

Please write clearly in block capitals.

Centre number

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Candidate number

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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	
TOTAL	



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⁻¹



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 (β^-) 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 Ω .

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 / m ²	Resistivity / Ω m
4.9×10^{-6}	2.0×10^{-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.

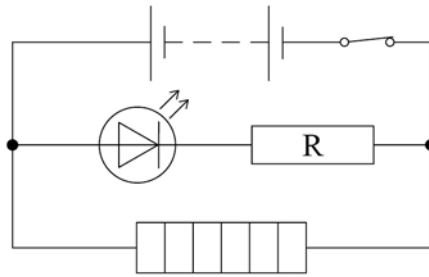
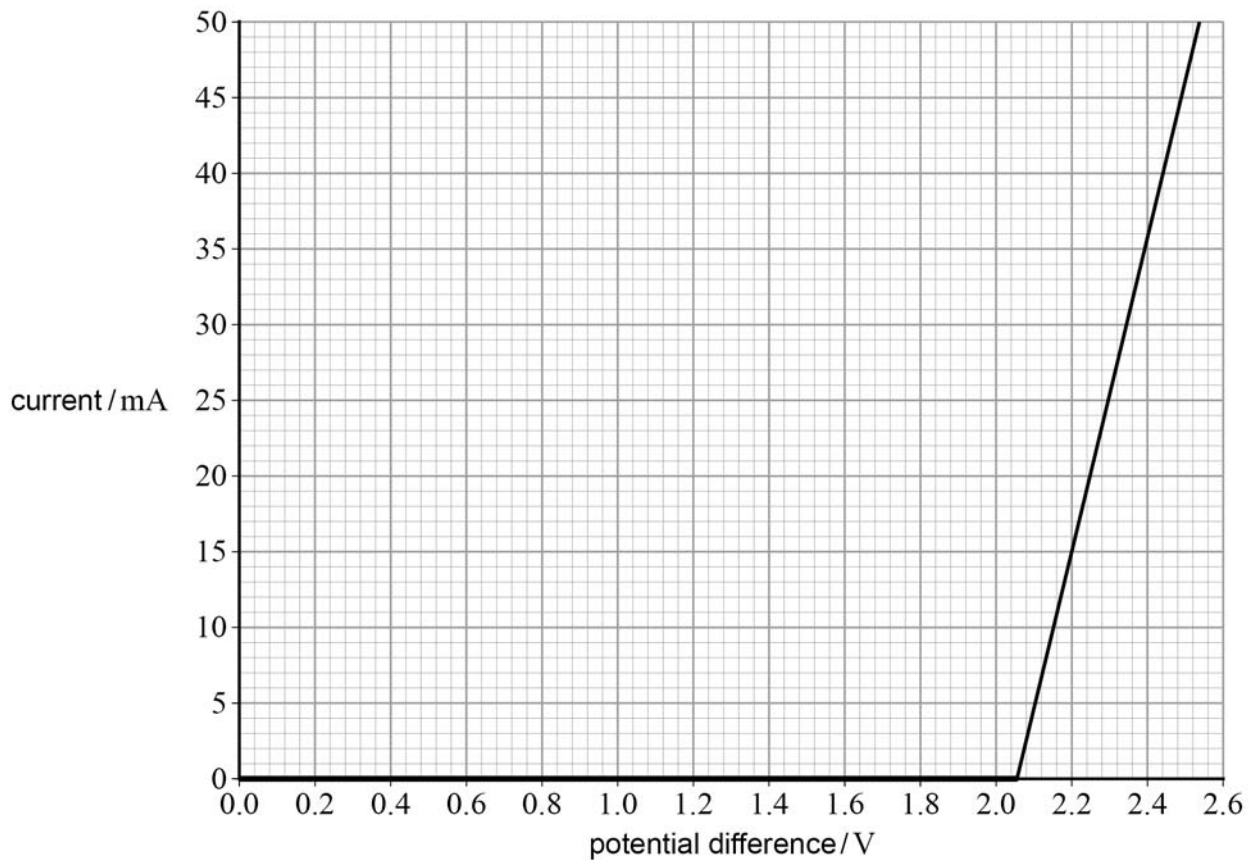
Figure 1

