Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS

B420U10-1

S24-B420U10-1

WEDNESDAY, 15 MAY 2024 – MORNING

PHYSICS – AS component 1
Motion, Energy and Matter

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**10**	
2.	**10**	
3.	**13**	
4.	**12**	
5.	**10**	
6.	**12**	
7.	**8**	
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. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

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. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

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 **4**(b)(i).

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Answer **all** questions.

1. (a) (i) Newton's second law of motion can be expressed by the equation:

$$\sum F = ma$$

State which quantities in the equation are vector(s) and which are scalar(s). [2]

Vector(s): .....

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Scalar(s): .....

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(ii) State the difference between vectors and scalars. Give **one further example** of each. [2]

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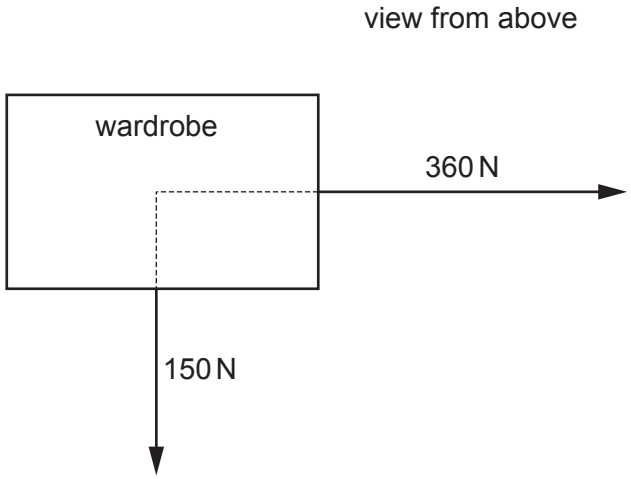
(b) Two people are dragging a wardrobe across a room. One pulls on a rope with a force of 360 N and the other pulls at right angles with a force of 150 N as shown.



(i) Determine the resultant of these two forces. Show clearly the direction of the resultant force. [4]

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(ii) Determine the force of friction acting on the wardrobe when it is moving at a constant velocity. [2]

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2. (a) One of the equations of motion can be written as:

$$v = u + at$$

Show that the equation is homogeneous in terms of units. [2]

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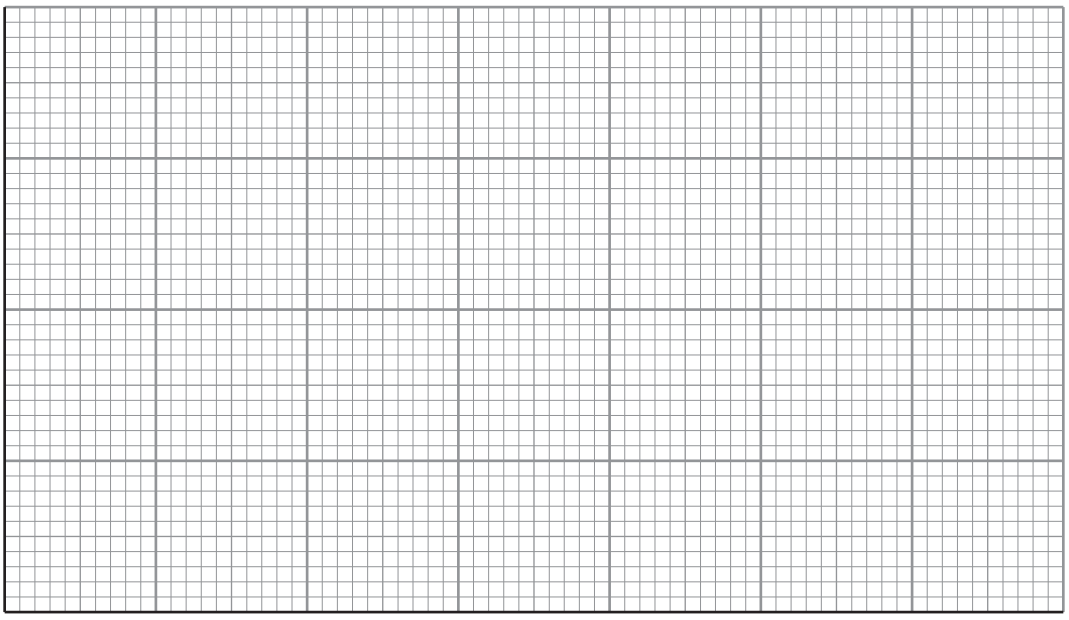
(b) (i) Milly throws a ball vertically upwards with a velocity of $15\,m\,s^{-1}$. She catches it when it returns to the same point she released it.

Draw a velocity-time graph for the motion of the ball during its flight. Add scales on both axes. Space has been left below for calculations. Ignore the effects of air resistance. [6]



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(ii) Calculate the maximum height reached by the ball. [2]

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Turn over.

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3. (a) Billy's physics teacher says that when his electric scooter is travelling at a velocity, v, with a force, F, the power, P, can be expressed by:

$$P = Fv$$

Starting with the definition of work show that Billy's teacher is correct. [2]

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(b) Billy rides his electric scooter on a road that is 200 m long at a **constant** speed of 8.5 m s^{-1}.

