Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A LEVEL – NEW

2420U10-1

S17-2420U10-1

PHYSICS – AS unit 1
Motion, Energy and Matter

TUESDAY, 23 MAY 2017 – MORNING

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**14**	
2.	**13**	
3.	**13**	
4.	**11**	
5.	**14**	
6.	**9**	
7.	**6**	
Total	**80**	

2420U101
01

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use pencil or gel pen. Do not use correction fluid.

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 continuation 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 80.

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 **Q7**.

MAY172420U10101

Examiner only

Answer **all** *questions.*

1. *(a)* In the production of steel alloy, atoms of carbon are added to iron. The resulting alloy is less *ductile* than pure iron. State the meaning of the term *ductile*, and describe, on an atomic scale, why the addition of carbon atoms can make steel less ductile than iron. [3]

.....

.....

.....

.....

.....

.....

(b) A wire of length 2.4 m and diameter 0.60 mm is made of steel of Young modulus $200 \times 10^9\,\text{N m}^{-2}$. The wire is loaded so that its length is increased by 1.8 mm. Assuming that the change is elastic, calculate:

(i) the strain; [1]

.....

.....

.....

(ii) the applied stress; [2]

.....

.....

.....

.....

(iii) the force applied to the wire; [2]

.....

.....

.....

.....

Examiner only

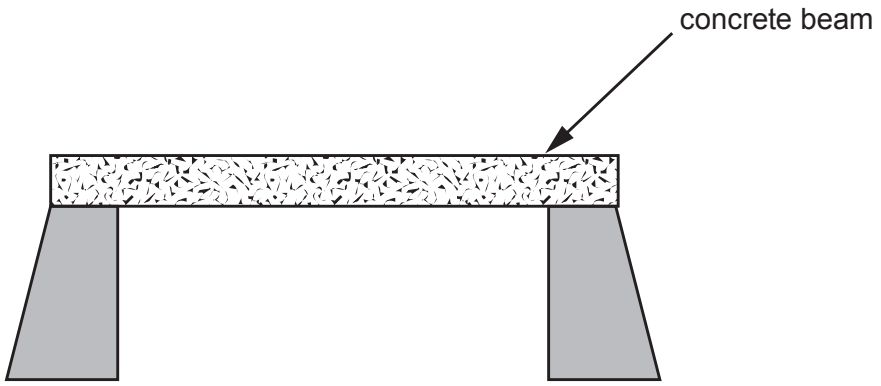
(iv) the elastic energy stored in the wire. [2]

.....

.....

.....

(c) The diagram shows how a gap can be bridged using a concrete beam.



(i) **On the diagram** label a point in tension with the letter **T**, and a point in compression with the letter **C**. [1]

(ii) Inserting a pre-stressed steel bar into the concrete beam would increase the breaking stress of the concrete. **On the diagram**, draw a pre-stressed steel bar in an appropriate position. [1]

(iii) Explain how the steel bar strengthens the beam. [2]

.....

.....

.....

.....

.....

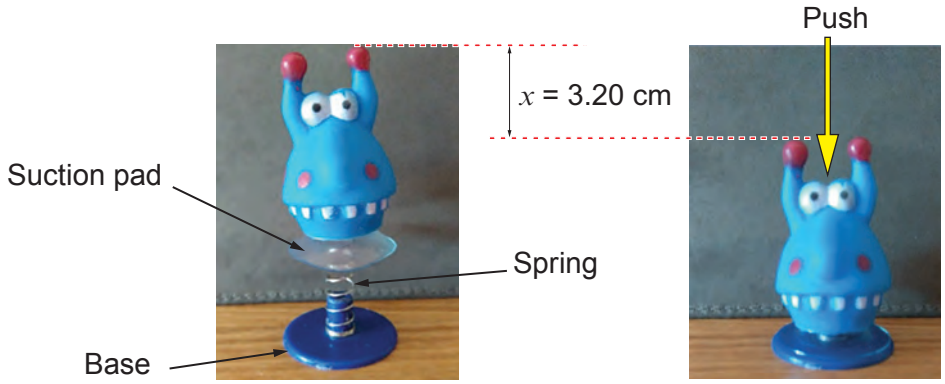
2420U101
03

14

Turn over.

