Surname	Centre Number	Candidate Number
Other Names		0

GCSE

C420UB0-1

S19-C420UB0-1

FRIDAY, 14 JUNE 2019 – MORNING

PHYSICS – Component 2
Applications in Physics

HIGHER TIER

1 hour 15 minutes

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1.**	**15**	
Section B	**2.**	**13**	
	3.	**9**	
	4.	**14**	
	5.	**9**	
	Total	**60**	

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01

ADDITIONAL MATERIALS

In addition to this paper you will require a calculator, a ruler and a resource booklet.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

This paper is in 2 sections, **A** and **B**.
Section **A**: 15 marks. Read the article in the resource booklet carefully then answer **all** questions. You are advised to spend about 25 minutes on this section.
Section **B**: 45 marks. Answer **all** questions. You are advised to spend about 50 minutes on this section.
The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question **4*(a)***.

EQUATION LIST

final velocity = initial velocity + acceleration × time	$v = u + at$
distance = $\frac{1}{2}$ × (initial velocity + final velocity) × time	$x = \frac{1}{2}(u + v)t$
(final velocity)^2 = (initial velocity)^2 + 2 × acceleration × distance	$v^2 = u^2 + 2ax$
distance = initial velocity × time + $\frac{1}{2}$ × acceleration × time^2	$x = ut + \frac{1}{2}at^2$
change in thermal energy = mass × specific heat capacity × change in temperature	$\Delta Q = mc\Delta\theta$
thermal energy for a change of state = mass × specific latent heat	$Q = mL$
energy transferred in stretching = $\frac{1}{2}$ × spring constant × (extension)^2	$E = \frac{1}{2}kx^2$
force on a conductor (at right angles to a magnetic field) carrying a current = magnetic field strength × current × length	$F = BIl$
potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil	$V_1 I_1 = V_2 I_2$
$\frac{\text{potential difference across primary coil}}{\text{potential difference across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
for gases: pressure × volume = constant (for a given mass of gas at a constant temperature)	pV = constant
pressure due to a column of liquid = height of column × density of liquid × gravitational field strength	$p = h\rho g$

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SECTION A

Read the article in the resource booklet carefully and answer **all** *the questions that follow.*

1. *(a)* Use the information in **Figures 1** and **2** to explain how the environment benefitted due to the changes in electricity generation methods between 2010 and 2015. [2]

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(b) Use the information in **Figure 3** to calculate the predicted drop in the power generated by **non-renewable** sources from 2010 to 2050. Assume that the total power generated in the U.K. remains at a constant 35 GW. [1]

Drop in power generation by non-renewable sources = ... GW

(c) A power station needs 55 000 tonnes of willow crop per year. Use the information in **Figure 4** to answer the following questions.

(i) Calculate the area of land needed to grow this amount of willow crop. [1]

Area = ... km^2

(ii) Calculate the energy content of 55 000 tonnes of willow crop. [1]

Energy content = ... units

(d) Use your knowledge and the information in **Figure 6** to describe the advantages of tidal water turbines compared to wind turbines. [3]

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(e) Use the information about solar panels on page 4 to answer the questions that follow.

(i) Use the equation:

$$\text{efficiency} = \frac{\text{output power transfer}}{\text{input power transfer}}$$

to calculate the efficiency of a solar panel in good sunlight. [2]

Efficiency = ...

(ii) Household voltage is 230 V. Use the equation:

$$\text{current} = \frac{\text{power}}{\text{voltage}} \quad \text{or} \quad I = \frac{P}{V}$$

to calculate the current that can be drawn from a solar panel of area $4\,m^2$ in good sunlight. [3]

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Maximum current = ... A

(iii) Calculate the energy (Wh) produced by a $4\,m^2$ solar panel in 6 hours of good sunlight. Give your answer to 1 significant figure. [2]

