

Please write clearly in block capitals.

Centre number

--	--	--	--	--

Candidate number

--	--	--	--

Surname

---

Forename(s)

---

Candidate signature

---

# AS PHYSICS

## Paper 1

Tuesday 14 May 2019

Morning

Time allowed: 1 hour 30 minutes

### Materials

For this paper you must have:

- a pencil and a ruler
- a scientific calculator
- a Data and Formulae Booklet.

### Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show all your working.

### Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.
- You are expected to use a scientific calculator where appropriate.
- A Data and Formulae Booklet is provided as a loose insert.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
<b>TOTAL</b>	



Answer **all** questions in the spaces provided.

*Do not write  
outside the  
box*

0 1 . 1

Deuterium is an isotope of hydrogen. Its nucleus contains one proton and one neutron.

Calculate the specific charge of the deuterium nucleus.

**[2 marks]**

specific charge = \_\_\_\_\_ C kg<sup>-1</sup>



**0 1 . 2**

The proton and neutron in the deuterium nucleus are held together by the strong nuclear force.

Which is an exchange particle of the strong nuclear force?

Tick (✓) **one** box.

**[1 mark]**

muon

☐

photon

☐

pion

☐ $W^+$  boson☐**0 1 . 3**

The deuterium nucleus is stable.

Describe how the variation of the strong nuclear force with distance contributes to the stability of the deuterium nucleus.

**[3 marks]**

---

---

---

---

---

---

---

---

**Question 1 continues on the next page**

**Turn over ►**

0 1 . 4

Tritium is an isotope of hydrogen. Its nucleus contains one proton and two neutrons. Tritium undergoes radioactive decay.

Three modes of radioactive decay are

- alpha decay
- beta minus ( $\beta^-$ ) decay
- electron capture.

Deduce which of these modes could produce the nucleus of another element when the tritium nucleus decays.

[3 marks]

---

---

---

---

---

---

---

---

---

---

9



0 2

A battery of emf 7.4 V and negligible internal resistance is used to power a heating element inside a glove. The heating element has a resistance of  $3.7 \Omega$ .

0 2 . 1

The designers state that the battery can produce a current of 2.0 A in the heating element for 240 minutes.

Calculate the energy dissipated in the heating element in this time.

[3 marks]

energy dissipated = \_\_\_\_\_ J

0 2 . 2

The length of the heating element needed is about 0.85 m.  
The designer considers using a carbon fibre tape for the heating element.  
**Table 1** gives information for the carbon fibre tape.

Table 1

Cross-sectional area / $\text{m}^2$	Resistivity / $\Omega \text{ m}$
$4.9 \times 10^{-6}$	$2.0 \times 10^{-5}$

Deduce whether the carbon fibre tape is suitable for making the heating element for the glove.

[2 marks]