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 = _____ Ω

9

Turn over for the next question

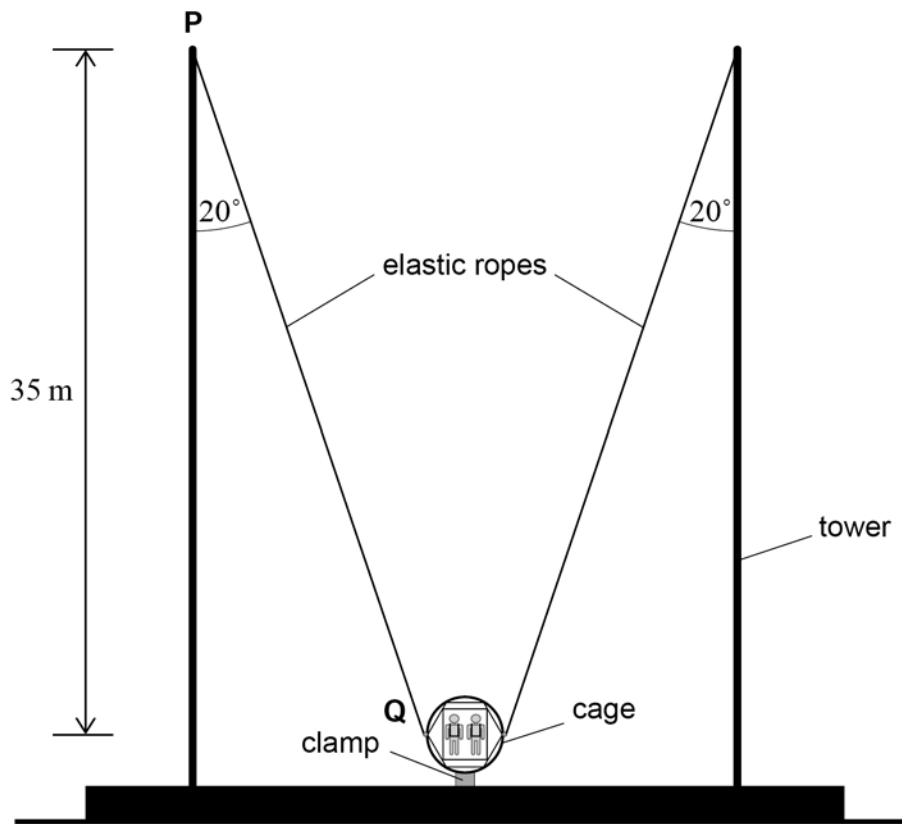
Turn over ►



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 3.7×10^4 N and each rope makes an angle of 20° with the vertical tower.

The total mass M of the loaded cage is 1.2×10^3 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 = _____ 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 5×10^5 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 km h^{-1} .

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

[3 marks]

kinetic energy = _____ J

0 3 . 6

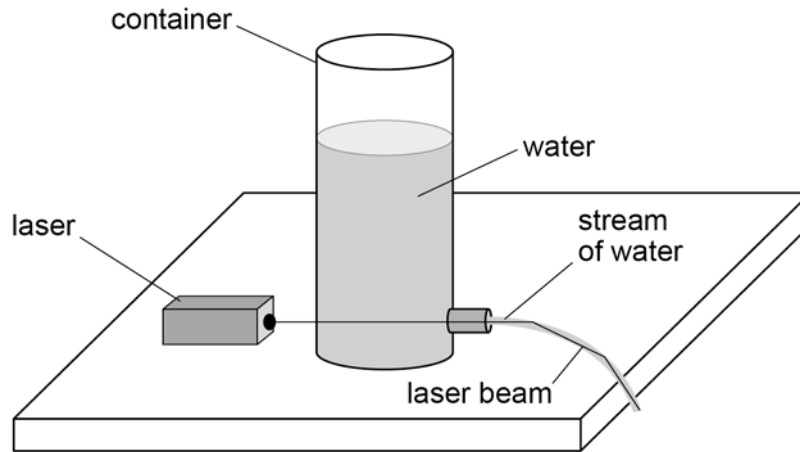
Deduce without further calculation whether the maximum speed claim is justified.

