Surname	Centre Number	Candidate Number
Other Names		2

GCE AS

B420U10-1

S18-B420U10-1

PHYSICS – AS component 1
Motion, Energy and Matter

TUESDAY, 15 MAY 2018 – MORNING

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**13**	
3.	**13**	
4.	**8**	
5.	**11**	
6.	**8**	
7.	**11**	
Total	**75**	

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ADDITIONAL MATERIALS

In addition to this paper, you will require a calculator and a **Data 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

The total number of marks available for this paper is 75.

The number of marks is given in brackets at the end of each question or part-question.

You are reminded to show all working. Credit is given for correct working even when the final answer is incorrect.

The assessment of the quality of extended response (QER) will take place in **5***(a).*

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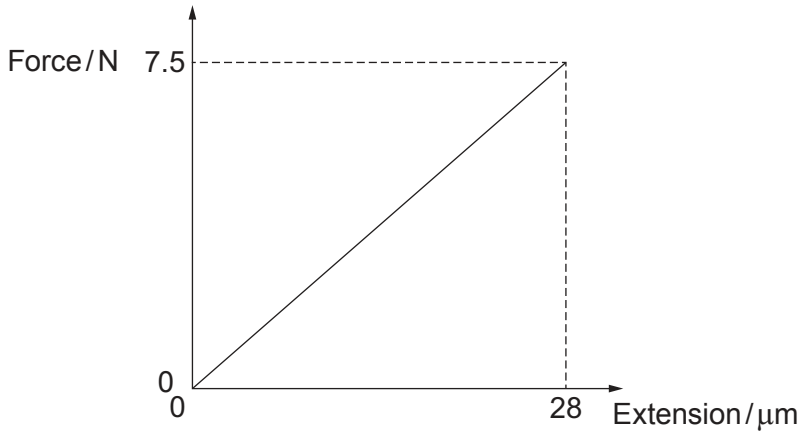
Answer **all** *questions.*

1. Emily carries out an experiment to obtain a force-extension graph for a thin glass fibre. She loads the thin glass fibre until it breaks. The force-extension graph obtained is shown below.



(a) (i) Emily measures the length and diameter of the glass fibre and finds them to be 19.8 cm and 1.01 mm respectively. Suggest what measuring instruments she uses. [1]

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(ii) Determine the Young modulus of glass. [3]

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(iii) Write a risk assessment for Emily's experiment. [2]

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(iv) Determine the energy stored in the glass just before breaking point is reached. [2]

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(b) Glass is a brittle material. Describe the process by which glass fractures. [3]

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Turn over.

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2. Xavi decides to use a rectangular piece of aluminium foil to determine the density of aluminium. He measured the width, w, and length, l, and obtained the following results:

$$w = 20.0 \pm 0.1\,\text{cm} \qquad l = 30.0 \pm 0.1\,\text{cm}$$

(a) (i) Determine the area of the foil along with its **percentage** uncertainty. [2]

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(ii) To increase the accuracy of the calculation Xavi folded the foil four times and measured the thickness of 16 sheets of the foil. He measured the thickness in 3 different places and obtained the following results.

Thickness / mm		
Trial 1	Trial 2	Trial 3
0.26	0.33	0.31

Calculate the mean thickness of the original piece of aluminium foil along with its **percentage** uncertainty. [3]

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(iii) Determine the volume of the rectangular piece of aluminium foil along with its **percentage** uncertainty. [2]

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(b) The mass of the rectangular piece of aluminium foil was found to be 2.81 ± 0.01 g. Determine the density of aluminium along with its **absolute** uncertainty. [4]

(c) State which of the measurements contributed most to the uncertainty in the calculation. Describe how you could reduce the uncertainty in this measurement to improve the results. [2]

