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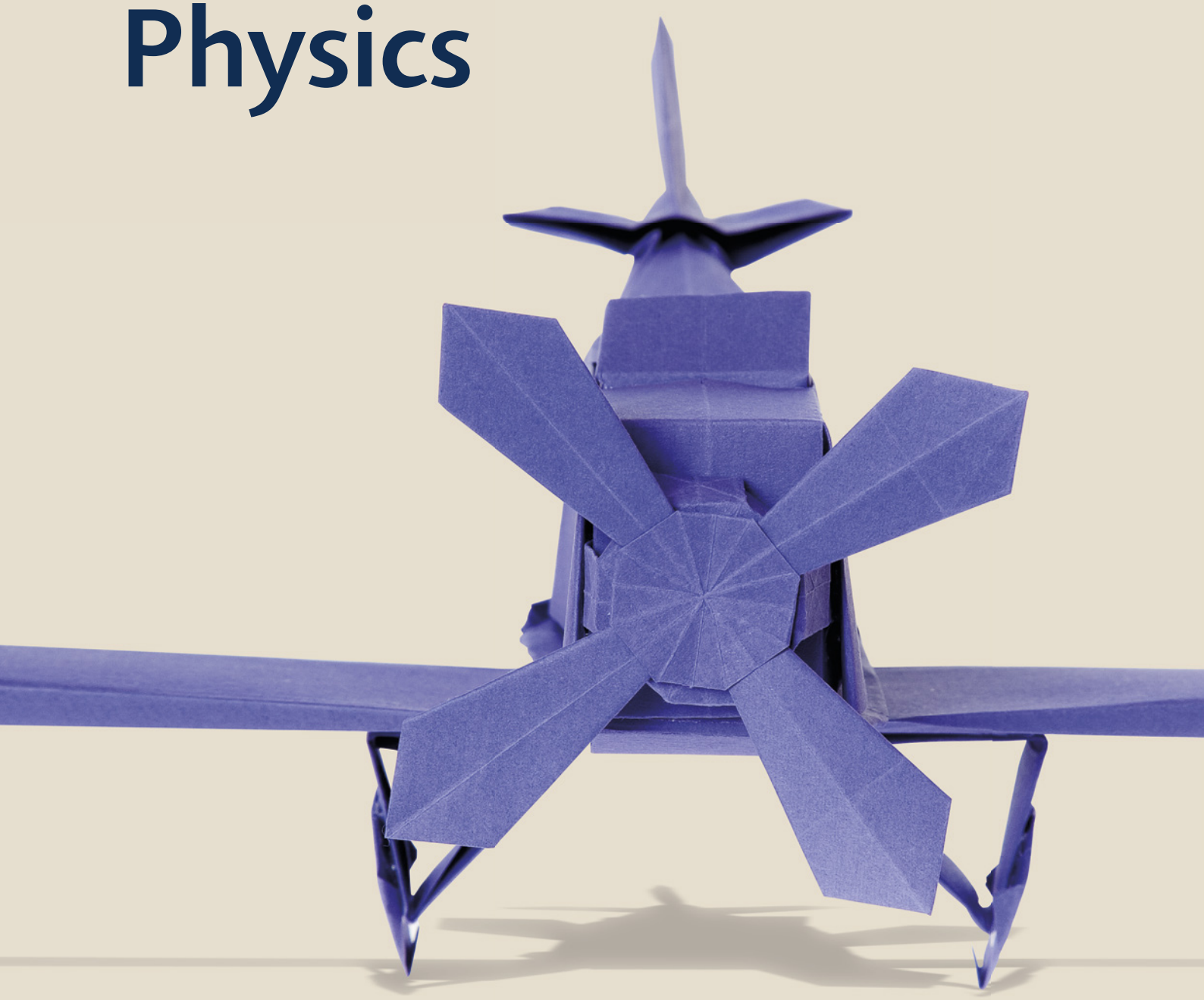
AS Physics



Sample Assessment Materials

Pearson Edexcel Level 3 Advanced Subsidiary GCE in Physics (8PH0)

First teaching from September 2015

First certification from 2016 | Issue 1

edexcel

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Sample Assessment Materials

First certification 2016

Edexcel, BTEC and LCCI qualifications

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Origami photography: Pearson Education Ltd/Naki Kouyioumtzis

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Contents

Introduction

The Pearson Edexcel Level 3 Advanced Subsidiary GCE in Physics is designed for use in schools and colleges. It is part of a suite of GCE qualifications offered by Pearson.

These sample assessment materials have been developed to support this qualification and will be used as the benchmark to develop the assessment students will take.

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than be penalised for omissions.
- Examiners should mark according to the mark scheme – not according to their perception of where the grade boundaries may lie.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification/indicative content will not be exhaustive.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, a senior examiner must be consulted before a mark is given.
- Crossed-out work should be marked **unless** the candidate has replaced it with an alternative response.

Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Physics

Advanced Subsidiary
Paper 1: Core Physics I

Sample Assessment Materials for first teaching September 2015
Time: 1 hour 30 minutes

Paper Reference
8PH0/01

You may need the Formulae Sheet, a calculator, protractor and a ruler.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions in Sections A and B.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You may use a scientific calculator.
- In questions marked with an *****, marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or how they follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- You are advised to show your working in calculations including units where appropriate.

Turn over ▶

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S 4 7 5 5 6 A 0 1 2 8

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SECTION A

Answer ALL questions.

All multiple choice questions must be answered with a cross ☒ in the box for the correct answer from A to D. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Which of the following is a correct statement?

☒ **A** charge is a base quantity

☒ **B** velocity is a base quantity

☒ **C** mass is a derived quantity

☒ **D** resistance is a derived quantity

(Total for Question 1 = 1 mark)

2 Which of the following is an equivalent unit to the newton?

☒ **A** kg m s^{-1}

☒ **B** kg m s^{-2}

☒ **C** kg m^{-1} s^{-2}

☒ **D** kg m^2 s^{-2}

(Total for Question 2 = 1 mark)

3 Which of the following is a scalar quantity?

☒ **A** displacement

☒ **B** force

☒ **C** weight

☒ **D** work

(Total for Question 3 = 1 mark)

4 Which of the following quantities has the same units as the area beneath an acceleration-time graph?

☒ **A** acceleration

☒ **B** force

☒ **C** momentum

☒ **D** velocity

(Total for Question 4 = 1 mark)

5 An object is acted on by a vertical force of 25 N and a horizontal force of 34 N.

The angle to the horizontal of the resultant force is given by

☒ **A** $\cos^{-1}(25/34)$

☒ **B** $\sin^{-1}(34/25)$

☒ **C** $\tan^{-1}(25/34)$

☒ **D** $\tan^{-1}(34/25)$

(Total for Question 5 = 1 mark)

6 Which of the following statements about the forces in a Newton's Third Law pair is **not** correct?

The forces

☒ **A** act along the same line.

☒ **B** act on the same body.

☒ **C** are equal in magnitude.

☒ **D** are of the same type.

(Total for Question 6 = 1 mark)

7 A potential difference is applied to a wire.

The current in the wire

☒ **A** depends only on the potential difference applied.

☒ **B** depends only on the resistance of the wire.

☒ **C** depends on both the potential difference and the resistance of the wire.

☒ **D** does not depend on the potential difference or the resistance of the wire.

(Total for Question 7 = 1 mark)

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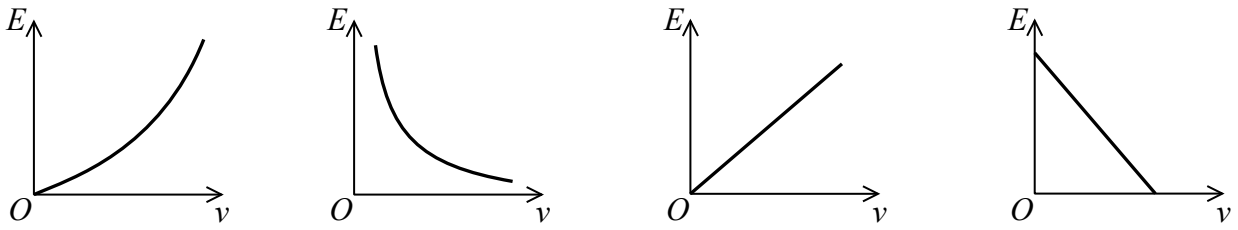
8 A ball is dropped from a student's hand and falls to the ground.

