Surname	Centre Number	Candidate Number
Other Names		2

GCE AS

B420U10-1

S19-B420U10-1

eduqas
Part of WJEC

PHYSICS – AS component 1
Motion, Energy and Matter

TUESDAY, 14 MAY 2019 – MORNING

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**11**	
3.	**11**	
4.	**9**	
5.	**11**	
6.	**13**	
7.	**9**	
Total	**75**	

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01

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

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(ii) Express the unit of the Young modulus in terms of S.I. base units. [3]

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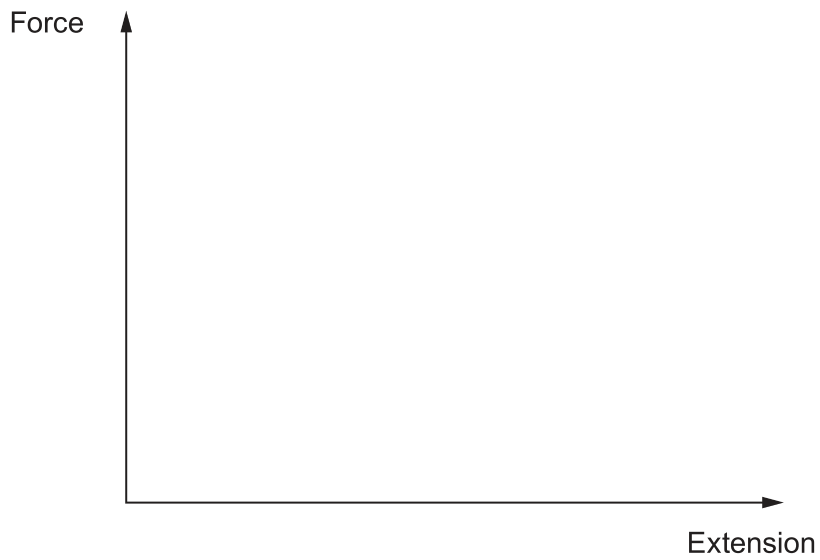
(b) (i) When a rubber band is gradually loaded and then unloaded it shows *hysteresis* and *permanent set*. Sketch, and **clearly label** a force-extension graph for rubber to illustrate these two effects. [3]



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(ii) Considering the molecular structure of rubber explain why it has a much lower value of Young modulus than that of a metal. [2]

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(iii) What is the effect on the Young modulus of rubber when its temperature rises? Explain your answer. [2]

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2. A wooden block on a string (ballistic pendulum) is a device that can be found at well equipped shooting ranges. It is used to find the speed of a bullet. To calculate the speed it is necessary to use both the principles of conservation of energy and momentum.

(a) State the principle of conservation of energy. [1]

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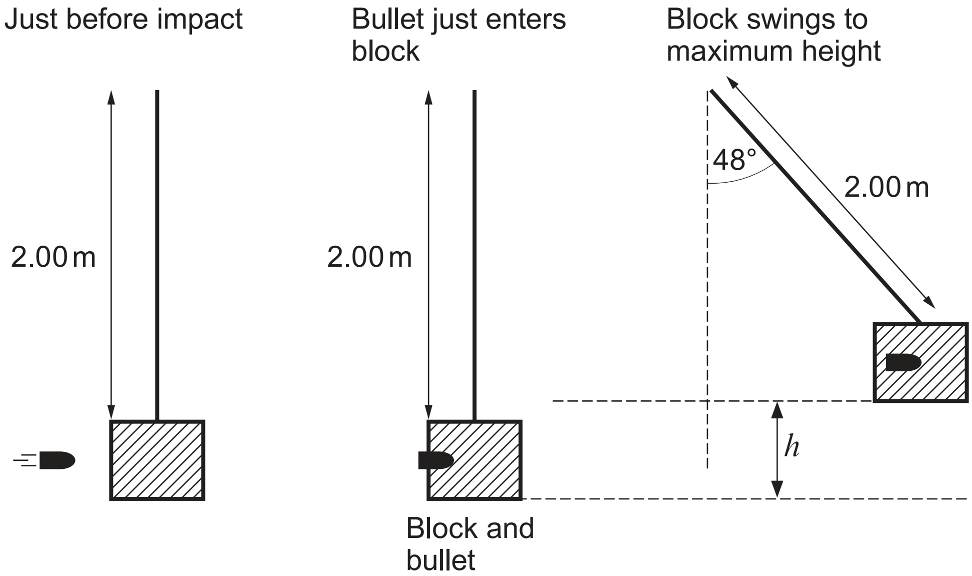
(b) When a bullet of mass 10.0 g is fired horizontally into a pendulum of mass 1.90 kg, the block rises through an angle of 48° as shown. The pendulum string is 2.00 metres long.