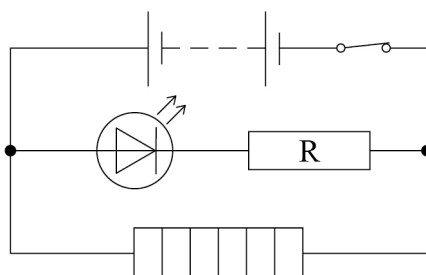
Question 2 continues on the next page

Turn over ►

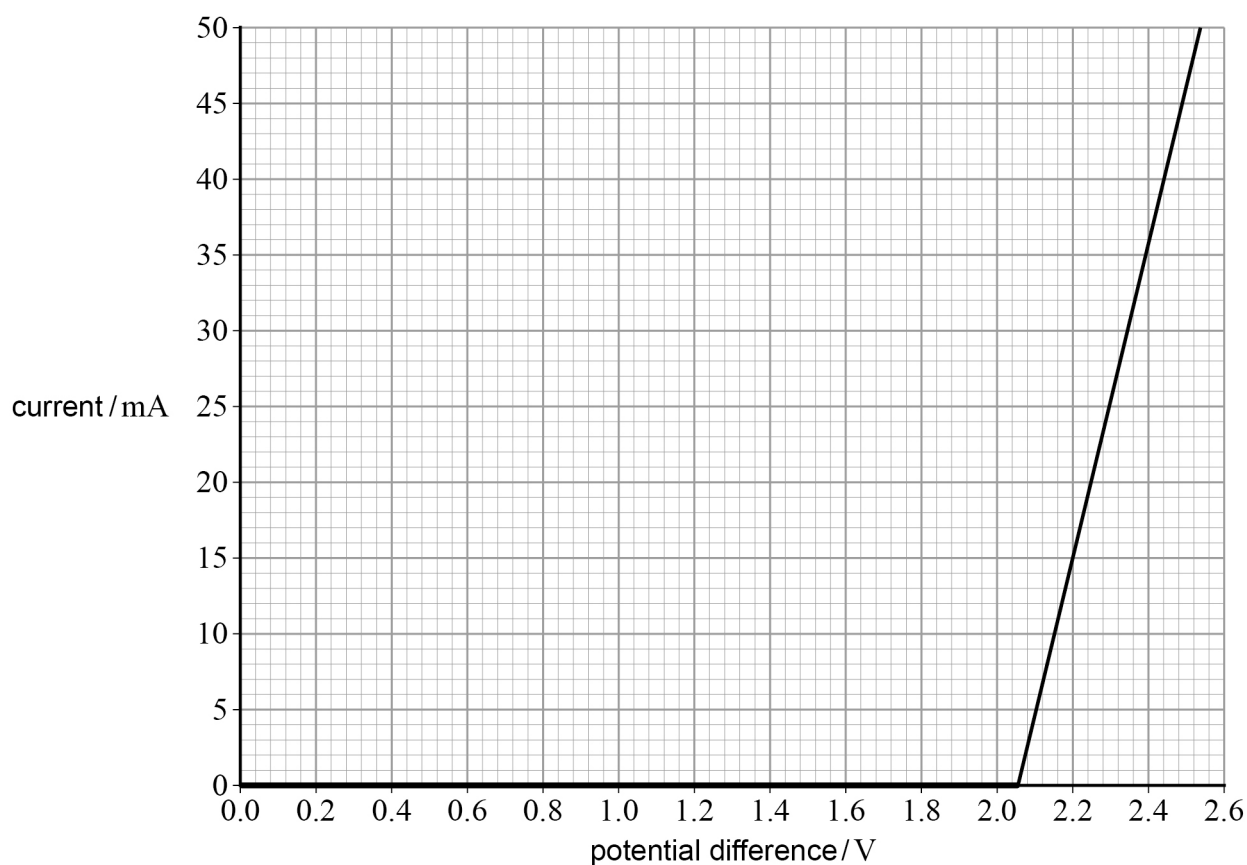


0 2 . 3

A light emitting diode (LED) is used to indicate that the switch in the glove is closed, as shown in **Figure 1**. Resistor  $R$  limits the current in the LED.

**Figure 1**

**Figure 2** shows part of the characteristic graph for the LED.

**Figure 2**

The circuit is designed so that the potential difference across the LED is 2.2 V when the switch is closed.

Calculate the resistance of R.

**[4 marks]**

resistance = \_\_\_\_\_  $\Omega$

9

**Turn over for the next question**

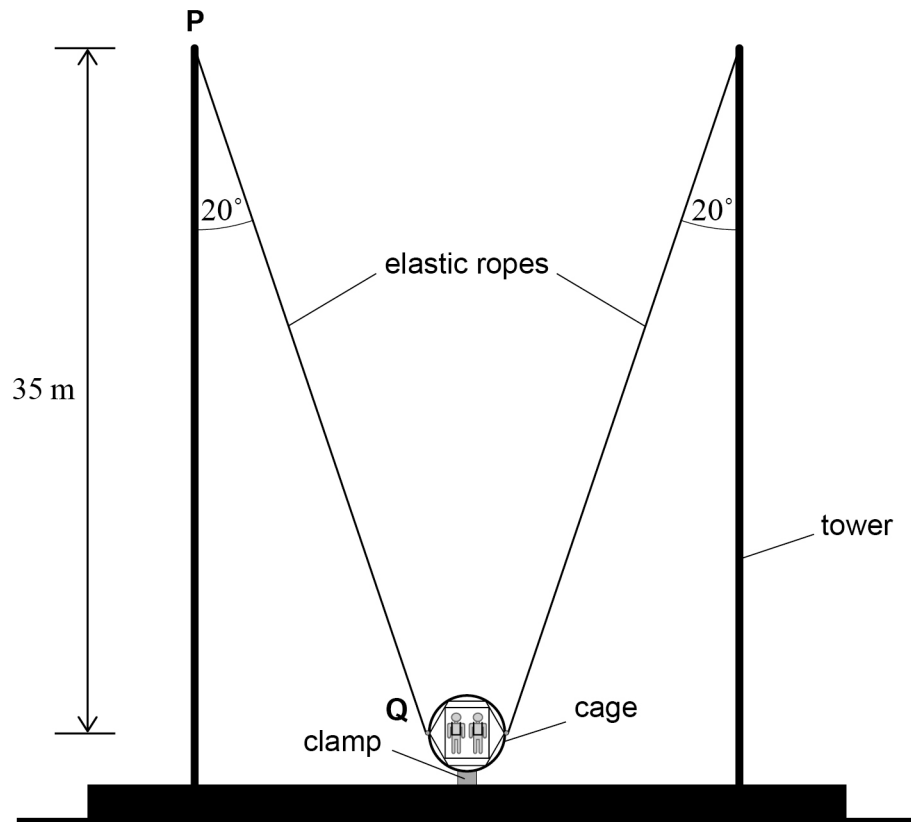
**Turn over ►**



0 3

Figure 3 shows a fairground ride called a 'reverse bungee'.