Which graph correctly shows the variation of kinetic energy E with velocity v for the ball?



A **B** **C** **D**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 8 = 1 mark)

---

9 An electric motor takes 45.0 s to lift a mass of 800 kg through a vertical height of 14.0 m. The potential difference across the motor is 230 V and the current is 13.0 A.

Calculate the efficiency of the motor.

Efficiency = ...

(Total for Question 9 = 3 marks)

10 The photograph shows cars travelling on a straight section of a motorway.

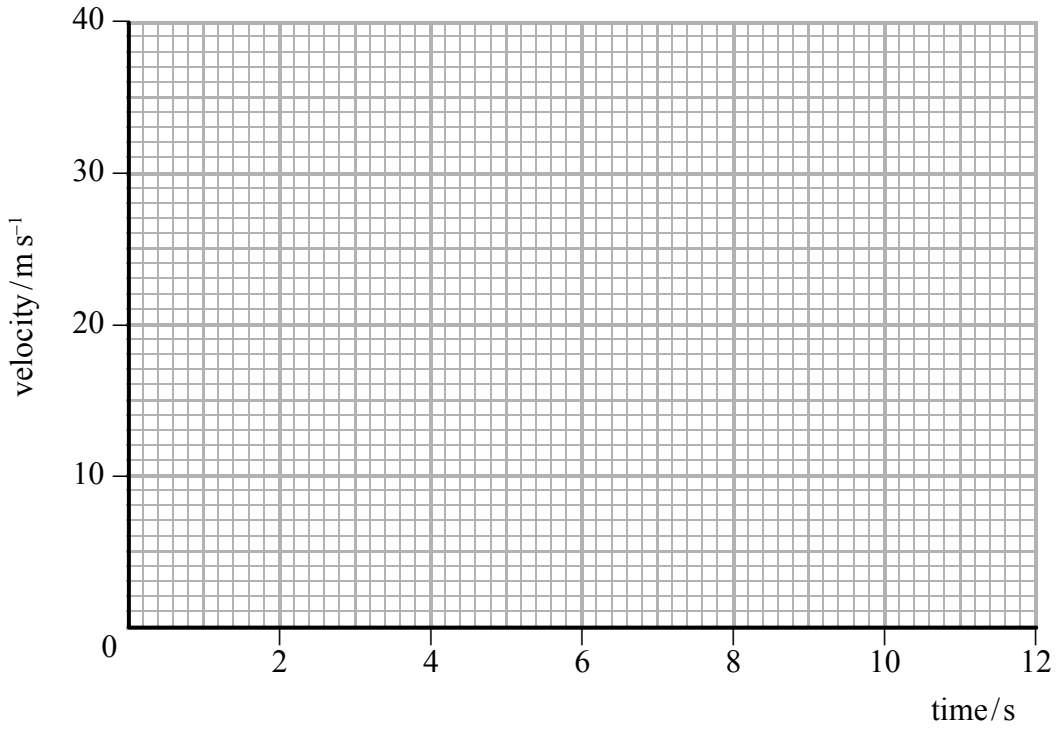
The maximum speed limit on a motorway in the U.K. is $31\,m\,s^{-1}$.

(source: http://tracksideviews.com/tag/motorway/)

(a) A car is travelling along the motorway at $31\,m\,s^{-1}$. The driver sees stationary traffic 180 m ahead. After 0.6 s the driver reacts by applying a constant braking force that stops the car in 10 s.

(i) Draw a velocity-time graph of the car's motion, from the instant the driver sees the stationary traffic until the car stops.

(1)



(ii) Analyse the data to determine whether the car stops without colliding with the stationary traffic.

(2)

TURN OVER FOR QUESTION 10(b)

(b) The maximum speed limit on motorways has not been raised since the 1960s. However, developments in engineering mean that modern cars have much higher top speeds than cars in the past and can stop safely in shorter distances.

Discuss the risks and benefits of raising the maximum speed limits on motorways.

(4)

(Total for Question 10 = 7 marks)

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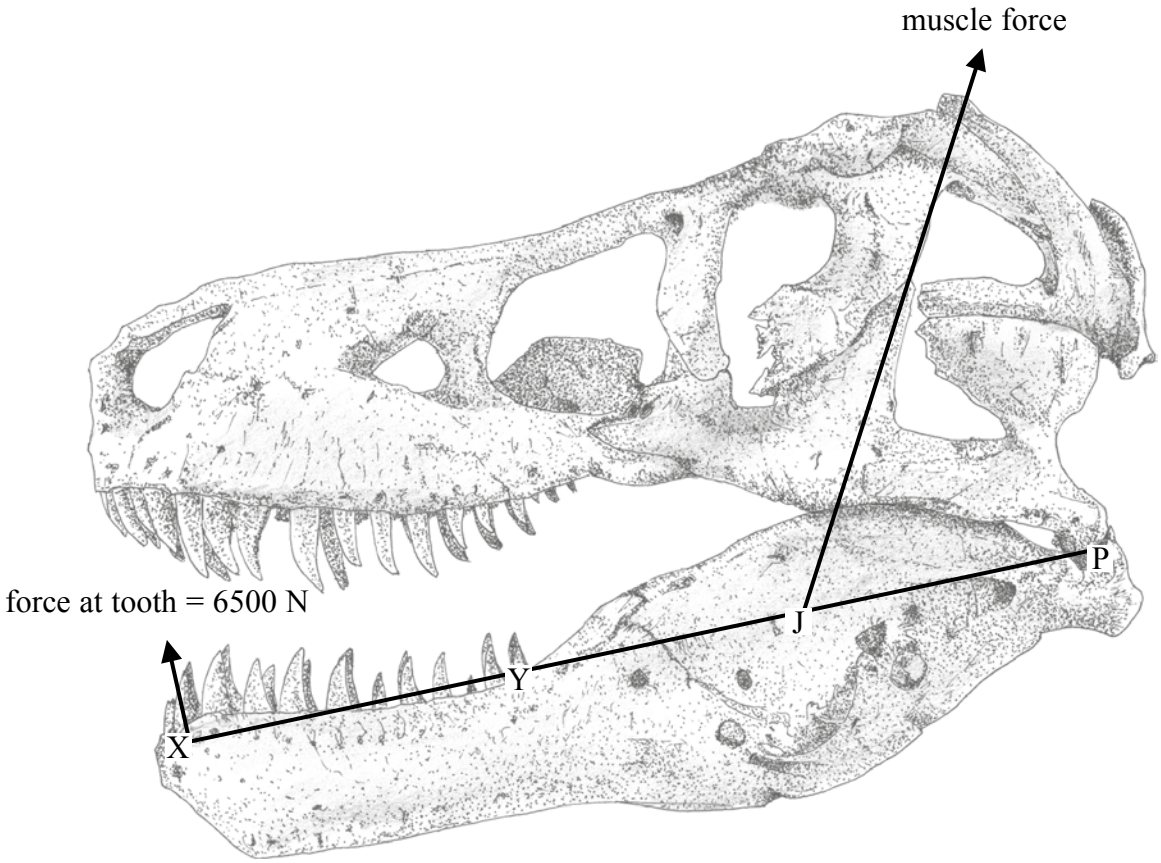
TURN OVER FOR QUESTION 11

11 Extinct animals can be studied by using their fossils. 70-million-year-old fossils from the *Tyrannosaurus rex* and *Triceratops* dinosaurs show that a *Triceratops* was sometimes eaten by a *Tyrannosaurus rex*.

The diagram shows a *Tyrannosaurus rex* skull.



