.3	6.5	0.26			

- He disconnects the ammeter.
- He reconnects the ammeter so that it is now in series with lamp **M** as shown in Fig. 2.4.





- He closes the switch.
- He measures the current *I* flowing through lamp **M**.
- He measures the potential difference *V* across lamp **M**.
- He opens the switch.

He records his readings in Table 2.2.

(i) He calculates the resistance of each lamp and records the results in Table 2.2.

Calculate $R_{\rm P}$, the sum of the resistances of lamps **L** and **M** in parallel.

 $R_{\rm P}$ = Ω [1]

(ii) He calculates the power output of each lamp and records the results in Table 2.2.

Calculate the total power output P_{P} of lamps **L** and **M** in parallel.

P_P = W [1]

(e) A student says that the combined resistance R_S of the lamps in the series circuit should be equal to the sum of the resistances R_P in the parallel circuit.

State whether your values of $R_{\rm S}$ and $R_{\rm P}$ from (c)(i) and (d)(i) support the suggestion made by the student.

Justify your statement by referring to the values you have calculated.

.....[1]

(f) (i) The student notices that the lamps in the series circuit in Fig. 2.1 are less bright than the lamps in the parallel circuits in Figs. 2.3 and 2.4.

Suggest **one** reason for this observation. Refer to the results in Tables 2.1 and 2.2.

.....

.....[1]

(ii) Suggest a change to the circuit in Fig. 2.1 which would cause the two lamps in series to have the same brightness as the lamps in Figs. 2.3 and 2.4.

.....[1]

[Total: 10]

Please turn over for Question 3.

11

3 A student investigates the rate of reaction between calcium carbonate and hydrochloric acid.

Fig. 3.1 shows the apparatus she uses.



Fig. 3.1

She uses the following method:

- She places a conical flask on a mass balance.
- She adds 5.00 g of calcium carbonate pieces (an excess) to the flask.
- She adds 50 cm³ hydrochloric acid to the flask.
- She places a piece of cotton wool in the neck of the conical flask as shown in Fig. 3.1.
- She starts a stopclock and records in Table 3.1 the mass m for time t = 0.
- She records in Table 3.1 the mass *m* every 15 seconds until there is no further change in mass.

mass <i>m</i> /g					
106.11					
105.73					
105.35					
105.16					
105.03					
105.01					
104.99					
104.99					

Table 3	3.1
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(a) Fig. 3.1 shows the reading on the balance at t = 60 seconds.

Record this mass in Table 3.1.

- (b) (i) Plot a graph of mass *m* (vertical axis) against time *t*.
 The vertical axis does not need to start at zero. [3]
 - (ii) Draw the best-fit line, which must be straight for the first 30 seconds and then should be the best-fit curve. [1]

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13

[1]

(c) (i) Calculate the gradient of the straight line part of your graph. Show all working and indicate on your graph the values you chose.

gradient = g/s [2]

(ii) The gradient represents the rate of reaction at the start of the experiment.

A second experiment is performed using acid of double the concentration and using the same mass of calcium carbonate and the same volume of acid as in **(a)**.

Draw a second line on the graph to show the rate of the reaction in this second experiment. Label the line S. [1]

(d) (i) Suggest why the piece of cotton wool is placed in the neck of the conical flask.

.....[1]

(ii) Explain why a tight fitting bung is **not** used instead of cotton wool.

-...

.....[1]

[Total: 10]

Please turn over for Question 4.

15

4 A student uses optics pins to trace the path of light through a rectangular block of transparent plastic in order to determine the refractive index of the plastic.

She sets up the experiment shown in Fig. 4.1.

•P₁







- She places the plastic block on a sheet of white paper on a cork mat.
- She places two optics pins **P**₁ and **P**₂ as shown in Fig. 4.1.
- (a) (i) Measure the distance P_1P_2 . Record your answer to the nearest millimetre.

P₁**P**₂ = mm [1]

(ii) On Fig. 4.1, draw a line joining pins **P**₁ and **P**₂.

Continue this line until it reaches the block at side AB.

Label the point where the line meets side **AB** with the letter **N**. [1]

(iii) On Fig. 4.1 draw a line at 90° to side **AB** at **N**.

Extend this line until it crosses side CD.

Label with the letter **M** the point at which this line crosses side **CD**. [1]

- (b) The student looks through side **CD** of the block from the direction shown by the eye in Fig. 4.1.
 - She places two more optics pins P₃ and P₄ below side CD and adjusts their positions until P₃, P₄ and the images of P₁ and P₂ seen through the block appear in a straight line, one behind the other.

The positions of P_3 and P_4 are shown in Fig. 4.1.

(i) On Fig. 4.1, draw a line joining **P**₃ and **P**₄.

Continue this line until it meets NM.

Label the point where the line crosses NM with the letter Q.

Label the point where the line crosses CD with the letter R.

Draw a straight line from **N** to **R**.

Measure the length a of NR.

a = mm [1]

(ii) Measure the length *b* of **QR**.

b = mm [1]

(c) Calculate the refractive index n of the plastic. Use the equation shown and your answers to (b)(i) and (b)(ii).

n =[1]

(d) The student repeats the experiment three more times using different positions of pins P_1 and P_2 . She obtains the following values for the refractive index *n* of the plastic.

1.57 1.60 1.54

Use your value of n from part (c) and the values calculated by the student to determine a mean value for the refractive index of plastic. Give your answer to three significant figures.

mean value for *n* =[2]

(e) The student states that, allowing for experimental error, the refractive index of the plastic is constant, whatever the positions of pins P₁ and P₂.