Figure 3



Two identical stretched elastic ropes are fixed to a cage with passengers inside. The loaded cage is held in place by a clamp. When the clamp is released the elastic ropes accelerate the loaded cage vertically into the air.

**P** is the point where the rope attaches to the top of the vertical tower.

**Q** is the point where the rope attaches to the cage. **Q** is level with the centre of mass of the loaded cage.

Before release, the tension  $T$  in each elastic rope is  $3.7 \times 10^4 \text{ N}$  and each rope makes an angle of  $20^\circ$  with the vertical tower.

The total mass  $M$  of the loaded cage is  $1.2 \times 10^3 \text{ kg}$  and the mass of the elastic ropes is negligible.





0	3	.	1
---	---	---	---

Show that the downward force  $F$  exerted by the clamp on the loaded cage is about  $6 \times 10^4 \text{ N}$ .

**[4 marks]**

0	3	.	2
---	---	---	---

Calculate the initial acceleration of the loaded cage when the clamp is released.

**[2 marks]**

acceleration = \_\_\_\_\_  $\text{m s}^{-2}$

**Question 3 continues on the next page**

**Turn over ►**



0	3	.	3
---	---	---	---

The unstretched length of each elastic rope is 24 m. The ropes obey Hooke's Law for all extensions used in the ride.

The **vertical** distance between points **P** and **Q** on **Figure 3** is 35 m.

Show that the total elastic potential energy stored in both ropes before the loaded cage is released is about  $5 \times 10^5$  J.

[4 marks]

0	3	.	4
---	---	---	---

The designers of the ride claim that the loaded cage will reach a height of 50 m above **Q**.

Deduce whether this claim is justified.

[3 marks]

---

---



0 3 . 5

The designers also claim that the loaded cage reaches a maximum speed of at least  $90 \text{ km h}^{-1}$ .

Calculate, in J, the kinetic energy of the loaded cage when it travels at  $90 \text{ km h}^{-1}$ .

[3 marks]

kinetic energy = \_\_\_\_\_ J

0 3 . 6

Deduce without further calculation whether the maximum speed claim is justified.

[1 mark]

---

---

---

---

---

---

---

17

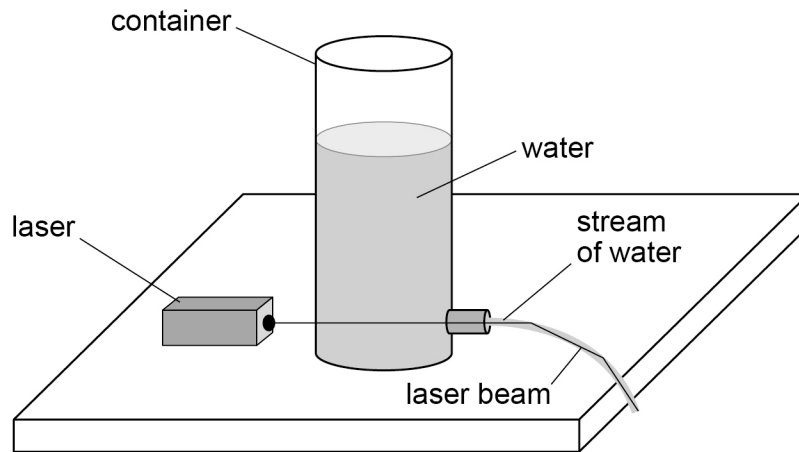
Turn over ►



0	4
---	---

In 1870 John Tyndall sent a beam of light along a stream of water.  
**Figure 4** shows a modern version of Tyndall's experiment using a laser beam.  
Water has a refractive index of 1.33

**Figure 4**



0	4	.	1
---	---	---	---

Explain why the laser beam stays inside the stream of water.

**[2 marks]**

---

---

---

---

---

---



0	4	.	2
---	---	---	---

Calculate the speed of the laser light in the water.  
Give your answer to an appropriate number of significant figures.

**[3 marks]**

speed = \_\_\_\_\_  $\text{m s}^{-1}$

0	4	.	3
---	---	---	---

Calculate the critical angle for the water–air boundary.