On the diagram, the position of the main biting muscle is indicated by the line labelled 'muscle force'. The muscle is connected to the jaw at point J. This produces a moment about point P where the jaw is hinged. Teeth marks found in fossilised *Triceratops* bones show that the force exerted by a tooth at the front of the jaw X could reach 6500 N.

The skull is drawn to a scale of 1 to 10. The force arrows are **not** drawn to scale.

(a) Take measurements from the diagram to determine the size of the muscle force when the force exerted by the tooth at X is 6500 N.

(5)

Muscle force = ...

(b) The length of a tooth from another dinosaur is approximately 10 cm.

Scientist A measures this length with a metre rule, and scientist B measures this length with callipers.

Scientist B claims that his measurement will produce a more accurate value for the length of the tooth.

Comment on the claim made by scientist B.

(3)

(Total for Question 11 = 8 marks)

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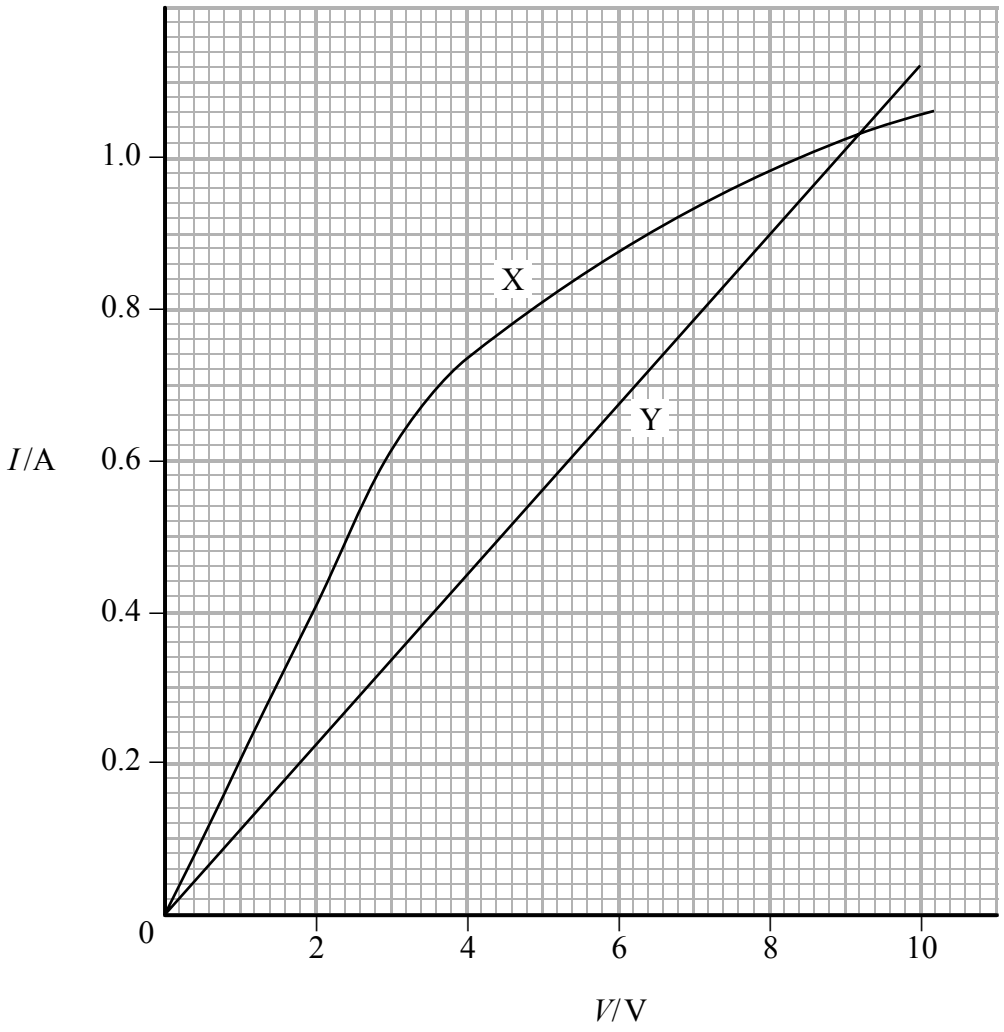
12 A potential difference is applied across the metal filament of a light bulb and charge flows.

(a) By referring to the mean drift velocity of the electrons, explain what happens to the current in the metal filament if the potential difference is unchanged and the temperature of the metal increases.

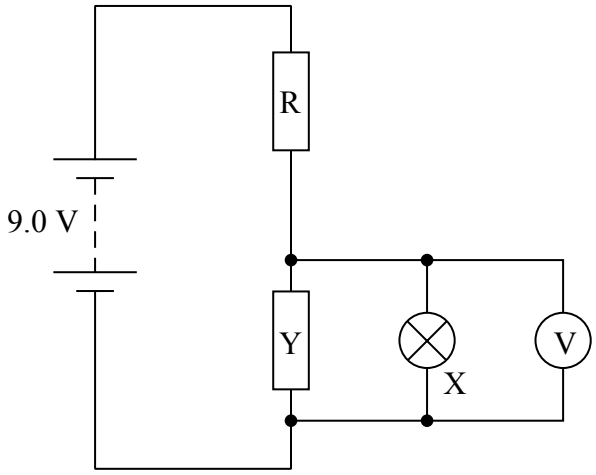
(3)

(b) The graph shows the variation of current I with potential difference V for two electrical components X and Y.

X is a filament bulb and Y is a fixed resistor.



A potential divider circuit consisting of components X and Y is connected to a 9.0 V supply in series with a fixed resistor R as shown. The supply has a negligible internal resistance.



The reading on the voltmeter is 3.0 V.

(i) Determine the current in the fixed resistor R.

(2)

Current in the fixed resistor R = ...

(ii) Component X is removed from the circuit.

Explain, without further calculation, how this would change the voltmeter reading.

(3)

(Total for Question 12 = 8 marks)

13 A laboratory technician found a reel of resistance wire, without a label.

(a) In order to determine the type of wire on the reel she recorded the following measurements.

Length of wire $l = 70.7$ cm ± 0.2 cm

Diameter of wire $d = 1.82$ mm ± 0.02 mm

Potential difference across wire $V = 1.50$ V

Current through wire $I = 4.11$ A

The uncertainty in the measurements of V and I is negligible.

Calculate the resistivity of the wire.

(3)

Resistivity = ...

(b) The technician used the internet to find values for the resistivity of the different wires available in the laboratory. She recorded these values in a table.

Wire	**Resistivity / × 10^{-8} Ωm**
Constantan	49.0
Nichrome	125
Kanthal	139

Use the uncertainties in the measurements to explain whether the technician could conclude which type of wire was on the reel.

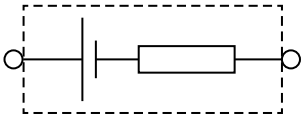
(4)

(Total for Question 13 = 7 marks)

14 A student is asked to determine the e.m.f. and internal resistance of a cell using standard laboratory apparatus and a graphical method.

(a) The diagram below shows a cell with internal resistance. Add to the diagram to show the circuit she could use.

(2)



(b) Explain how she should determine the e.m.f. and internal resistance of the cell. Your answer should include a sketch of the graph.

(5)

(Total for Question 14 = 7 marks)

15 The photograph shows a small plastic container, its lid and some pellets of frozen carbon dioxide, known as dry ice. When at room temperature the dry ice gradually changes state directly from solid to gas.

Dry ice is placed in the container and the lid is put on. The container is turned upside down and placed on the floor. After a few minutes the pressure of the gas causes the container to fly into the air, leaving the lid and some dry ice behind.

A student investigated the motion of the container.

(a) The student obtained measurements of the maximum height reached by the container for a particular initial mass of dry ice. The student determined that the maximum height was 2.5 m.

Calculate the initial speed of the container.

(2)

.....

.....

.....

Initial speed = ...

(b) The student investigated how the maximum horizontal distance travelled by the container varies with launch angle.

Calculate the maximum horizontal distance the container would travel if launched at an initial speed of 6.5 m s^{-1} at an angle of 20° to the vertical.