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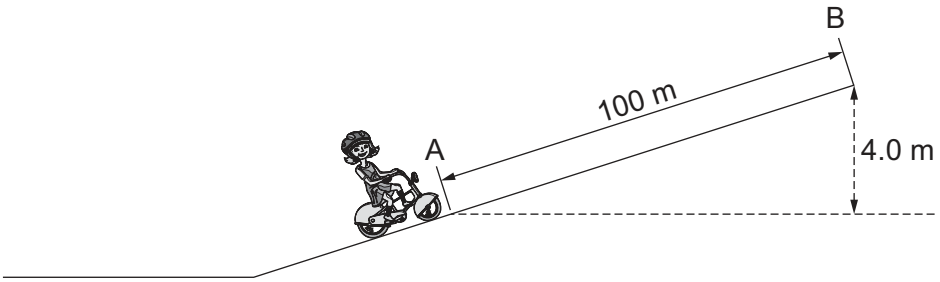
3. Helen is riding an electric bike (a bike that is assisted by an electric motor) up a hill at a speed of 4.5 m s^{-1}. At point A she starts the electric motor and accelerates uniformly reaching a speed of 9.2 m s^{-1} at B. Whilst accelerating she also gains a height of 4.0 m as shown in the diagram below.



(a) Show that the time taken for Helen's journey between A and B is approximately 15 s. [2]

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(b) Helen and the bike have a combined mass of 95 kg. Determine the gain in total energy between A and B. [3]

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(c) (i) If the bike's electric motor operates at 36 V and 7.0 A calculate the electrical energy used by the motor between A and B. [2]

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(ii) Helen, by pedalling, also provides 5 500 J of work between A and B. Determine the efficiency of the electric motor. *Ignore all resistive forces on Helen and the bike.* [2]

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(iii) In practice resistive forces will act. Identify these forces and where they act. [2]

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(d) Helen believes that by riding an electrically powered bike to the shops rather than using her car she is benefiting the environment. Explain whether or not Helen is correct. [2]

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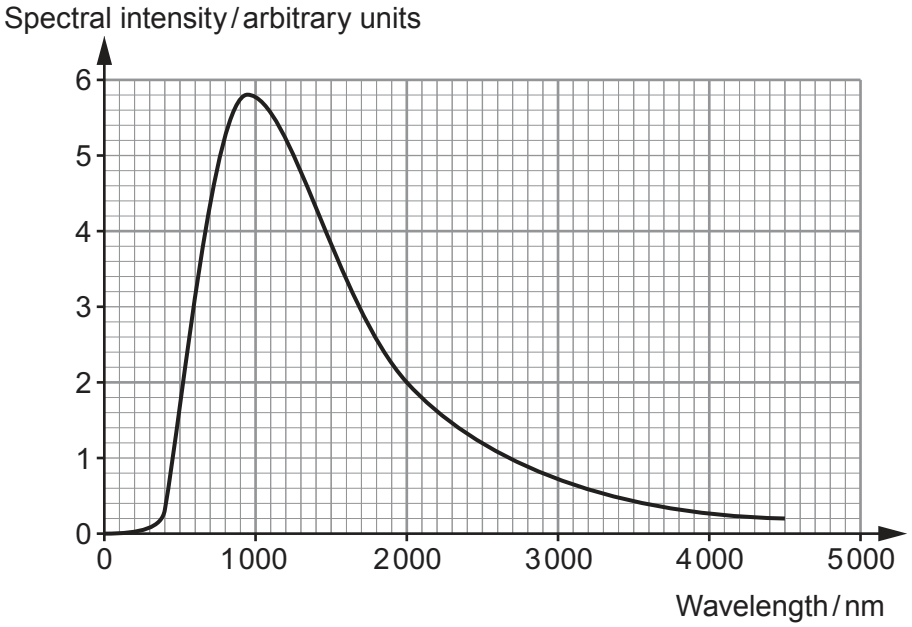
4. *(a)* Stefan's law can be written as:

$$P = A\sigma T^4$$

Show that Stefan's constant, σ, has the base SI units of $kg\,s^{-3}K^{-4}$. [3]

(b) Our nearest star is called Proxima Centauri. The following graph shows its spectrum.