Examiner only

2. A student is asked to find a value for the spring constant, k, of a spring used in a jumping toy. Pushing down on the toy compresses the spring allowing the suction pad to stick to the base. After a few seconds the force on the suction pad decreases and the toy 'jumps' into the air.



The student measures the jump height for five separate jumps using a metre rule. The results are shown in the table.

Jump number	1	2	3	4	5
Jump height / cm	48	52	54	46	49

(a) (i) Calculate the mean jump height, h_{mean} along with the **absolute** uncertainty in its value. [2]

.....

.....

.....

(ii) Calculate the **percentage** uncertainty in h_{mean}. [1]

.....

.....

(b) (i) The student applies a principle of physics to the jumping toy to show that:

$$k = \frac{2mgh_{\text{mean}}}{x^2}$$

where: m is the mass of the toy and x is the compression of the spring.

State which principle was used and explain how it can be applied to derive the formula shown. [2]

.....

.....

.....

.....

Examiner only

(ii) The student uses an accurate balance to measure the mass, m, of the toy to be 48.40 g and digital callipers to measure the compression of the spring, x, to be 3.20 cm. He decides **not** to determine the uncertainty in these measurements.

I. Explain why it is reasonable for the student to ignore these uncertainties. [2]

.....

.....

.....

II. Calculate k along with the **absolute** uncertainty in its value. Give both values to an appropriate number of significant figures. [3]

.....

.....

.....

.....

.....

.....

III. State whether your answer to *(b)*(ii)(II) is likely to be smaller than or greater than the actual value for k. Justify your answer. [2]

.....

.....

.....

(c) Describe one practical procedure by which the student could reduce the uncertainty in k. [1]

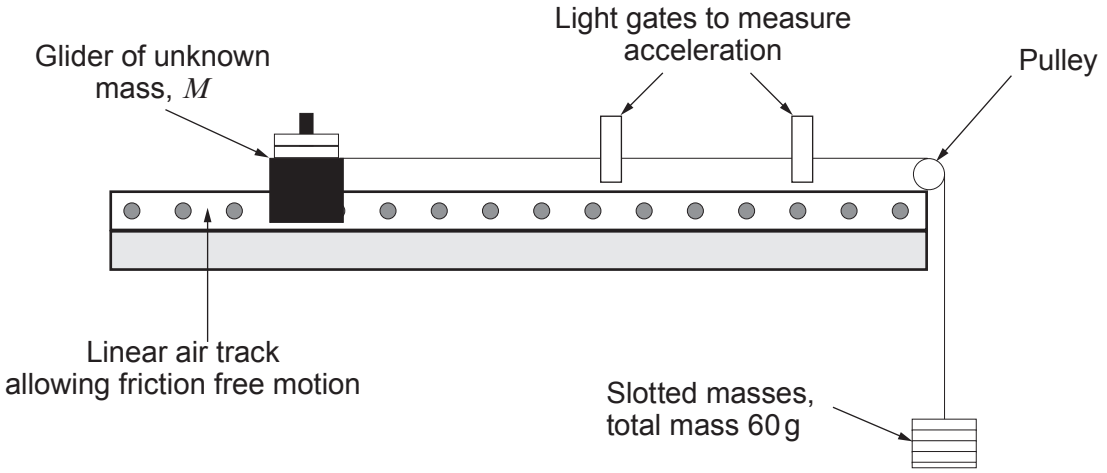
.....

.....

.....