**[1 mark]**

critical angle = \_\_\_\_\_ degrees

**Question 4 continues on the next page**

**Turn over ►**



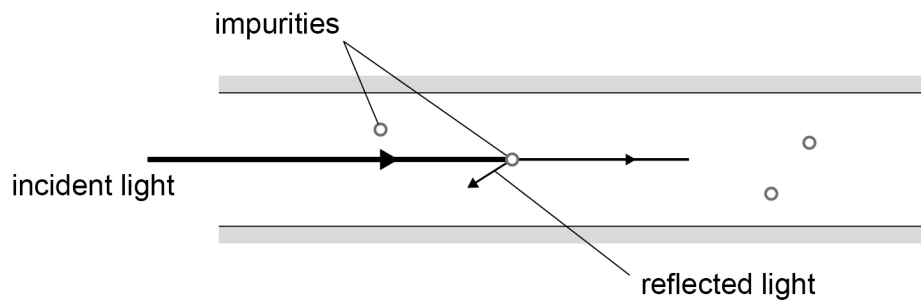
This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

**Turn over ►**

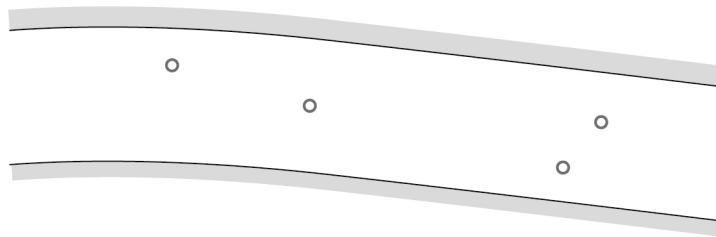


0 4 . 5

Scientists use optical fibres to monitor earthquakes. Light travelling through an optical fibre can be reflected by impurities in the fibre, as shown in **Figure 6**.

**Figure 6**

Earthquakes bend the optical fibre slightly, as shown in **Figure 7**. This changes the amount of reflected light.

**Figure 7**

Suggest why the amount of reflected light changes as the fibre bends. You may draw on **Figure 7** as part of your answer.

**[2 marks]**


---

---

---

---

---

---

---

---





0	4	.	6
---	---	---	---

The waves caused by earthquakes can be longitudinal or transverse.

Describe the difference between longitudinal waves and transverse waves.

**[2 marks]**

---

---

---

---

---

---

16
----

**Turn over for the next question**

**Turn over ►**

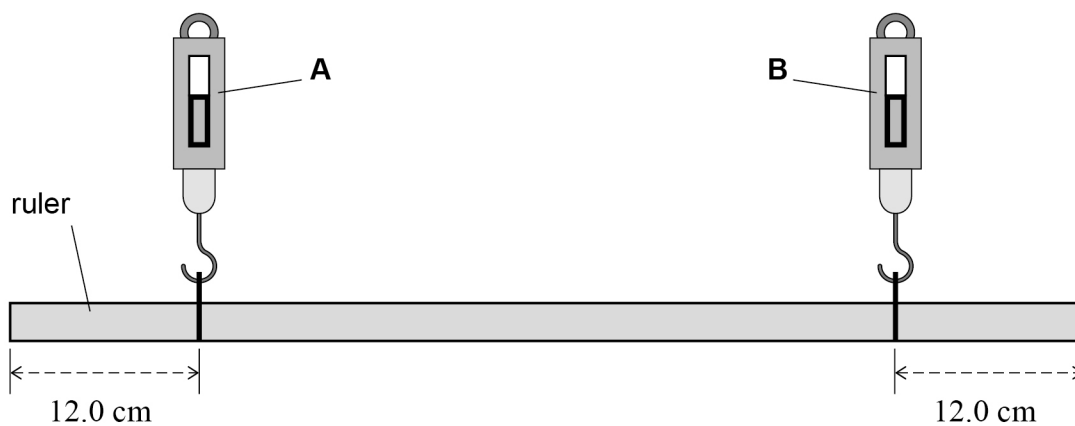


0 5

A student investigates moments by suspending a 100 cm ruler from two force meters, **A** and **B**. **A** and **B** are attached to the ruler 12.0 cm from each end. Their supports are adjusted to make **A** and **B** vertical and the ruler horizontal.

**Figure 8** is a simplified diagram of the experiment.

**Figure 8**



0 5

1

The ruler is uniform and weighs 1.12 N.

Determine the reading on **A**.

[1 mark]

reading = \_\_\_\_\_ N

0 5

2

The student suggests that the forces exerted on the ruler by **A** and **B** act as a couple.