(5)

Maximum horizontal distance = ...

(c) The student added dry ice to the container again and placed it on its side on the floor. When the lid was forced off, the container moved forward at a speed of 5.5 m s^{-1} and the lid moved backwards. The pellets of dry ice remained in their original position.

mass of container = 4.3 g
mass of lid = 1.6 g

(i) Calculate the initial speed of the lid.

(3)

Initial speed of lid = ...

(ii) Explain why the dry ice remained at the original position.

(2)

(Total for Question 15 = 12 marks)

TOTAL FOR SECTION A = 60 MARKS

SECTION B

Answer ALL questions.

16 Fibre optic cables are made from strands of optically pure glass as thin as a human hair. Although they are used in a wide range of applications, they are particularly important in communication systems.

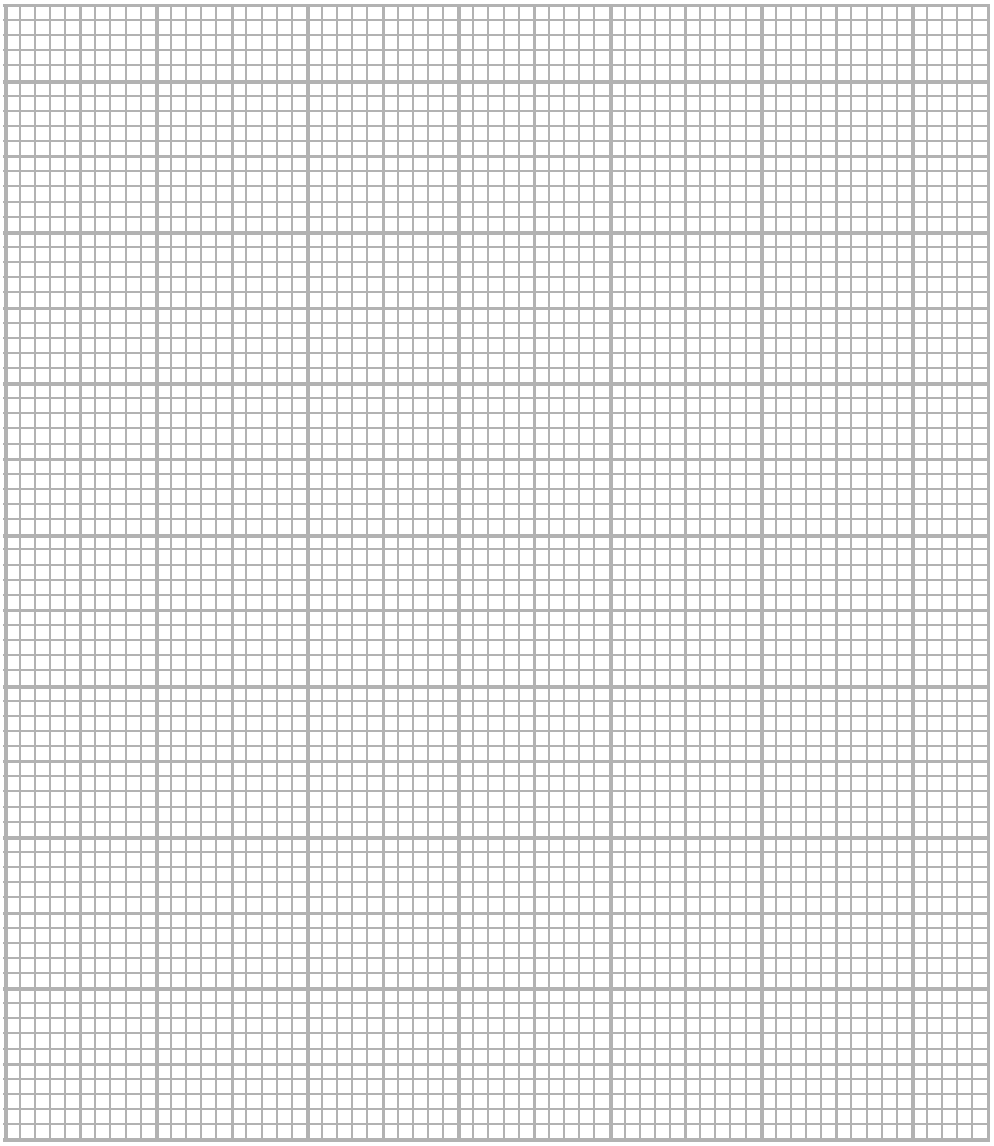
Bending an optical fibre can cause the fibre to break.

(a) The table shows data collected when the optical fibre is bent. Theory suggests that the strain in the fibre is inversely proportional to the bending radius.

Radius/mm	% strain
2	3.15
3	2.10
7	0.90
9	0.70
10	0.65

(i) Use the data to draw a graph to determine whether the suggested relationship is correct.

(4)

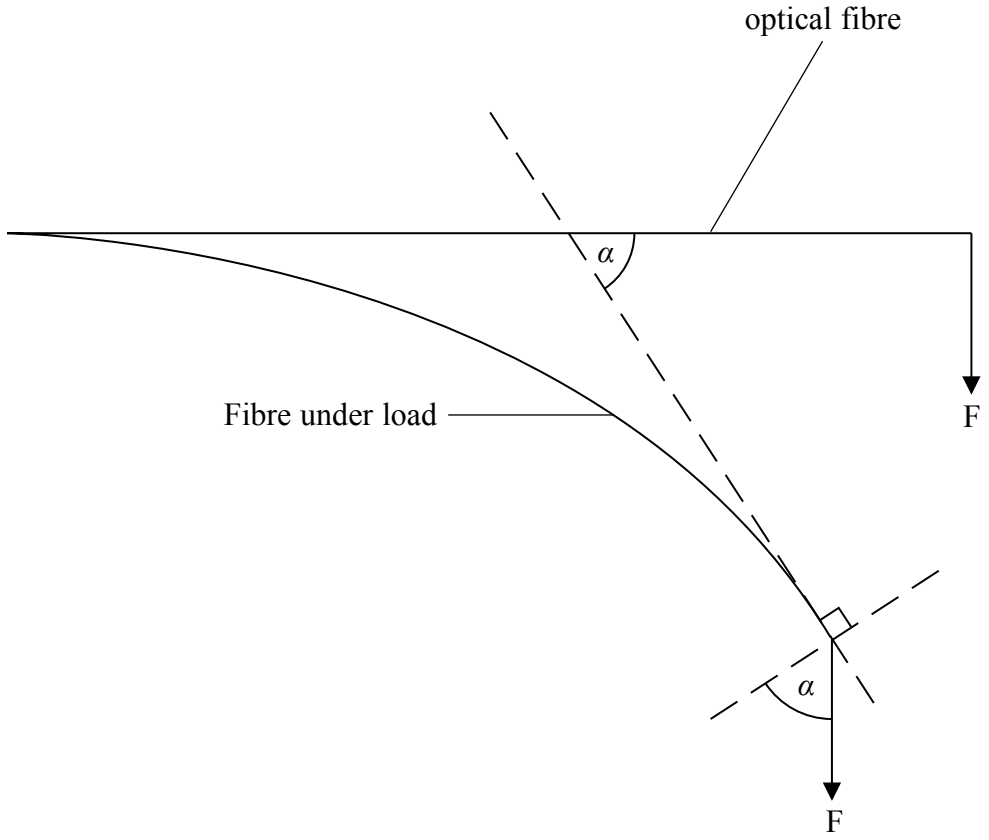


(ii) The fibre can fail under repeated strains in excess of 2.4%.

Use your graph to estimate the smallest bending radius that the fibre should be subjected to.

(2)

(b) The diagram shows an optical fibre. A small force F is applied to the end of the optical fibre causing it to bend through an angle α.



Explain why the stress parallel to the surface of the fibre increases as the fibre bends.