[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 = _____ m s⁻¹**0 4 . 3**

Calculate the critical angle for the water–air boundary.

[1 mark]

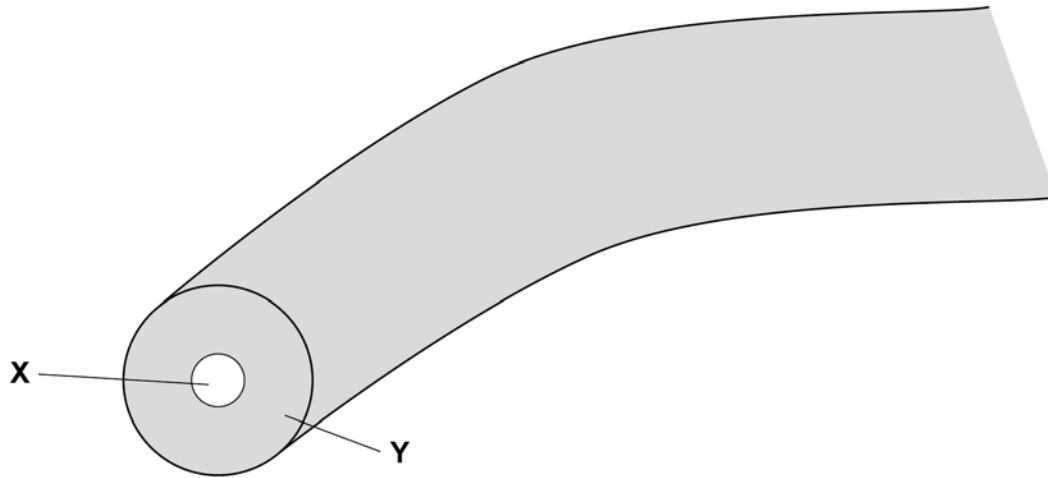
critical angle = _____ degrees

Question 4 continues on the next page**Turn over ►**

0 4 . 4

Tyndall's experiment led to the development of optical fibres.
Figure 5 shows a step-index optical fibre.

Figure 5



Discuss the properties of a step-index optical fibre.

Your answer should include:

- the names of part **X** and part **Y**
- a description of the functions of **X** and **Y**
- a discussion of the problems caused by material dispersion and modal dispersion and how these problems can be overcome.

[6 marks]



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Question 4 continues on the next page

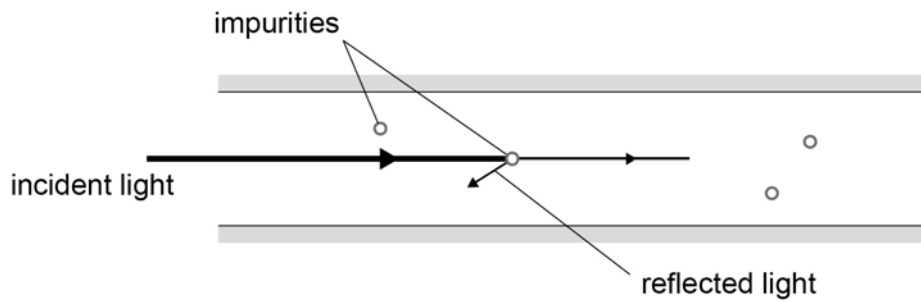
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0 4 . 5

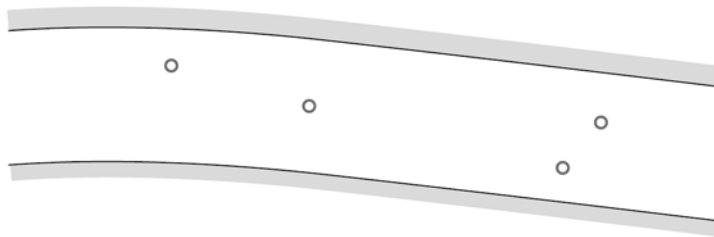
Scientists use optical fibres to monitor earthquakes. Light travelling through an optical fibre can be reflected by impurities in the fibre, as shown in **Figure 6**.