Energy produced = ... Wh

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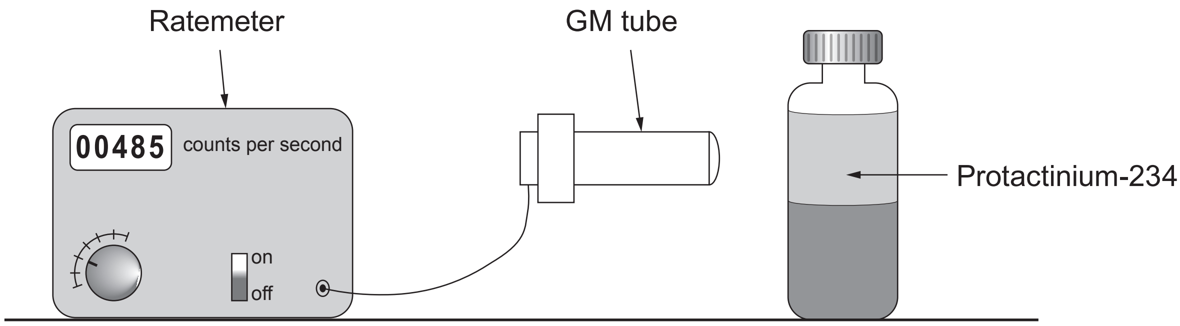
SECTION B

2. An experiment that may be used to demonstrate the decay of the radioactive element protactinium-234 (Pa-234) is shown below.

Protactinium-234 decays into uranium (U) with the emission of a **beta (β) particle**.



(a) A science technician is asked to set up the apparatus for a lesson. Before he does, he carries out a risk assessment. **Complete** the risk assessment. [1]

Hazard	Risk	Control measure
Ionising radiation	May damage cells if exposed for long time periods or if too close.	

(b) **Complete** the decay equation for protactinium-234. [2]

$$^{234}_{91}\mathrm{Pa} \longrightarrow \ldots\ldots\ldots\ldots \;+\; \ldots\ldots\ldots\ldots$$

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(c) The mean background count of the laboratory is measured by the teacher.
The bottle of protactinium is now placed next to the GM tube.

The reading on the ratemeter is measured every 40 s for a total time of 4 minutes.

The data collected is shown in the table below.

Reading	Time (s)	Measured rate (counts per second)	Corrected rate (counts per second)
1	0	485	480
2	40	325	320
3	80	218	213
4	120	147	142
5	160	100	95
6	200	68	63
7	240	Not recorded	....

(i) Using information in the table state the mean background count. [1]

Mean background count = ... counts per second

(ii) A power cut occured during the demonstration so the last reading was not obtained. The teacher correctly states that the data in the **corrected rate** column follows a constant ratio relationship. To 1 decimal place (**1 d.p.**), the ratio of reading 1 to 2 equals the ratio of reading 2 to 3. This equals the ratio of readings 3 to 4, etc.

Complete the table for the missing value of **corrected rate**. [2]

Space for working.

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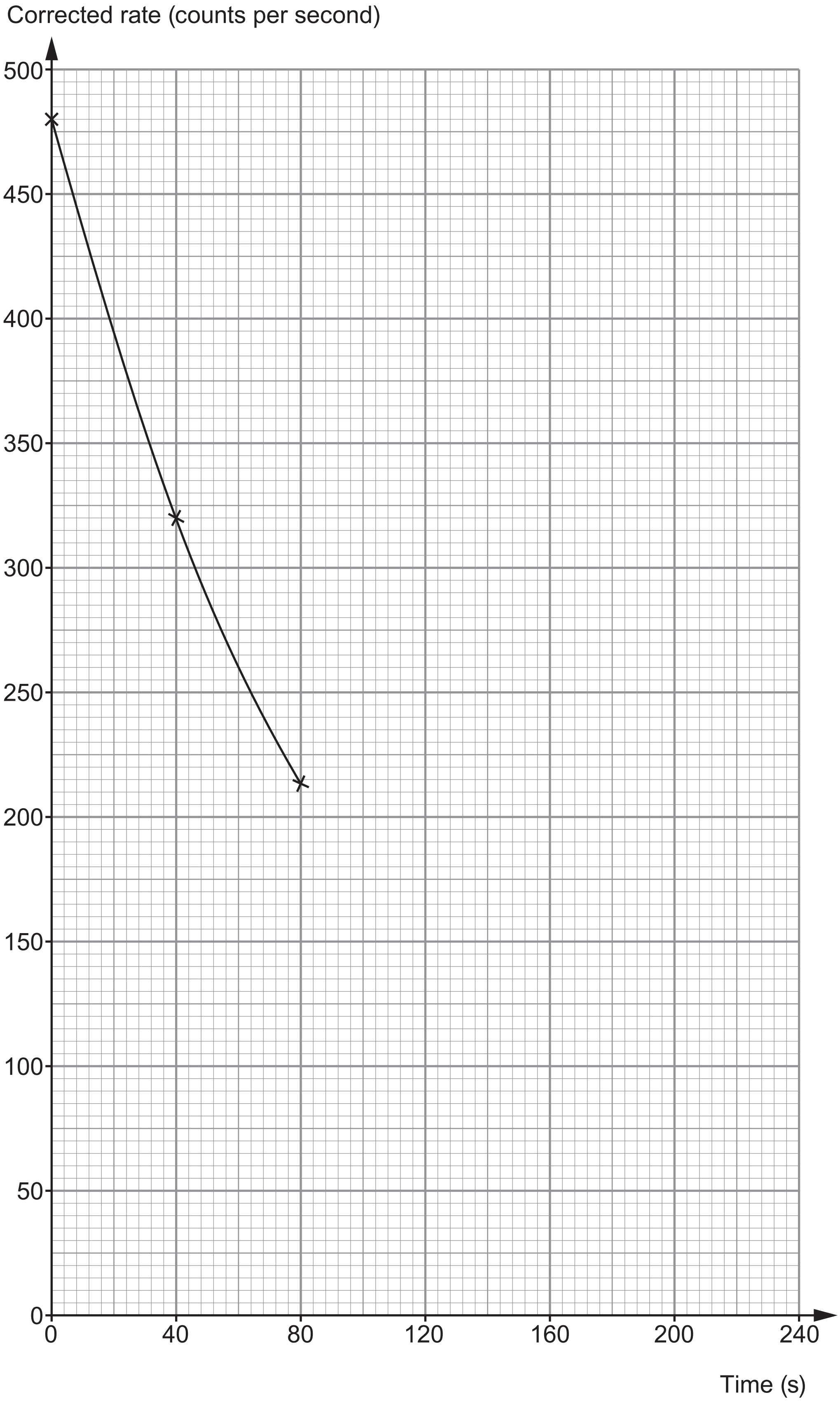
(iii) On the grid below plot the data and complete the graph. The first three data points have already been plotted. [2]