(4)

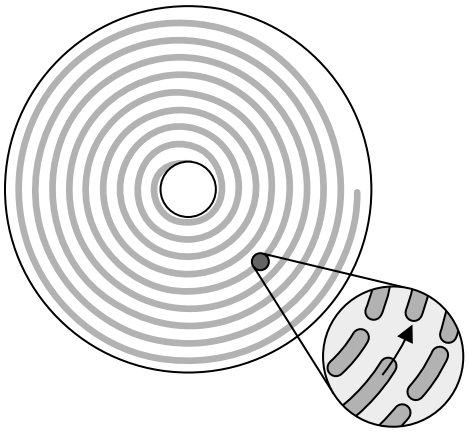
(Total for Question 16 = 10 marks)

17 An 8 W, 230 V energy-efficient light bulb is used as a reading lamp.

(a) Calculate the number of electrons passing a point in the reading lamp circuit in one hour.

(4)

*(b) The light from the lamp is reflected from the surface of a CD, which consists of a spiral track of elongated bumps.



CD surface showing spiral track of bumps with a smooth reflective surface in between.

(Source: http://gantisreerajiv.blogspot.co.uk/2012/04/you-cant-imagine-world-if-there-are.html:)

A physics student notices that although the light from the lamp is white, different colours are seen in the reflected light. He suggests that the colours are produced when diffraction occurs at the surface of the CD.

Discuss the extent to which the student's suggestion explains the presence of colours in the light reflected from the surface of the CD.

(6)

(Total for Question 17 = 10 marks)

TOTAL FOR SECTION B = 20 MARKS
TOTAL FOR PAPER = 80 MARKS

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Paper 1 Mark scheme

Question Number	Acceptable Answer	Additional Guidance	Mark
1	D		**1**
2	B		**1**
3	D		**1**
4	D		**1**
5	C		**1**
6	C		**1**
7	C		**1**
8	A		**1**

(Total for Multiple Choice Questions = 8 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
9	• use of $\Delta E_{grav} = mg\Delta h$ and use of $P = VI$ **(1)** • correct use of time **(1)** • efficiency = 0.816 or 81.6 % **(1)**	Example of calculation: ΔE_{grav} = 800 kg × 9.81 m s^{-2} × 14 m/s = 109900 J P = 230 V × 13.0 A = 2990 W E = Pt = 2990 W x 45 s = 134600 J efficiency = 109900 J/134600 J = 0.816 Alternative calculation: $\text{Efficiency} = \frac{(800\,\text{kg} \times 9.81\,\text{N kg}^{-1} \times 14\,\text{m})/45.0\,\text{s}}{230\,\text{V} \times 13.0\,\text{A}} = 0.816$ Accept rounding variations if alternative calculation method used.	**3**

(Total for Question 9 = 3 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
10 (a)(i)	• Two straight lines drawn between points (0, 31) to (0.6, 31) and (0.6, 31) to (10.6, 0) **(1)**		**1**
10 (a)(ii)	• Use of area under graph or equations of motion to determine distance **(1)** • Distance travelled = 170 m which is less than 180 m so concludes car stops without colliding **(1)**	Example of calculation distance = (0.6 s x 31 m s^{-1}) + (10 s × 31 m s^{-1}) /2 = 174 m	**2**
10 (b)	Must give at least on benefit to obtain full marks **Risks** • Increased speed produces increased kinetic energy so more energy to dissipate in a collision **(1) OR** collisions more likely to result in injury **(1) OR** collisions more likely to cause damage to vehicle/property **(1)** • Human reaction time unchanged so thinking distance is larger at higher speed **(1)** • Greater likelihood of colliding with stationary traffic **(1) OR** Greater hazard to stationary vehicles **(1) OR** maintenance crews on the hard shoulder **(1)** • Road surfaces need to be better maintained **(1)** **Benefits** • Shorter journey times **(1)** • Cars on road for shorter time leading to less congestion **(1)**	Allow credit for correct equivalent points provided they have a physics basis.	**4**

(Total for Question 10 = 7 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
11 (a)	• Uses scale 1:10 **(1) OR** determines the ratio of lengths from the diagram **(1)** • Use of moment equation for tooth force = force × (perp) distance **(1)** • Use of moment equation for muscle force = force × sin (angle with jaw) × (perp) distance **(1)** • Moment of tooth force = moment of muscle force **(1)** • Muscle force = 24 000 N **(1)**		**5**
11 (b)	• Accuracy relates to how close the measurement is to the true value **(1) OR** accuracy depends on the way in which the measurement is made **(1)** • Callipers reduce random/measurement errors in determining the value, giving a lower uncertainty in the measurement than that for a metre rule **(1)** • so scientist B has not made a more accurate measurement he has made a measurement with lower uncertainty **(1)**	This refers to digital, dial or vernier callipers but if reference to a compass style callipers MP2 would become: The callipers would reduce parallax errors due to movement and MP 3 becomes a more accurate measurement because it is closer to a true value	**3**

(Total for Question 11 = 8 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
12 (a)	An explanation that makes reference to: • amplitude of lattice vibration increases **(1)** • resulting in more frequent collisions of electrons with lattice ions **(1)** • so this results in a smaller (mean) drift velocity $I=nAve$ and consequently the current decreases **(1)**	Must be the idea of a greater frequency of collisions, not just a greater number of collisions. Do not accept collisions between electrons. MP3 dependent on MP1 and MP2	**3**
12 (b)(i)	• Reads current values at 3V for both components **(1)** • Current through fixed resistor R = 0.94 A **(1)**	Current values are 0.33 (A) and 0.61 (A) Allow tolerance of ± 0.01 A Allow tolerance of ± 0.02 A	**2**
12 (b)(ii)	An explanation that makes reference to: • resistance of Y will be greater than resistance of parallel combination **(1)** • Y will have a greater share of the p.d **(1) OR** R will have a lower share of the p.d. **(1)** • so the reading on the voltmeter will increase. **(1)** **OR** • the current through R decreases **(1)** • as V = IR, the p.d. across R decreases**(1)** • so the p.d. across Y and the voltmeter reading will increase **(1)**	To score the final marking point candidates must score both MP1 and MP2	**3**

(Total for Question 12 = 8 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
13 (a)	• Use of R = V/I **(1)** • Use of R = ρl/A **(1)** • $\rho = 1.34 \times 10^{-8}$ Ωm **(1)**	Example of calculation: R = 1.50 V/4.11 A = 0.365 Ω $\rho = RA/l$ = 0.365 Ω × π × $(1.82 \times 10^{-3}/2)^2$ m^2 /0.707 m $\rho = 1.34 \times 10^{-8}$ Ωm	**3**
13 (b)	An explanation that makes reference to: • Calculates percentage uncertainty in *l* as 0.3% and in *d* as 1% **(1)** • Calculates percentage uncertainty in resistivity by doubling that for *d* and adding that for *l* **(1)** • Calculates range of values for ρ **(1)** • Using these values the technician could not conclude whether the wire was Kanthal or Nichrome **(1)**	Example of calculation: (0.2/70.7) x 100 % = 0.3 % (0.02/1.82) x 100 % = 1 % %U in ρ = 2 x 1% + 0.3 % = 2.3 % 1.34×10^{-8} x 0.0023 = 0.003 $1.37 \times 10^{-8} > \rho > 1.31 \times 10^{-8}$ If answer to calculation is wrong, then credit can still be given for MP4 for comments consistent with the calculated value. If no calculation is completed then MP4 cannot be awarded.	**4**