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
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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 ►

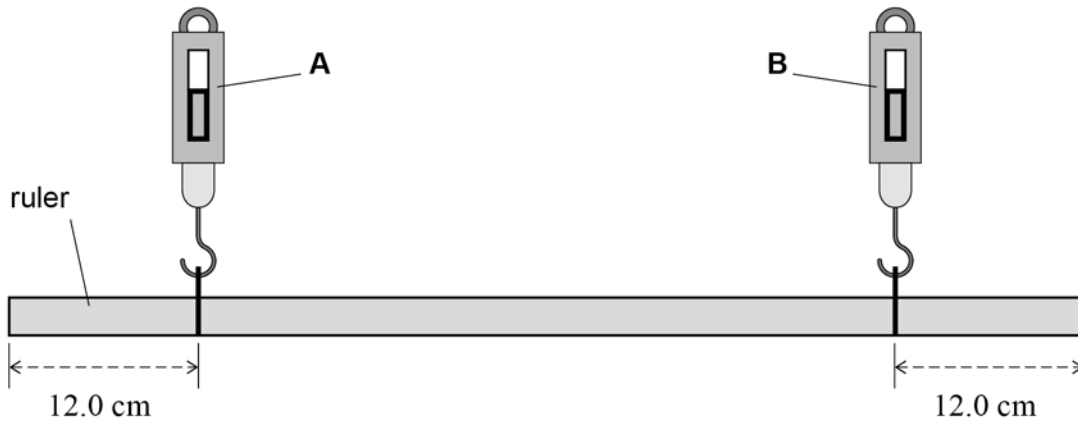


0 5

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.

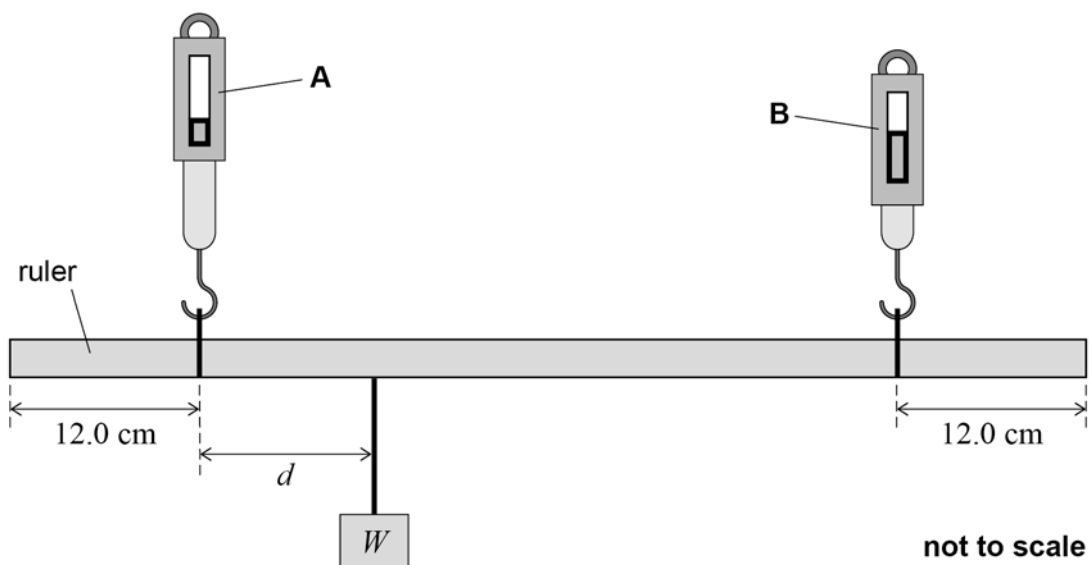
[2 marks]



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]

$$W = \underline{\hspace{4cm}} \text{ N}$$

$$d = \underline{\hspace{4cm}} \text{ m}$$

Question 5 continues on the next page

Turn over ►



0	5	.	4
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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



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2 4



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