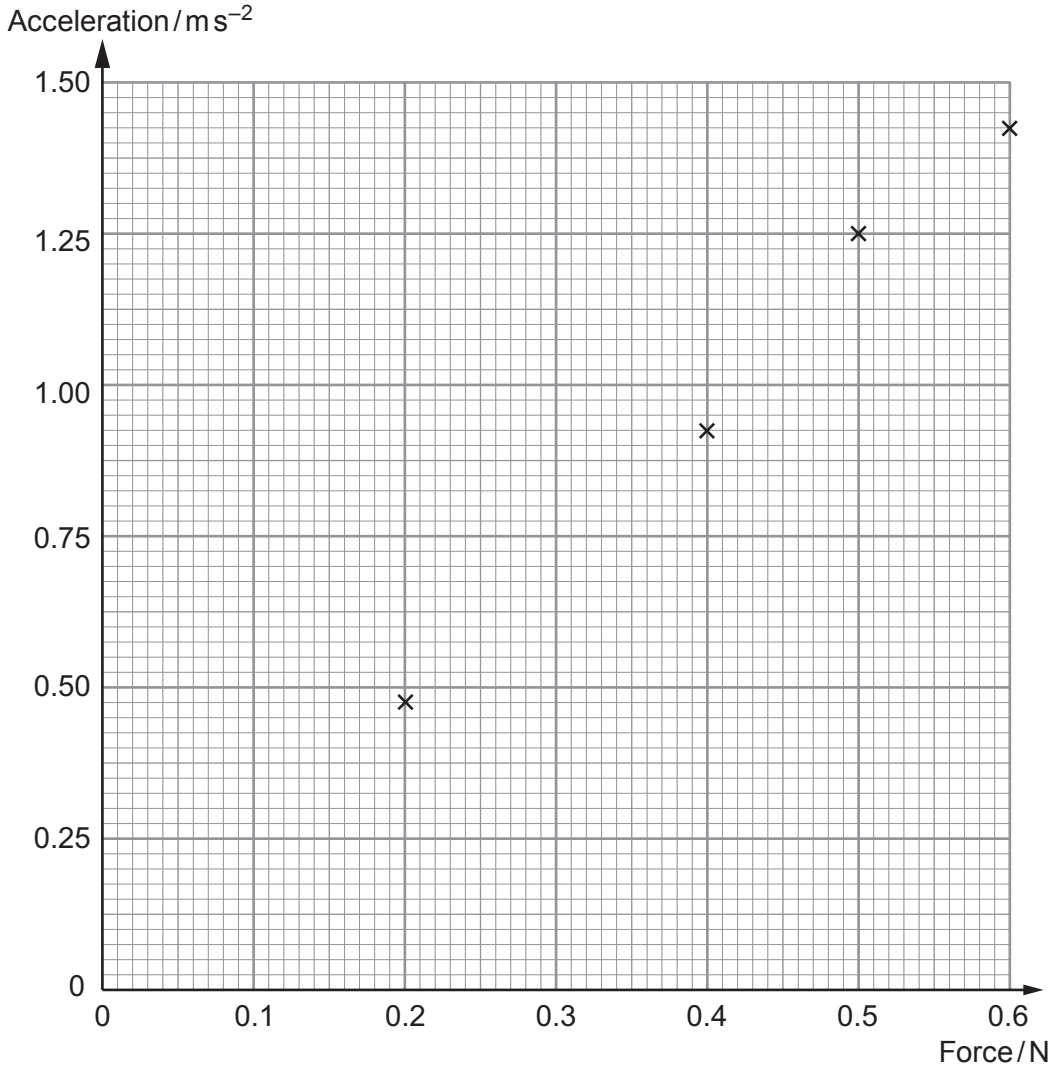
Examiner only

3. *(a)* A student uses the following apparatus to determine the unknown mass, M, of a glider.



The total mass of the system is kept constant by removing one of the slotted masses from the hanging weight and placing it on the glider for each reading of force and acceleration.

She plots **some** of her measurements on the grid below.



Examiner only

(i) Draw a line of best fit on the graph and use it to determine the gradient. [2]

.....