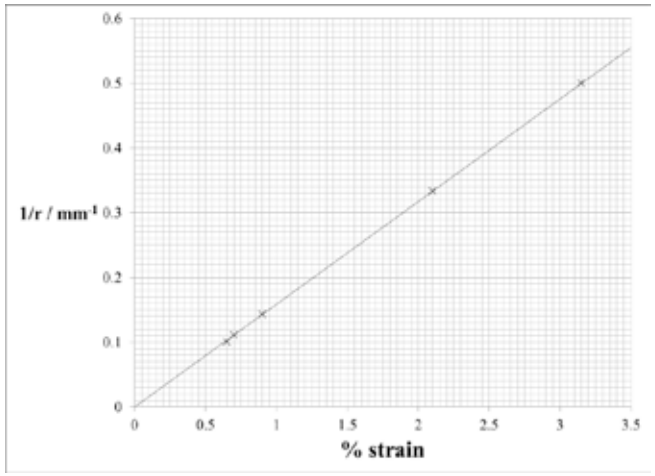
(Total for Question 13 = 7 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
14 (a)	• Means of varying the current **(1)** • Ammeter, voltmeter and variable resistor correctly connected **(1)**	Accept a circuit that will allow correct measurements to be taken.	**2**
14 (b)	An explanation that makes reference to: • Vary the current using the variable resistor **(1)** • Record corresponding values for *I* and *V* **(1)** • Graph of V against I is a straight line with negative gradient **(1)** • The e.m.f. is given by the intercept on the V axis **(1)** • The internal resistance is given by the gradient **(1)**		**5**

(Total for Question 14 = 7 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
15 (a)	• use of $v^2 = u^2 + 2as$ **(1) OR** use of ½ mv^2 =mgh **(1)** • initial speed = 7.0 m s^{-1} **(1)**	Example of calculation: $v = 0$ $a = -9.81$ m s^{-1} $s = 2.5$ m $u^2 = -2as$ $u^2 = -(2 \times -9.81$ m $s^{-1} \times 2.5$ m$) = 49$ m^2 s^{-2} $u = 7.0$ m s^{-1} Alternative calculation: ½ v^2 = gh v = √(2gh) = √(2 x 9.81 x 2.5) = = 7.0 m s^{-1}	**2**
15 (b)	• use of trig function to find *v* vertical **(1)** • use of trig function to find *v* horizontal **(1)** • use of equation of motion to find time of flight **(1)** • use of equation of motion to find distance **(1)** • horizontal distance = 2.7 m **(1)**	Example of calculation vertical velocity = 6.5 m s^{-1} sin 20 = 2.22 m s^{-1} time of flight using $v = u + at$ -2.22 m s^{-1} = 2.22 m s^{-1} + (-9.81 m $s^{-1} \times t$) $t = 0.45$ s horizontal velocity = 6.5 m s^{-1} cos 20 = 6.11 m s^{-1} horizontal distance using $s = ut$ $s = 6.11$ m $s^{-1} \times 0.45$ s $s = 2.7$ m	**5**
15 (c)(i)	• use of $p=mv$ **(1)** • correctly applies conservation of momentum **(1)** • $v = 14.8$ m s^{-1} **(1)**	Example of calculation: momentum of lid = − momentum of canister 1.6 g × v = 4.3 g × 5.5 m s^{-1} $v = 14.8$ m s^{-1}	**3**
15 (c)(ii)	An explanation that makes reference to: • no unbalanced force on dry ice **(1)** • so no acceleration according to Newton's First Law **(1)**	MP2 is dependent on MP1 Allow suitable reference to Newton's Second Law for MP2	**2**

(Total for Question 15 = 12 marks)

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>16 (a)(i)</td><td>
• Student analyses inverse relationship by determining 1/r or 1/strain values (1)
• Axes labelled and sensible scales chosen (1)
• All points plotted correctly (1)
• Student concludes from straight line drawn through origin that strain in the fibre is inversely proportional to its bending radius (1)


</td><td>
Example of calculation:
<table>
<tr><th>Radius, r/mm</th><th>% strain</th><th>1/r/mm^{-1}</th></tr>
<tr><td>2</td><td>3.15</td><td>0.50</td></tr>
<tr><td>3</td><td>2.10</td><td>0.33</td></tr>
<tr><td>7</td><td>0.90</td><td>0.14</td></tr>
<tr><td>9</td><td>0.70</td><td>0.11</td></tr>
<tr><td>10</td><td>0.65</td><td>0.10</td></tr>
</table>
Must cover at least half of grid in both directions for MP2 to be awarded.
One mis-plot loses MP3

Alternative calculation:
<table>
<tr><th>Radius/mm</th><th>% strain</th><th>1/strain</th></tr>
<tr><td>2</td><td>3.15</td><td>0.32</td></tr>
<tr><td>3</td><td>2.10</td><td>0.48</td></tr>
<tr><td>7</td><td>0.90</td><td>1.11</td></tr>
<tr><td>9</td><td>0.70</td><td>1.43</td></tr>
<tr><td>10</td><td>0.65</td><td>1.54</td></tr>
</table>
</td><td>4</td></tr>
<tr><td>16 (a)(ii)</td><td>
• Lines drawn on graph and 1/r = 0.38 mm^{-1} (1)
• r = 2.6 (3) mm (1)
</td><td>
Example of calculation
R= 1/ y value = 1/0.38 min^{-1} = 2.6 mm
Ecf for their graph
</td><td>2</td></tr>
<tr><td>16 (b)</td><td>
An explanation that makes reference to:
• Stress caused by component of F (1)
• Parallel to surface (1)
• = F sin α (1)
• As α increases, sin α increases (1)
</td><td></td><td>4</td></tr>
</table>

(Total for Question 16 = 10 marks)

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>17 (a)</td><td>• Use of I = P/V (1)
• Use of Q=It (1)
• Use of number of electrons = Q/e (1)
• N= 7.7 x 10^{20} (1)</td><td>Example of calculation:
I = P/V = 8 W/230 V= 0.034 A
Q = It = 0.34 A x 3600 = 122.4 C
N=Q/e = 122.4 C /1.6 x 10^{-19} C = 7.65 x 10^{20} s^{-1}</td><td>4</td></tr>
<tr><td>17 (b)*</td><td>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.

<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5 - 4</td><td>3</td></tr>
<tr><td>3 - 2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
</td><td>Guidance on how the mark scheme should be applied:

The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points which is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).

If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</td><td></td></tr>
</table>

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>17 (b)*
(continued)</td><td>The following table shows how the marks should be awarded for structure and lines of reasoning.

<table>
<tr><td></td><td>Number of marks awarded for structure of answer and sustained line of reasoning</td></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr>
</table>
</td><td></td><td></td></tr>
</table>

Question Number	Acceptable Answer	Additional Guidance	Mark
17 (b)* (continued)	**Indicative content** • Analyses and interprets the text to conclude that diffraction occurs when light is reflected from the CD surface • Each ring on the CD acts as a diffraction centre scattering light in all directions • Interference occurs (superposition of light from the multiple light sources) • In directions in which there is a phase difference equal to an even multiple of π rad constructive interference (reinforcement) occurs **OR** in directions in which there is a path difference equal to a whole number of wavelengths constructive interference (reinforcement) occurs • White light is a range (mixture) of wavelengths • Hence each wavelength of light reinforces in a different direction which explains why a spectrum is seen		**6**

(Total for Question 17 = 10 marks)

Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | | | | | |

Candidate Number | | | | |

Physics

Advanced Subsidiary
Paper 2: Core Physics II

Sample Assessment Materials for first teaching September 2015

Time: 1 hour 30 minutes

Paper Reference

8PH0/02

You may need the Formulae Sheet, a calculator, protractor and a ruler.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions in Sections A and B.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You may use a scientific calculator.
- In questions marked with an *****, marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- You are advised to show your working in calculations including units where appropriate.

Turn over ▶

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S 4 7 5 5 7 A 0 1 3 2

PEARSON

SECTION A

Answer ALL questions.

All multiple choice questions must be answered with a cross ☒ in the box for the correct answer from A to D. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Which of the following would increase the amount of detail (resolution) in an ultrasound scan?