Discuss whether his suggestion is correct.

[2 marks]

---



---



---



---



---



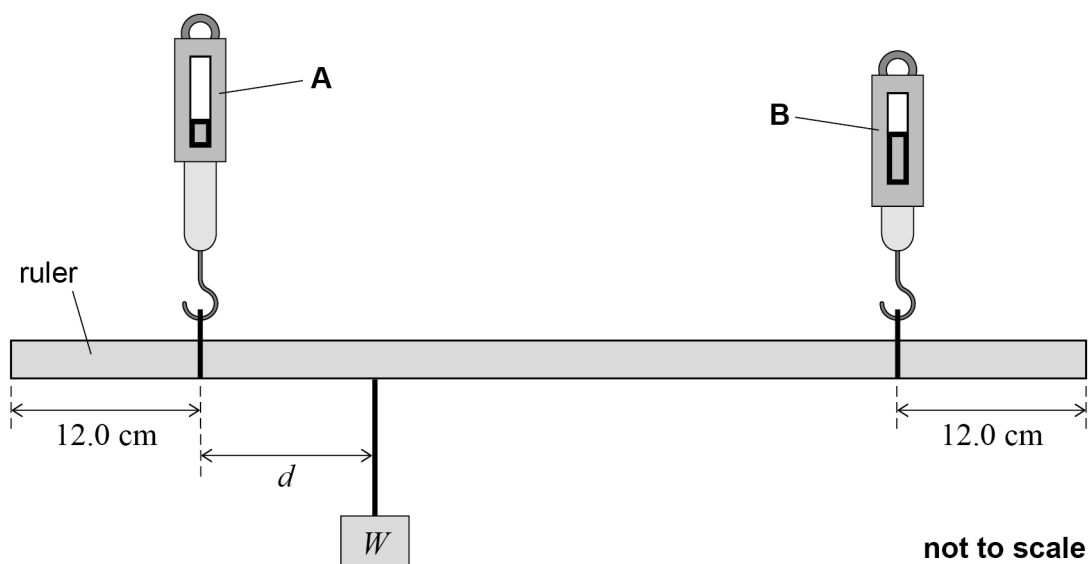
---



0 5 . 3

The student hangs a mass of weight  $W$  on the ruler between **A** and **B**, as shown in **Figure 9**.  
He adjusts the supports so that **A** and **B** are again vertical and the ruler is horizontal.  
The mass hangs at a distance  $d$  from **A**.

Figure 9



The reading on **A** is 0.82 N and the reading on **B** is 0.62 N.

Determine

- $W$
- $d$ .

[4 marks]

$$W = \text{_____ N}$$

$$d = \text{_____ m}$$

Question 5 continues on the next page

Turn over ►



**0 5 . 4**

A second student sets up the same apparatus as shown in **Figure 9**. She suspends the mass in the same position on the ruler as in question **05.3**. She moves the supports to make **A** and **B** vertical but does not make the ruler horizontal.

Discuss whether the readings on **A** and **B** taken by this student are different to those in question **05.3**.

**[2 marks]**

---

---

---

---

---

---

---

---

**9**

0 6

Scientists at CERN have produced atoms of antihydrogen.  
An atom of antihydrogen contains the antiparticle of the proton and the antiparticle of the electron.

0 6 . 1

State what is meant by an antiparticle.

[2 marks]

---



---



---

0 6 . 2

Complete **Table 2** with the names of the antiparticles in an atom of antihydrogen.

[2 marks]

Table 2

Name of particle	Name of antiparticle
proton	
electron	

Question 6 continues on the next page

Turn over ►



0	6	.	3
---	---	---	---

The particles in antihydrogen can be made by pair production.

Calculate the total minimum energy, in J, needed to produce the particles in one atom of antihydrogen.

**[3 marks]**

energy = \_\_\_\_\_ J



0 6 . 4

Line emission spectra of hydrogen and antihydrogen have been compared.

Explain in terms of energy changes how line emission spectra are produced.

**[3 marks]**

---

---

---

---

---

---

---

---

---

---

**10**

**END OF QUESTIONS**



**There are no questions printed on this page**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**

**Copyright information**

For confidentiality purposes, acknowledgements of third-party copyright material are published in a separate booklet rather than including them on the examination paper or support materials. This booklet is published after each examination series and is available for free download from [www.aqa.org.uk](http://www.aqa.org.uk) after the live examination series.

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team, AQA, Stag Hill House, Guildford, GU2 7XJ.

Copyright © 2019 AQA and its licensors. All rights reserved.



2 4



1 9 6 A 7 4 0 7 / 1

IB/M/Jun19/7407/1