(i) Show that the height, h, the block rises is approximately 0.70 m. [2]

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(ii) Using the principle of conservation of energy, determine the velocity of the block **and** the bullet just after the bullet has embedded itself in the block. [2]

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(c) (i) State the principle of conservation of momentum. [2]

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(ii) Determine the speed of the bullet just before it enters the block. [2]

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(d) Discuss whether you feel it would be appropriate for a Physics teacher to carry out this experiment in school with a group of sixth form students. [2]

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3. A child's jumping toy uses the compression of a spring to fire it up into the air. The spring used requires a force of 0.50 N to compress it by 1.0 cm.

(a) State Hooke's law. [1]

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(b) The toy has a mass of 20 g and the spring is compressed by 6.0 cm and then released.

(i) Calculate the velocity with which it leaves the ground. [3]

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(ii) Determine the initial acceleration of the toy as the spring extends. State any assumption you make. [2]

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(c) (i) Ignoring air resistance, determine the maximum height gained by the toy. [3]

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(ii) Determine the total time of flight. [2]

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4. *(a)* Define a black body. [1]

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(b) A physics student, Tony, notices that the classroom is warmer when it has a number of students in it rather than when it is empty. Tony claims that each student will behave like a perfect black body and will emit about the same amount of heat as a 200 W light bulb. Assuming a typical human body has a surface area of 2 m^2. Evaluate whether or not Tony appears to be correct. Normal body temperature can be taken to be 37 °C. [3]

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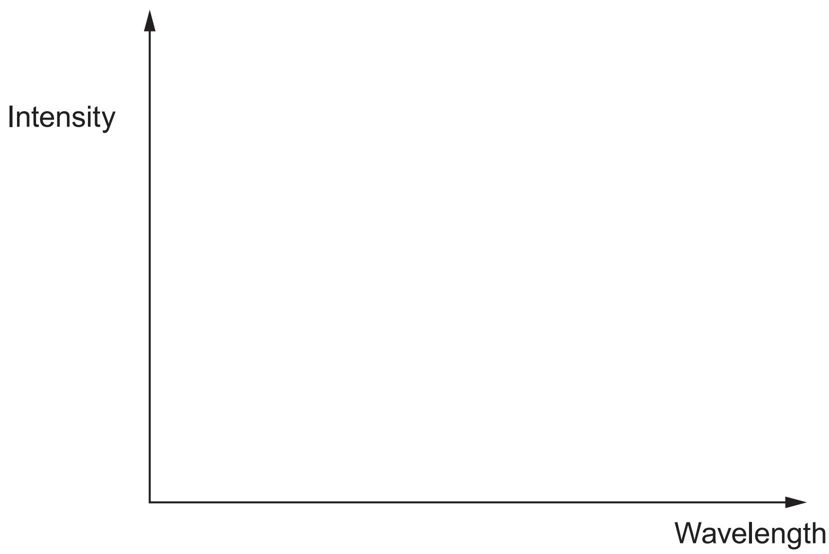
(c) (i) Some stars appear to be coloured to the naked eye. For two stars of similar diameter one appears red and the other appears blue. Sketch and label typical black body spectra for each star on the graph below. [3]



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(ii) Suggest why it is that no stars appear to be green in colour. [2]

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5. *(a)* Describe how you could determine the mass of an unknown object using only a metre ruler, pivoted at the 30 cm point, and a known mass. Assume both the known and unknown masses are similar to the mass of the metre ruler. **You cannot change the position of the pivot.** [6 QER]

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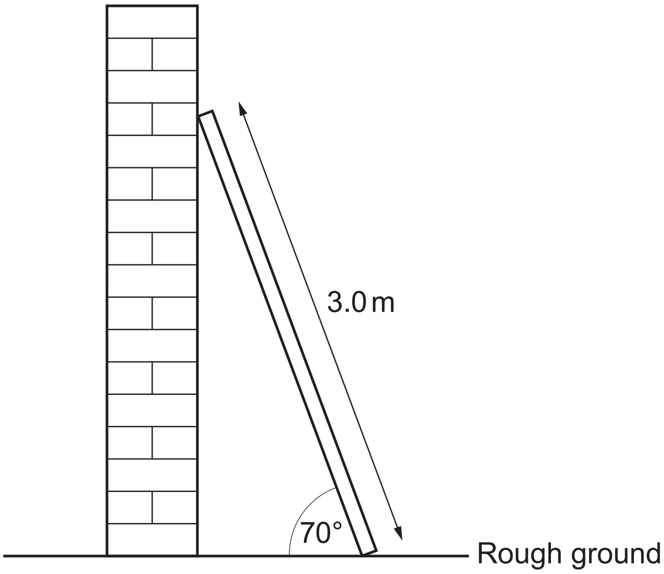
(b) A uniform ladder of length 3.0 m and mass 30 kg rests against a frictionless wall at an angle of 70° to the ground as shown below.