(i) Determine the time taken for Billy's journey. [2]

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(ii) Billy and his scooter have a combined mass of 85 kg. The road has an upward incline of 1.5°. Determine the gain in potential energy during his journey. [3]

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(iii) Billy's scooter operates at 36 V and 6.0 A. Calculate the electrical energy used by the motor during the journey. [2]

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(iv) Determine the overall efficiency of the scooter. [2]

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(c) Some people think electric scooters should be banned from using pavements and pedestrian areas. Explain, giving your reasons, whether you agree or disagree. [2]

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4. (a) (i) Define the Young modulus of a material. [1]

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(ii) Rubber is a polymer. Describe its structure on a molecular scale. [2]

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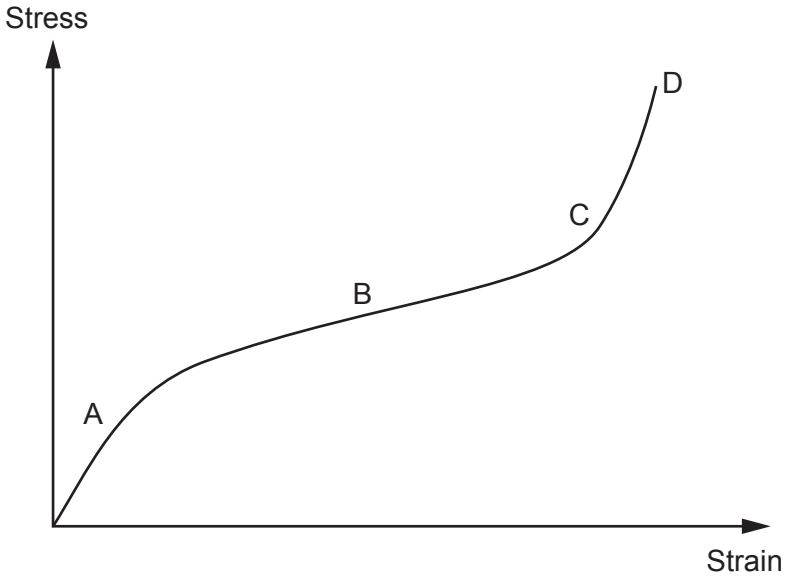
(b) A stress against strain graph for rubber is shown below.



(i) Explain the shape and gradient of the graph in terms of the molecular behaviour of rubber. [6 QER]

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(ii) **On the same axes**, sketch the graph that would be obtained when unloading the rubber band, assuming it undergoes hysteresis. [1]

(iii) Explain why hysteresis occurs. [2]

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5. (a) Explain how hadrons and leptons differ from each other. Give **one** example of each. [4]

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(b) (i) Scientists at CERN observed the following reaction, where x is an unidentified particle.

$$\nu_e + n = p + x$$

Identify particle x. Give your reasoning. [4]

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(ii) Doug believes this to be a strong force interaction. Determine whether Doug is correct. [2]

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6. (a) A ball bearing quickly reaches terminal velocity when falling through oil. Explain in terms of forces why a terminal velocity is reached. [2]

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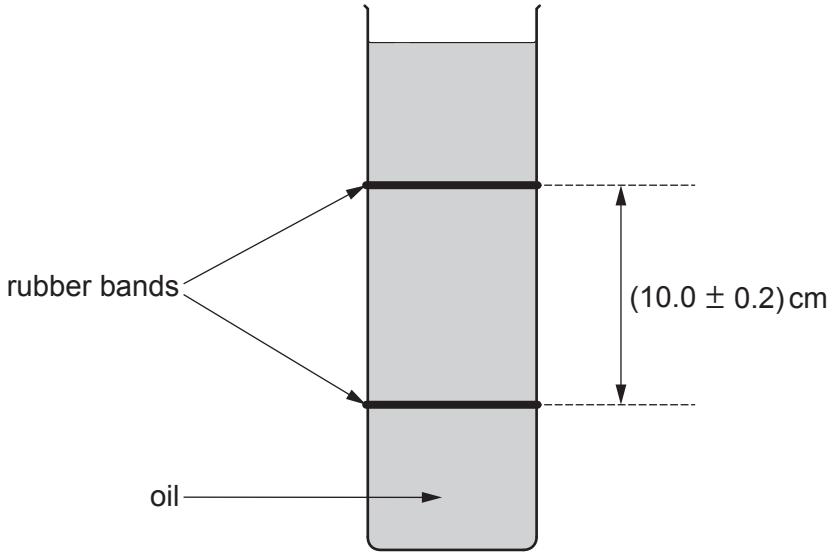
(b) Anagha decides to carry out an experiment to determine the terminal velocity of the ball bearing. She uses a measuring cylinder full of oil and puts two thin bands on the flask 10.0 ± 0.2 cm apart, as shown below.



Anagha measures the time it takes for the ball bearing to fall between the two rubber bands. She repeats the measurements a total of three times and obtains the following results.

Time / s		
Trial 1	Trial 2	Trial 3
5.06	4.81	4.90

(i) Determine the mean for these readings. [1]

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(ii) Determine the terminal velocity along with its **percentage** uncertainty. Assume the ball bearing reaches terminal velocity by the time it gets to the first rubber band. [5]

(iii) Determine the **absolute** uncertainty in the terminal velocity. Hence, state the terminal velocity with its absolute uncertainty to a suitable number of significant figures. [2]

(iv) Determine **two** ways in which Anagha could reduce the uncertainty in her final result. [2]

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TURN OVER FOR THE LAST QUESTION

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7. (a) Neutron stars have an outer layer that radiates as a black body. Explain what is meant by a black body. [1]

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(b) RX J1856.5 -3754 is one of the closest neutron stars to Earth in the constellation Corona Australis. It has a diameter of 20 km and a surface temperature of approximately 7×10^5 K.

(i) Calculate the wavelength of its greatest spectral intensity. [2]

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(ii) State which part of the electromagnetic spectrum this radiation belongs to. [1]

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(iii) Calculate the total power emitted by the neutron star. [2]

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(iv) The distance from the neutron star to the Earth is 3.8×10^{18} m. Calculate the intensity of the radiation from the star received at the Earth. [2]

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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