.....

.....

(ii) Show clearly that the gradient has units $\mathbf{kg^{-1}}$. [2]

.....

.....

.....

(iii) Determine the value of M, the unknown mass of the glider. [3]

.....

.....

.....

.....

.....

(iv) Comment on the quality and sufficiency of the data obtained. [2]

.....

.....

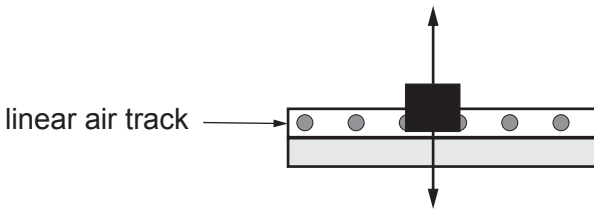
.....

.....

Examiner only

(b) Two vertical forces acting on the glider are shown below.

Force on glider due to air = ...N



Weight of glider = ...N

(i) **Fill in the missing values** on the above diagram. [2]

(ii) The two forces shown **do not** form a Newton 3rd law pair. Give two reasons why. [2]

.....

.....

.....

.....

13

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

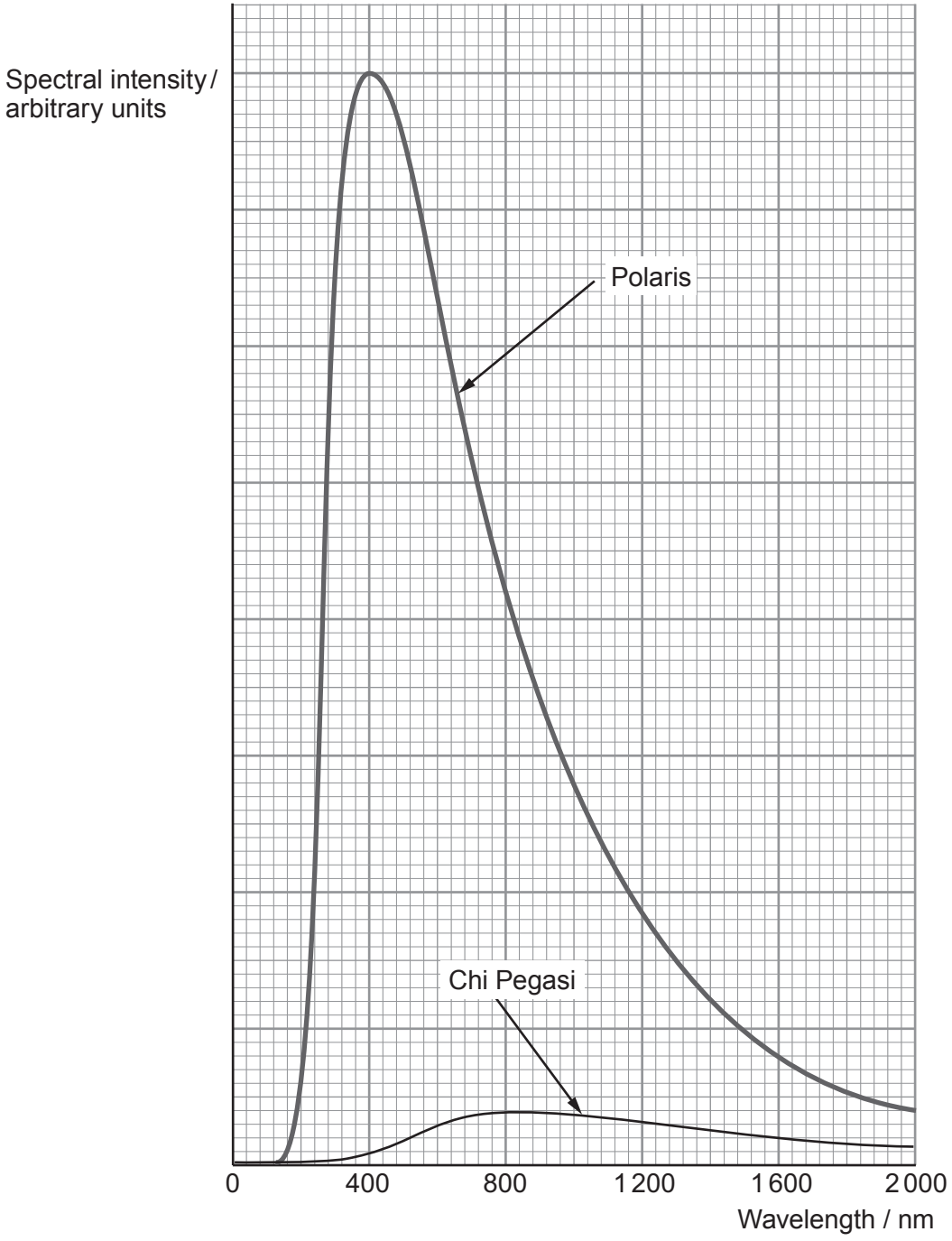
Examiner only

4. *(a)* Stars are very good approximations to *black bodies*. State what is meant by a *black body.* [1]

.....

.....

(b) The graph shows the black body radiation curves for the two stars Polaris (sometimes called the North Star) and Chi Pegasi (a red supergiant in the constellation Pegasus). The stars are equidistant from the Earth.