☒ **A** faster wave speed

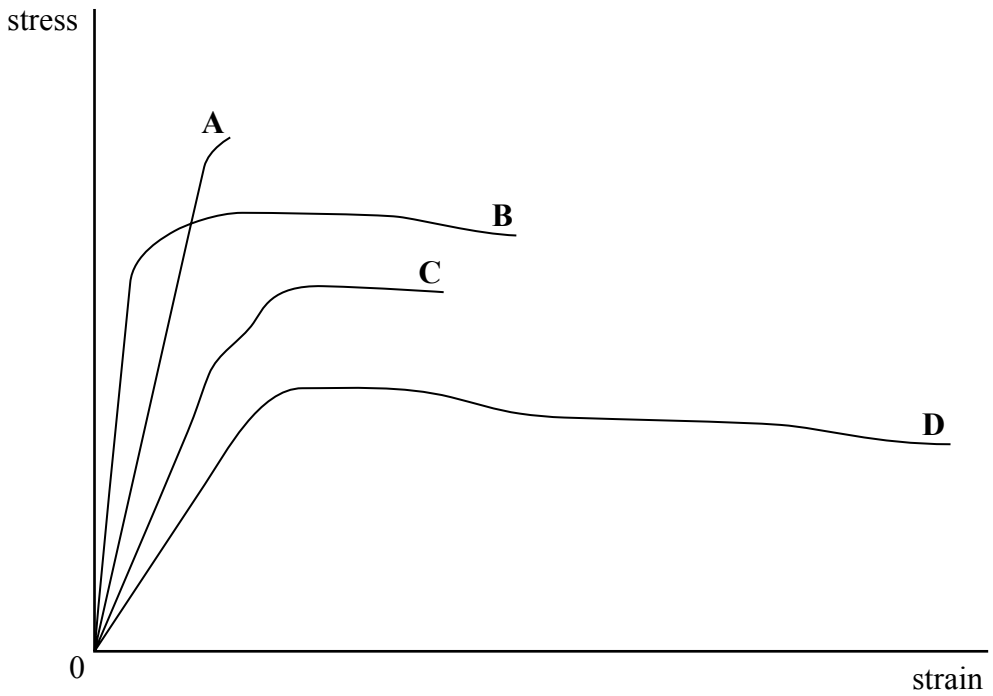
☒ **B** larger wavelength

☒ **C** lower frequency

☒ **D** shorter pulses

(Total for Question 1 = 1 mark)

2



Which of the materials represented in the graph has the largest value of the Young Modulus?

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 2 = 1 mark)

3 Light passes between medium X and medium Y.

Speed of light in X = 2.00×10^8 m s^{-1}

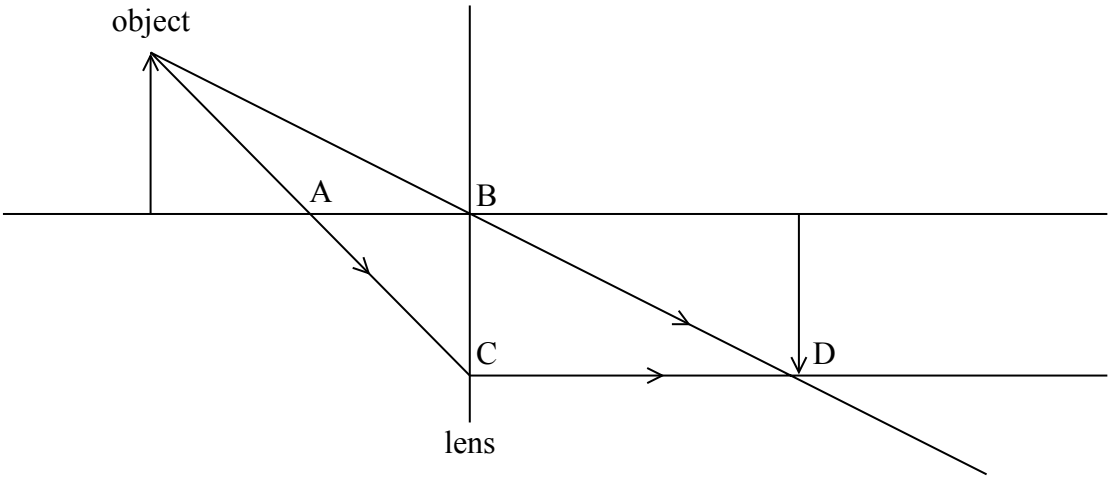
Speed of light in Y = 2.25×10^8 m s^{-1}

Which line of the table correctly shows what happens to the frequency and wavelength of the light as light passes from medium X to medium Y?

	Frequency	Wavelength
☒ **A**	decreases	increases
☒ **B**	increases	decreases
☒ **C**	unchanged	increases
☒ **D**	unchanged	decreases

(Total for Question 3 = 1 mark)

4 The diagram shows how an image is formed by an object that is placed a small distance from a thin converging lens.



Which of the labels A, B, C or D represents the focal point of the lens?

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 4 = 1 mark)

5 The viscosity of fluids varies with temperature.

Which line of the table correctly shows the change in viscosity with increasing temperature?

		Oil	Dry air
☒	**A**	decreases	decreases
☒	**B**	decreases	increases
☒	**C**	increases	decreases
☒	**D**	increases	increases

(Total for Question 5 = 1 mark)

6 In everyday life the effect of diffraction is more significant for sound than for light.

This is because

☒ **A** light has a much shorter wavelength than sound.

☒ **B** light is a transverse wave but sound is a longitudinal wave.

☒ **C** light is an electromagnetic wave but sound is a mechanical wave.

☒ **D** the speed of light in air is much higher than the speed of sound.

(Total for Question 6 = 1 mark)

7 Two waves have the same amplitude and are travelling in the same medium.

The two waves can produce a standing wave if they

☒ **A** have different frequencies and travel in opposite directions.

☒ **B** have different frequencies and travel in the same direction.

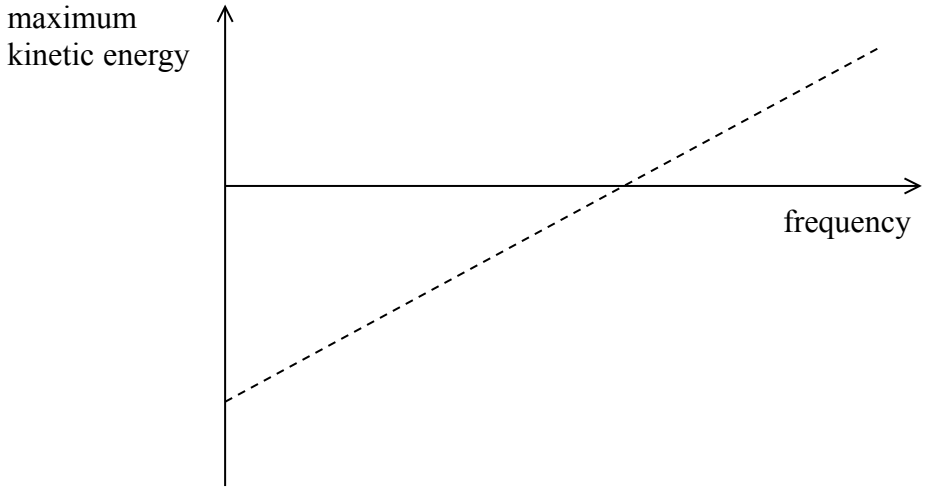
☒ **C** have the same frequency and travel in opposite directions.

☒ **D** have the same frequency and travel in the same direction.

(Total for Question 7 = 1 mark)

8 In an investigation of the photoelectric effect, a metal plate is illuminated with light of different frequencies.

The graph shows the maximum kinetic energy of emitted electrons at different frequencies.



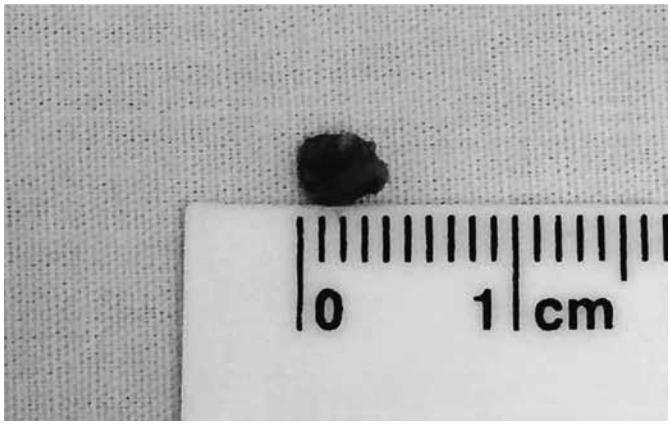
Which line of the table correctly shows the values given by the graph?