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(i) The total power output of electromagnetic radiation emitted from Proxima Centauri is 5.9×10^{23} W. Use this information and the graph opposite to calculate its effective diameter. [4]

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(ii) State what colour you would expect Proxima Centauri to appear and name the region of the electromagnetic spectrum in which most of the star's power is radiated. [1]

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5. *(a)* Subatomic particles can be classified as either hadrons or leptons. Giving examples of each, fully describe the differences and similarities between these two groups. Include the types of interaction they undergo and how one of the groups can be further sub divided. [6 QER]

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(b) Electron capture occurs when an electron interacts with a proton in the nucleus of an atom. The following interaction occurs:

$$p + e^- \longrightarrow n + x$$

(i) Identify the particle, x, explaining how you used the relevant conservation laws. [3]

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(ii) Describe the change in quark flavour during electron capture. [1]

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(iii) State and explain which interaction is responsible for this decay. [1]

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6. *(a)* State what is meant by the centre of gravity of an object. [1]

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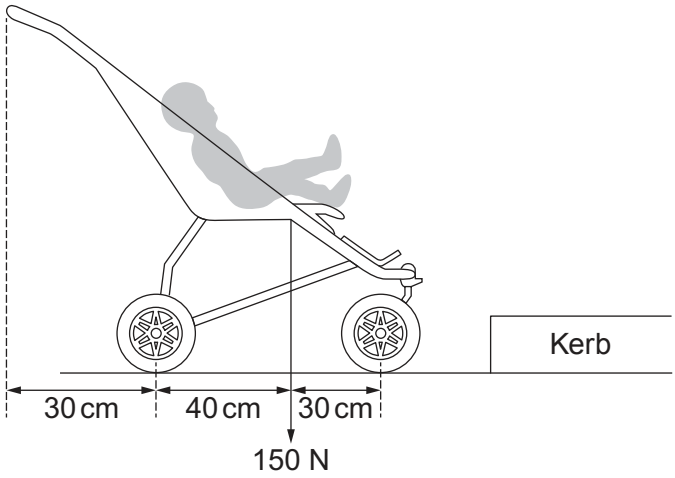
(b) A baby is being pushed in a buggy as shown below. The baby and buggy have a combined weight of 150 N.



(i) The father moves the buggy from the road over the kerb. By taking moments about the rear wheel of the buggy calculate the vertical downward force on the handle that would be needed to just lift the front wheel. [2]

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(ii) The father finds it a lot easier to turn the buggy around and, using the handle, lift the back wheel onto the kerb while keeping the front wheel on the ground. Explain why the father finds this new approach easier and justify your answer with a calculation. [3]

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(iii) Describe **two** ways in which you could alter the design of the buggy in order to make it more stable. [2]

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Examiner only

7. *(a)* Ignoring the effects of air resistance, describe how, if at all, the vertical and horizontal components of a projectile's velocity change during flight on Earth. [2]

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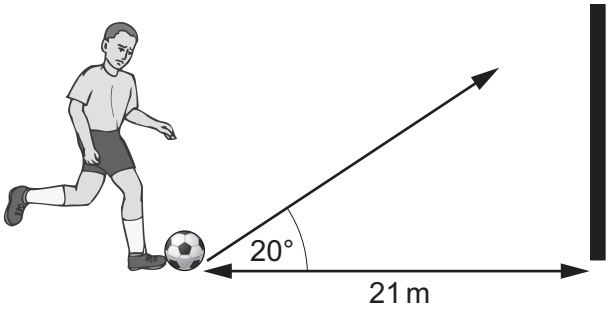
(b) (i) A football player takes a free kick 21 m away from the goal. The ball leaves the ground at an angle of 20°. Show that the velocity he must strike the ball at is approximately 25 m s^{-1} if it is to reach its maximum height at the moment it reaches the goal. *Ignore the effects of air resistance.* [4]



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(ii) The height of the cross bar is 2.44 m above the ground. Justify numerically whether the ball crosses the goal line above or below the bar. [3]

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(iii) Discuss how air resistance might affect the height at which the ball reaches the goal. [2]

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END OF PAPER