Examiner only

(i) Use the graph to state **three** differences between Polaris and Chi Pegasi. [3]

.....

.....

.....

.....

.....

(ii) The surface temperature of Polaris is 7 250 K. How does the graph confirm this? [2]

.....

.....

.....

(iii) Polaris is 431 light years from Earth and the intensity of radiation received on Earth from it is 4.05×10^{-9} W m^{-2}. Show that the luminosity of Polaris is approximately 8.5×10^{29} W. [1 light year = 9.46×10^{15} m] [2]

.....

.....

.....

.....

(iv) Calculate the radius of Polaris. [3]

.....

.....

.....

.....

.....

.....

11

Examiner only

5. *(a)* Two equations of accelerated motion are $v = u + at$ and $v^2 = u^2 + 2ax$. Use these equations to show that, for a body accelerating uniformly from rest: [2]

$$x = \tfrac{1}{2}\, at^2$$

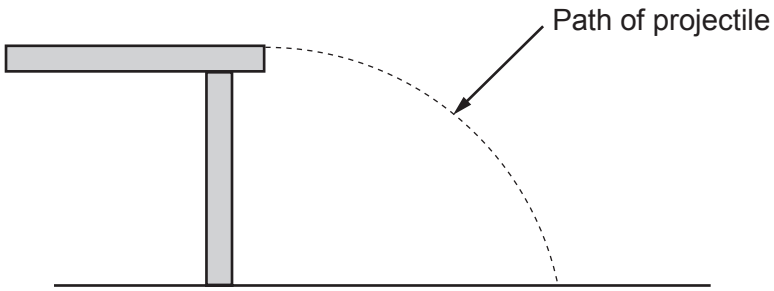
.....

.....

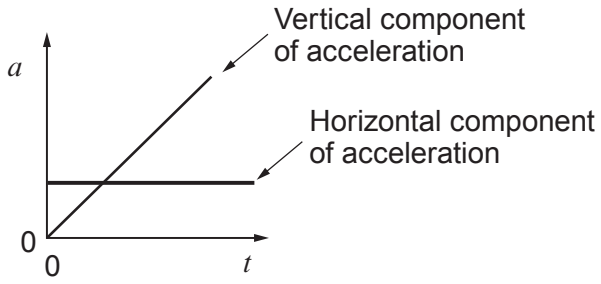
.....

.....