By taking moments about a suitable point calculate the size of the force that the ladder exerts on the wall and explain in which direction it acts. [5]

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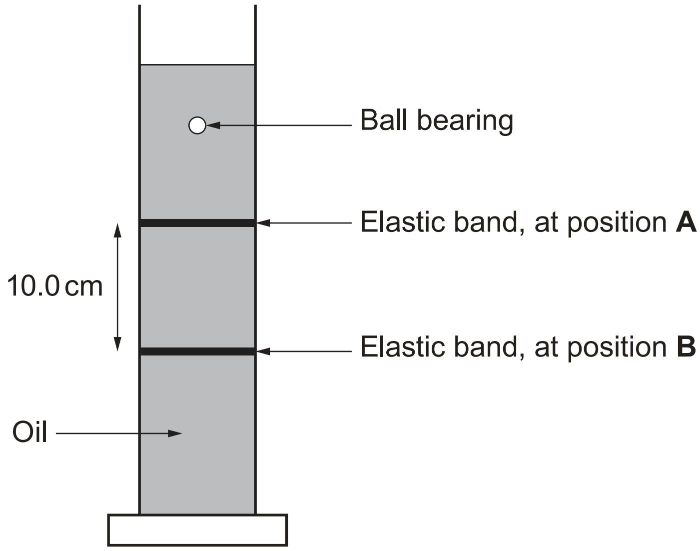
6. Emma investigates the viscosity of oil by measuring the terminal velocities of a number of different sized ball bearings as they move through it. She uses the following apparatus.



(a) (i) Once released, a ball bearing attains terminal velocity before it reaches the elastic band at position **A**. Explain what is meant by terminal velocity. [1]

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(ii) At terminal velocity the two main forces acting on the ball bearing are its weight and the drag of the oil. According to Newton's third law, for each of these forces there is a corresponding equal and opposite force. Identify each of these forces and the body upon which it acts. [2]

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(b) Emma measures the time it takes the ball bearings to fall from the elastic band at position **A** to the elastic band at position **B**. She carries out each measurement twice, and obtains the following results. The distance between the two elastic bands is 10.0 cm. The uncertainty in this distance can be considered negligible when calculating the uncertainty in the terminal velocity.

Ball bearing		Time to fall			Terminal velocity	
Diameter, d / cm	(Diameter)^2, d^2 / cm^2	Reading 1 / s	Reading 2 / s	Mean / s	Velocity, v / cm s^{-1}	Uncertainty, Δv / cm s^{-1}
0.24	0.058	14.0	14.6	14.3		± 0.01
0.32	0.10	8.0	8.6	8.3		± 0.05
0.40	0.16	5.3	5.9		1.8	±
0.48	0.23	3.6	4.1		2.6	±
0.64	0.41	2.2	1.9	2.1	4.8	± 0.3

Complete the table. *Space has been left for any calculations if needed.* [4]

(c) (i) Emma's friend, Fiona, thinks that the terminal velocity, v, is directly proportional to the square of the diameter, d, of the ball bearing,

$$v \propto d^2.$$

Plot a suitable graph to check whether Fiona is correct. [4]

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(ii) Evaluate whether or not Fiona is correct. [2]

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7. *(a)* Quarks and electron neutrinos are fundamental particles whereas protons and neutrons are not. Explain this statement. [2]

(b) (i) State why it is that electron neutrinos are very difficult to detect. [2]

(ii) Electron neutrinos can be detected when they interact with deuterium nuclei, ${}^{2}_{1}\mathrm{H}$, that are present in heavy water. The following reaction is observed.

$$\nu_e + {}^{2}_{1}\mathrm{H} \rightarrow \mathrm{p} + \mathrm{p} + \mathrm{x}$$

Identify particle x and justify your answer using the conservation laws. [3]

(c) When a positron and an electron meet they annihilate to produce two gamma ray photons.

$$e^{+} + e^{-} \rightarrow \gamma + \gamma$$

State which force is responsible for this interaction, giving your reasoning. [2]

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END OF PAPER

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