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(iv) Using your graph and showing your workings, determine the mean value for the half-life of protactinium. [2]

Half-life = ... s

(v) The area under the line of the graph represents the total number of beta particles detected. Estimate the number of beta particles detected by the GM tube in the first 80 seconds of the demonstration. [3]

Number of beta particles detected = ...

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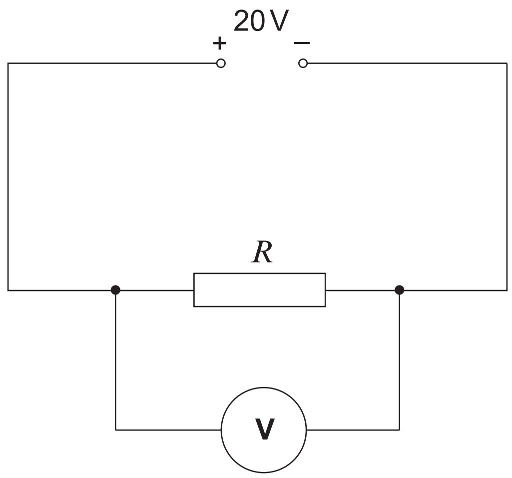
3. The following circuit is set up by students. The potential difference (p.d.) is measured across a fixed resistor, of resistance R, using a voltmeter.



(a) State the unit of resistance. [1]

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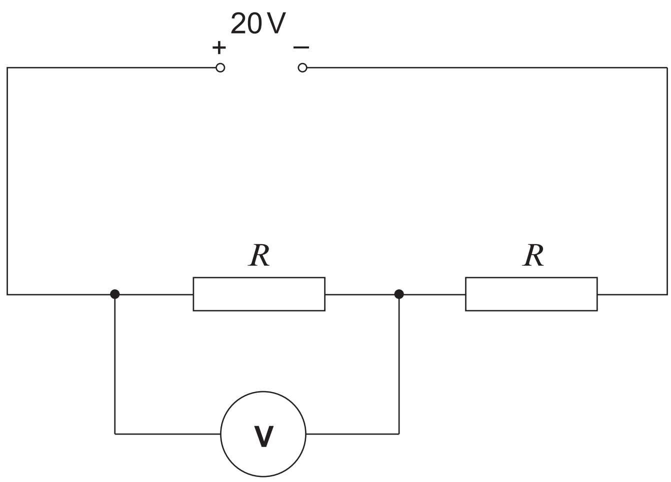
(b) The students investigate how the p.d. on the voltmeter changes when identical resistors are added in series. An identical resistor is added to the original circuit as shown below. The new p.d. across the first resistor is measured.