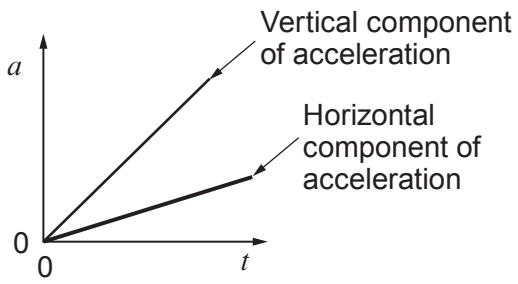
(b) The diagram shows the path of a projectile after it is launched horizontally from a table.



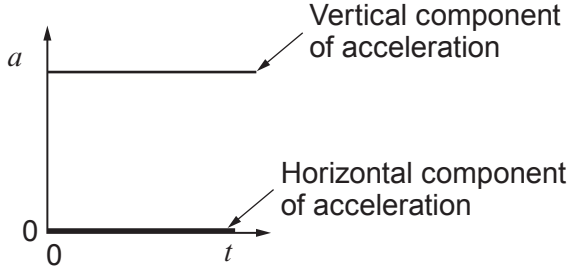
When considering the horizontal and vertical components of the motion, graphs of horizontal acceleration and vertical acceleration against time are sketched. **Only one** of the following sketch graphs shows a correct combination. *[Ignore air resistance for the remainder of the question.]*



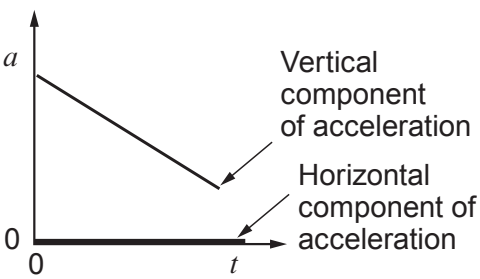
Graph 1



Graph 2



Graph 3



Graph 4

Examiner only

State which graph shows the correct combination and explain your answer. [3]

.....

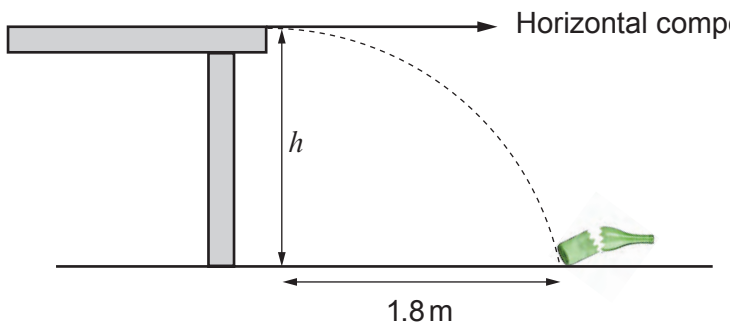
.....

.....

.....

.....

(c) A bottle is accidentally knocked from the table and follows the path shown.



(i) Calculate the height, h, of the table. [3]

.....

.....

.....

.....

.....

.....

Examiner only

(ii) Calculate the magnitude of the velocity and the direction of travel of the bottle just before it hits the ground. [4]

.....

.....

.....

.....

.....

.....

.....

(d) State whether or not the following statement is correct and justify your answer. [2]

The flight time for the bottle in part (c) will depend on the horizontal velocity – the greater the horizontal velocity, the longer it will take for the bottle to hit the floor after leaving the table.

.....

.....

.....

.....

14

Examiner only

6. *(a)* State the conditions necessary for a body to remain in equilibrium. [2]