Use the results from (c) and (d) to state whether you agree with the student and justify your answer.

(f) When looking through the plastic block to line up pins P_3 and P_4 with the images of pins P_1 and P_2 , it is good experimental technique to view the part of each pin closer to the paper while lining them up.

Suggest a reason for this.

.....[1]

[Total: 10]

5 A student investigates the three alcohol fuels, ethanol, propanol and butanol, to find out which of them supplies the most energy per kilogram when they burn in air.

He uses the apparatus shown in Fig. 5.1.





- He measures the mass m_1 of the spirit burner and ethanol before burning. He records this mass m_1 in Table 5.1.
- He places 100 cm³ of water into the beaker and clamps the beaker above the spirit burner as shown in Fig. 5.1.
- He measures the temperature T_1 of the water to the nearest 0.5 °C. He records this value in Table 5.2.
- He lights the burner.
- He extinguishes the burner when the temperature rises above 50 °C.
- He stirs the water and records in Table 5.2 the highest temperature T_2 .
- He then measures the mass m_2 of the spirit burner and ethanol after burning. He records this value in Table 5.1.
- He repeats the procedure for propanol and butanol.

alcohol	m ₁ /g	<i>m</i> ₂ /g	mass of alcohol burned <i>m</i> /g
ethanol	188.48	187.41	1.07
propanol	175.63	174.67	0.96
butanol	191.03	190.10	0.93



20



alcohol	T₁/°C	<i>T</i> ₂ /°C	change in temp ΔT /°C
ethanol	22.0	60.0	38.0
propanol	23.0	61.5	38.5
butanol	23.5		

(a) (i) Fig. 5.2 shows the thermometer for the highest temperature T_2 observed for the burning of butanol.

Record in Table 5.2 the reading to the nearest 0.5 °C.

[1]



highest temperature T_2 for butanol

Fig. 5.2

(ii) Calculate the change in temperature ΔT for butanol. Record this value in Table 5.2. [1]

State and explain one safety precaution that should be taken when carrying out this (b) (i) experiment. precaution explanation _____ [1] (ii) The student uses the same volume of water for all three alcohols. State another variable that must be kept constant to make this a fair test.[1] (iii) Name a piece of apparatus suitable for measuring the volume of water.[1] Calculate the thermal energy E transferred into the water when ethanol is burned. Use (c) (i) the equation shown.

21

E = volume of water (cm³) × 4.2 × ΔT

Record your answer in Table 5.3 to 3 significant figures.

E/J

16200

16800

Table 5.3

energy per gram of alcohol

/J per g

14900

16900

18100

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alcohol

ethanol

propanol

butanol

(ii) The third column in Table 5.3 shows the thermal energy transferred into the water per gram of alcohol burned.

Write an equation to show how the student calculates the numbers in this column.

[1]

(iii) Use the end the most th	ergy per gram values in Table 5.3 to s ermal energy per kilogram burned.	tate and explain which alcohol provides
(d) Suggest one rec	$r_{\rm cons}$ why the thermal energy Γ values	in Table 5.2 are lower than the eveneted
values.	ason why the thermal energy E values	in Table 5.3 are lower than the expected
		[1]
		[Total: 10]

6 A teacher sets up the apparatus shown in Fig. 6.1 to determine the half-life of a radioactive source.

She uses a detector connected to a counter to measure the count rate of the radioactive radiation emitted by the source.





(a) Before the teacher starts the experiment, she sets up the detector and the counter without the radioactive source present.

She measures the background count in 1 minute and repeats this three times.

Her results are shown in Table 6.1.

Table 0.1	Та	bl	е	6.	1
-----------	----	----	---	----	---

	count rate/cou	ints per minute	
20	24	18	19

Calculate the average count rate due to background radiation. Give your answer to the nearest whole number.

average background count rate = counts per minute [1]

- (b) The radioactive source used in the experiment is a beta (β) emitter.
 - The teacher places the detector close to the source.
 - She switches on the counter and measures the initial count rate.
 - She then measures the count rate at intervals of 30 seconds for 3 minutes.
 - She records her results in Table 6.2.

time t/s	measured count rate / counts per minute	count rate from source / counts per minute
0	770	750
30	557	
60	434	414
90	327	307
120	249	229
150	190	
180	146	126

Table 6.2

Use your answer from part (a) and the measured count rates in Table 6.2 to calculate the actual count rates from the source at t = 30 s and t = 150 s.

Record your answers in Table 6.2.

[1]

- Plot a graph of count rate from source (vertical axis) against time t. Start your graph at (c) (i) the origin (0,0). [2]
 - Draw the best-fit curve. (ii)

[1]



t/s

count rate from source / counts per minute

25

- (d) The half-life of a radioactive source is the time taken for the count rate from the source to halve.
 - (i) Use your graph to determine the time when the count rate from the source is at 600 counts per minute and at 300 counts per minute.

Record the times below.

		600 counts per minute at time <i>t</i> = s
		300 counts per minute at time <i>t</i> =s [1]
	(ii)	Deduce the half-life of the source.
		half-life = s [1]
(e)	The that	e teacher uses the apparatus in Fig. 6.1 and sheets of paper and aluminium foil to show the radioactive source emits beta particles only.
	(i)	Describe how the teacher uses the sheets of paper and aluminium foil with the apparatus.

.....[1]

(ii) State and explain the results you would expect if the source emits beta particles only.

.....[2]

[Total: 10]

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