A third identical resistor is connected in series. The p.d. across the first resistor is measured. This method is repeated until a total of 10 identical resistors have been connected in series. The p.d. is always measured across the first resistor.

(i) Identify a controlled variable in the experiment. [1]

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(ii) The data collected are put into a spreadsheet.

Number of resistors in series, N	p.d. (V)
1	20.00
2	10.00
3	6.67
4	5.00
5	4.00
6	3.33
7	2.86
8	2.50
9	2.22
10	2.00

One student, Mary, declares,

"the number of resistors in series, $N \times$ p.d. = constant."

Use data from the table to explain whether Mary's declaration is correct. [2]

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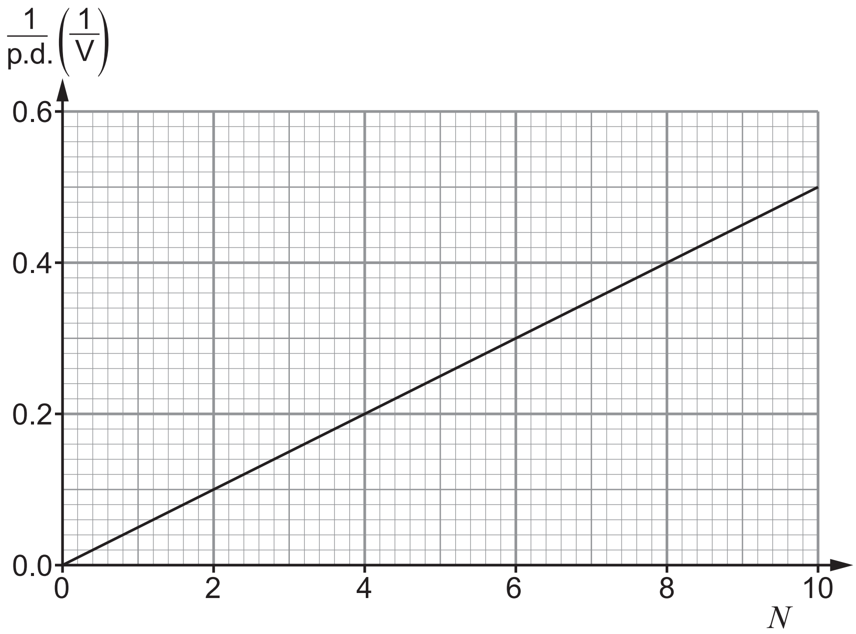
(c) The spreadsheet is now used to plot a graph of $\frac{1}{\text{p.d.}}$ against the number of resistors in series, N. The graph is shown below.



(i) Calculate the gradient of the line. [1]

Gradient = ...

(ii) Write an equation, in the form: $y = mx + c$ for the line shown on the graph. [2]

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(iii) Mary's friend predicts that if the number of resistors connected in series is 15 the voltmeter will read a p.d. of 0.75 V. Explain whether you agree with this prediction.
Space for working. [2]

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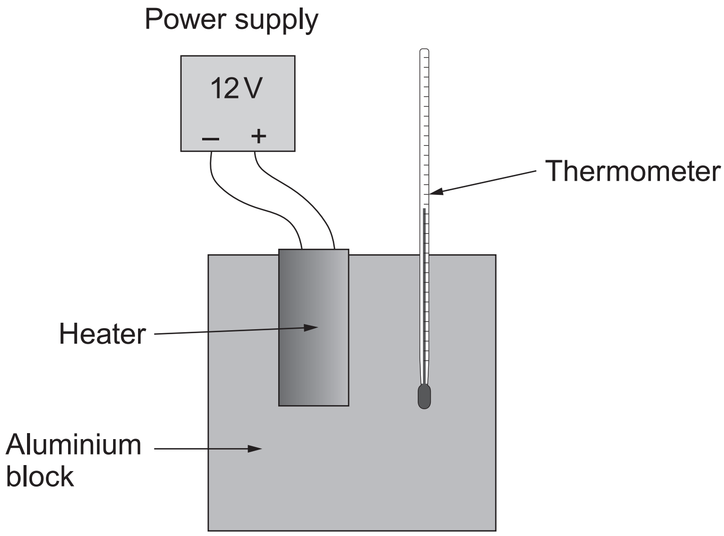
4. The aim of a physics lesson is to determine the specific heat capacity of aluminium.