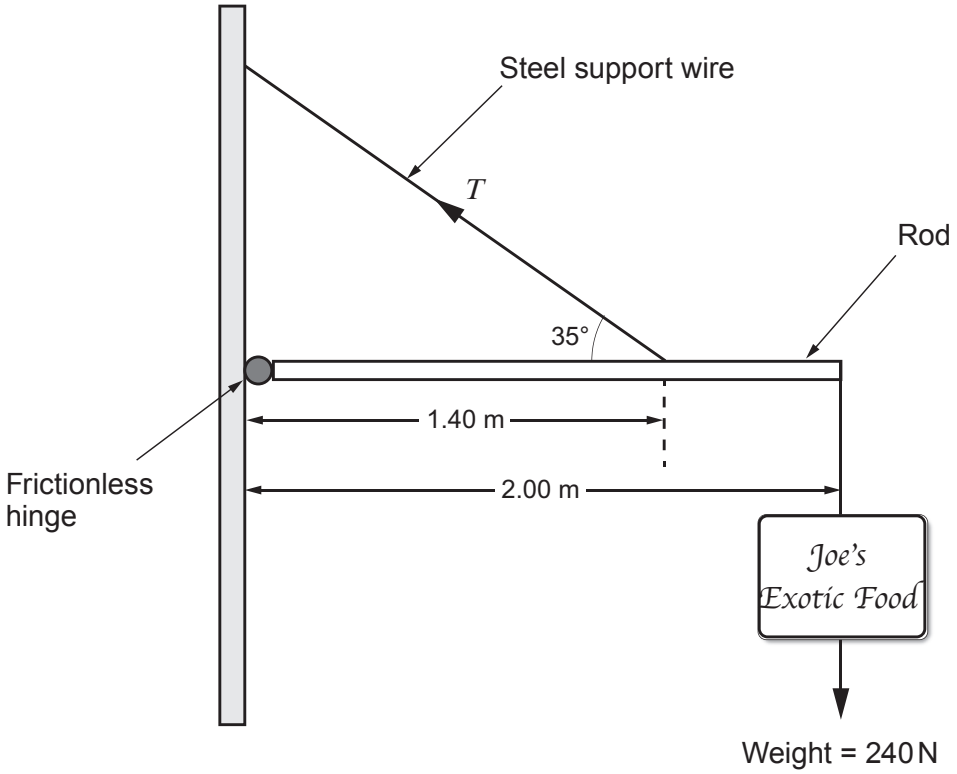
.....

.....

.....

.....

(b) A shopkeeper wishes to hang a heavy sign of weight 240 N outside his shop using the following arrangement. He has steel wires of various diameters to choose from. You may neglect the weight of the rod.



The shopkeeper needs to ensure that the steel wire he decides to use has a breaking strength greater than is required to support the sign. By taking moments about an appropriate point, show that the tension, T, in the wire in the above diagram is approximately 600 N. [3]

.....

.....

.....

.....

.....

Examiner only

(c) The shopkeeper finds the following information on a website advertising steel wire ropes.

Minimum breaking strength and safe working load of uncoated steel wire ropes are indicated below.

Diameter of rope / mm	Minimum breaking strength / N	Safe working load / N at 5:1 ratio	Safe working load / N at 3:1 ratio
1.5	1 900	380	633
2.0	2 750	550	916
2.5	3 300	660	1 100
3.0	5 400	1 080	1 800

Loading Information

SAFE WORKING LOAD (SWL) is the load that can be applied without causing any damage to the wire rope.

WE PROVIDE TWO SWLs FOR YOUR CONSIDERATION AT RATIOS 5:1 AND 3:1.

Factors of safety should always be applied when determining maximum wire rope loading conditions. If in doubt a suitably qualified engineer should be consulted to assess loading factors.

Examiner only

(i) Based on the information on the web page the shopkeeper decides to apply a SWL ratio of 3:1 for the wire he will use. State, giving your reasoning, which **minimum** diameter of wire rope he should choose to use. [2]

.....

.....

.....

.....

.....

(ii) The shopkeeper has no engineering background. Evaluate whether or not he has made an informed decision. [2]

.....

.....

.....

.....

.....

.....

9

TURN OVER FOR THE LAST QUESTION

Examiner only

7. The following process describes the decay of a neutron.

$$n \rightarrow p + e^- + \bar{\nu}_e$$

Give a detailed description of the process, including how conservation laws apply. [6 QER]

END OF PAPER

6

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

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

Examiner only