Apparatus

- 1 kg aluminium block
- stopwatch
- 12 V d.c. power supply
- connecting leads
- 50 W, 12 V heater
- thermometer



(a) Describe how this experiment is carried out safely **and** how the data collected are used to calculate the specific heat capacity of aluminium. [6 QER]

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(b) Six groups of students carried out this experiment on aluminium blocks. They used their data to correctly calculate the specific heat capacity of aluminium.
Their values are shown in the table.

Group	1	2	3	4	5	6
Specific heat capacity (J / kg °C)	1 520	1 500	1 480	1 500	1 530	1 470

The **published** value for the specific heat capacity of aluminium is 902 J / kg °C.

(i) Using data in the table, calculate a mean value for the specific heat capacity of aluminium. [1]

Specific heat capacity = ... J / kg °C

(ii) The following expression can be used to find the percentage uncertainty of a mean value from data:

$$\text{Percentage uncertainty} = \frac{0.5 \times \text{range in data}}{\text{mean}} \times 100\,\%$$

Calculate the percentage uncertainty in the mean value of the specific heat capacity. [2]

Percentage uncertainty = ... %

(iii) Explain whether the values for specific heat capacity obtained from this experiment are accurate and reproducible. [3]

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(iv) Explain the reason for the difference between the published value of specific heat capacity and the calculated values in the table. You may assume that the mass of the block and the power of the heater are correct and that the equipment operates correctly. [2]

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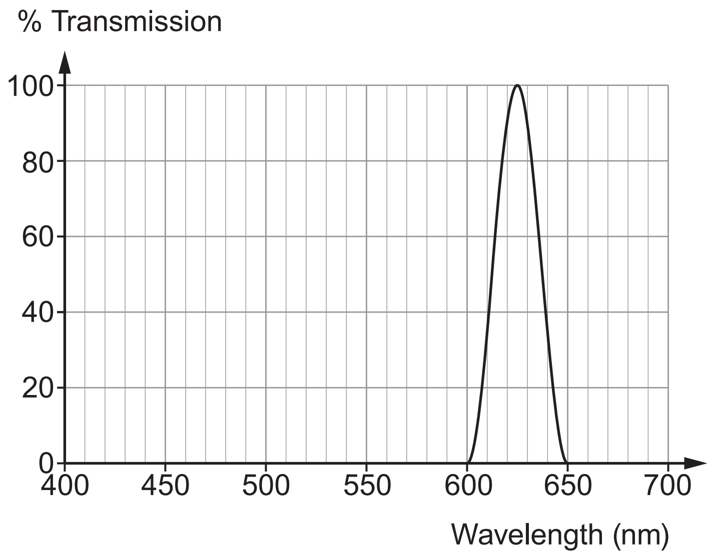
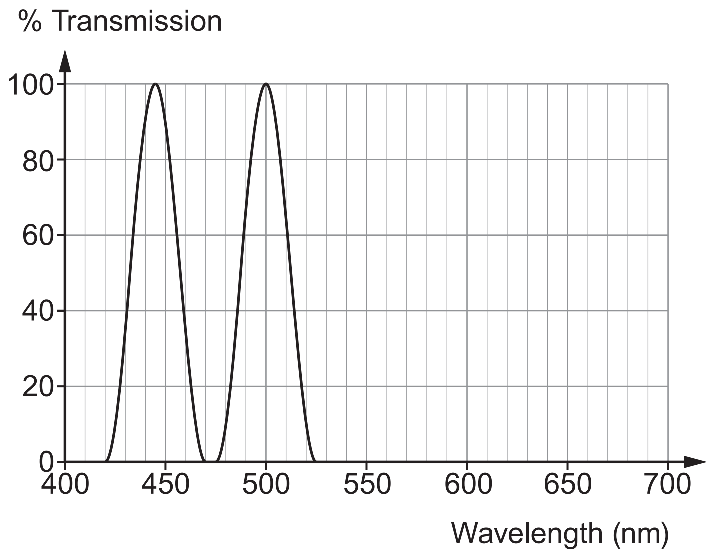
5. A set of three coloured filters is purchased by a physics department. Each filter is supplied with a graph showing the range of wavelengths that pass through it.

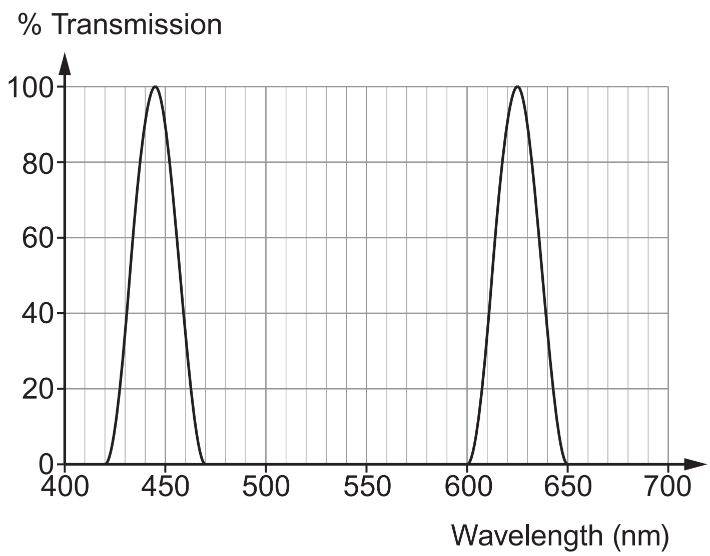
Red filter



Cyan filter



Magenta filter



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(a) (i) Use the information opposite and a suitable equation to calculate the **maximum** frequency of light that can pass through the red filter. [3]
(Speed of light = 3×10^8 m/s)

Frequency = ... Hz

(ii) Phillip uses the red filter to look at a filament lamp that emits white light. Explain what Phillip observes. [2]

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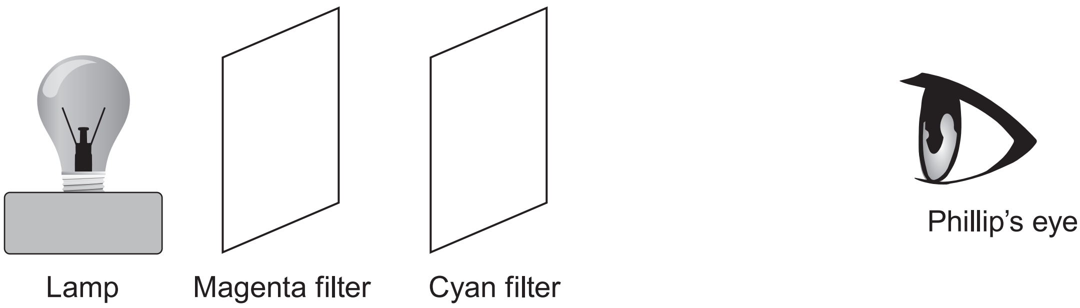
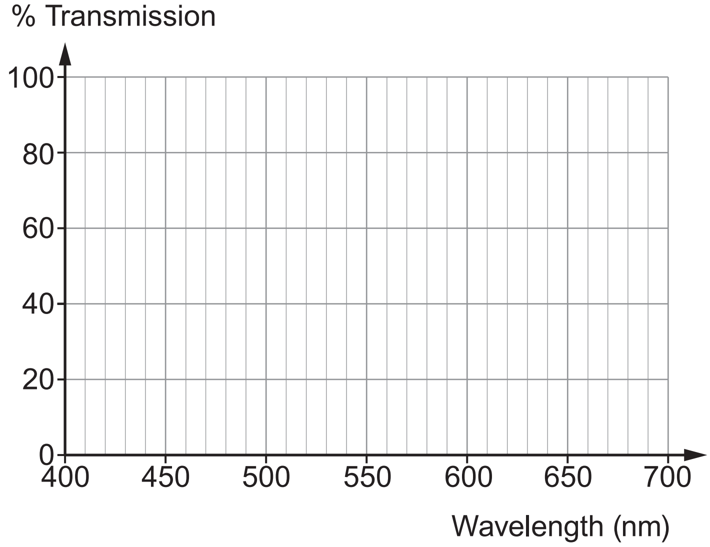
(b) Phillip sets up the following experiment using the magenta and cyan filters.



He looks at the lamp with the cyan filter in front of the magenta filter as shown in the diagram. Use information given previously to **complete the graph** below to show Phillip's observation when he views the lamp. [2]



TURN OVER FOR THE LAST PART

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(c) In sunlight, a school tie is blue with an embroidered red castle and yellow sun on it. Complete the table to show its appearance if the tie is viewed in red light. [2]

	Appearance in sunlight	Appearance in red light
Tie	blue	....
Castle	red	....
Sun	yellow	....

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END OF PAPER