		***x* intercept**	**negative *y* intercept**
☒	**A**	Planck constant	work function
☒	**B**	threshold frequency	Planck constant
☒	**C**	threshold frequency	work function
☒	**D**	work function	threshold frequency

(Total for Question 8 = 1 mark)

9 Kidney stones can form from the deposit of minerals in a human kidney.

The photograph shows a kidney stone that has been removed from a hospital patient.



This kidney stone was detected using pulses of ultrasound.
The ultrasound used to detect this kidney stone had a frequency of 2.5 MHz.

Justify whether this was a suitable frequency for detecting this kidney stone.

Speed of sound in body tissue = 1500 m s^{-1}

(Total for Question 9 = 4 marks)

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TURN OVER FOR QUESTION 10

10 (a) Electromagnetic radiation can be polarised.

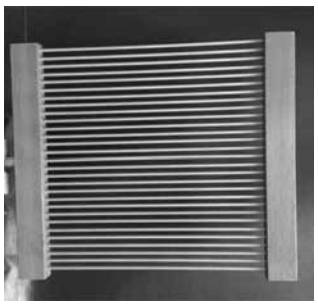
Describe what happens during the polarisation of an electromagnetic wave.

(3)

(b) The photograph shows a filter for microwave radiation.

The filter is placed between a microwave source and a detector, which detects a strong signal.

When the filter is rotated by 90° about a horizontal axis to the position shown below, the detected signal falls from a maximum to zero.



Explain this observation.

(3)

(Total for Question 10 = 6 marks)

11 A student carries out an experiment to determine the viscosity of a liquid. To do this, she takes measurements to determine the terminal velocity of a solid sphere falling through the liquid.

The data needed for such an experiment is:

weight of sphere = 4.8×10^{-3} N
radius of sphere = 2.5×10^{-3} m
volume of sphere = 6.5×10^{-8} m^3
density of liquid = 1300 kg m^{-3}

(a) Show that the upthrust on the sphere is about 8×10^{-4} N.

(3)

.....

.....

.....

.....

.....

.....

(b) The student calculates that the terminal velocity is 4.6×10^{-3} m s^{-1}.

Use this value to calculate the viscosity of the liquid in kg m^{-1} s^{-1}.

(3)

.....

.....

.....

.....

.....

Viscosity = ... kg m^{-1} s^{-1}

(Total for Question 11 = 6 marks)

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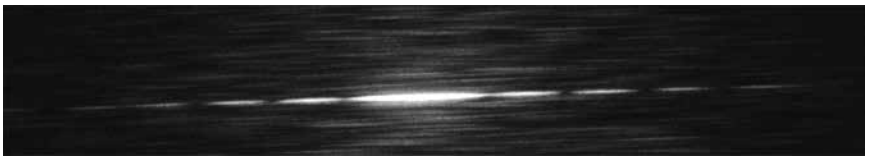
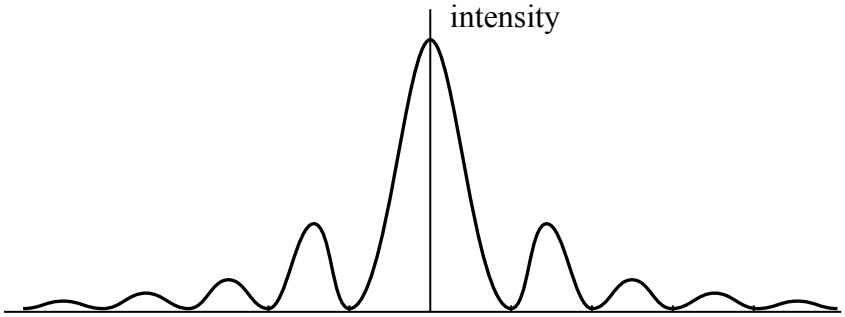
TURN OVER FOR QUESTION 12

12 A student obtains the following diffraction pattern on a wall by shining a red laser beam through a single narrow slit.

The corresponding graph of intensity against position is shown below.





(a) Explain how the diffraction pattern is created.

(3)

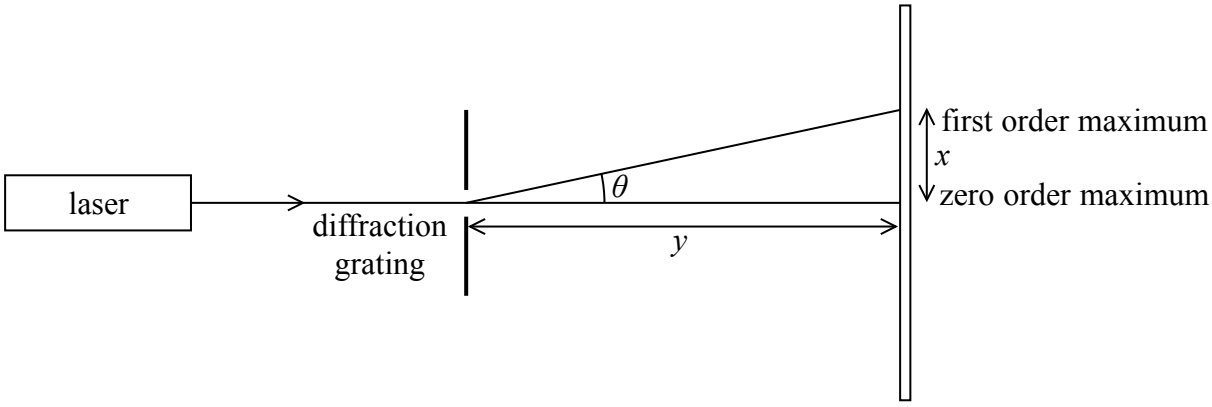
(b) Explain how the pattern would differ if green laser light were used instead of red laser light.

(3)

(c) A student replaces the single slit with a diffraction grating and obtains the pattern shown in the photograph.

The photograph shows the zero order maximum and the first and second orders on either side.

The student takes measurements to determine the grating spacing.



The student measures x, the distance between the zero order maximum and the first order maximum, and y, the distance between the slit and the screen.

x = 23 cm
y = 1.5 m
Number of lines per millimetre = 300

Calculate the wavelength of light from the laser.

(3)

Wavelength = ...

(Total for Question 12 = 9 marks)

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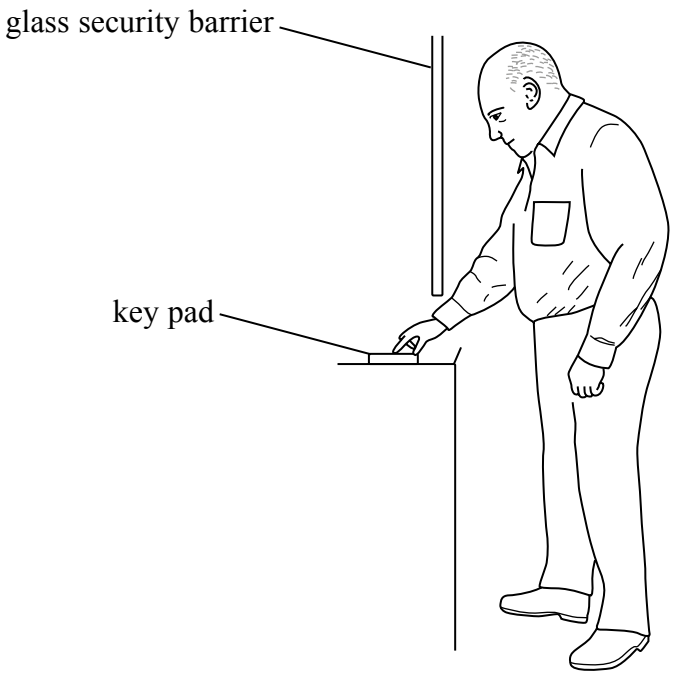
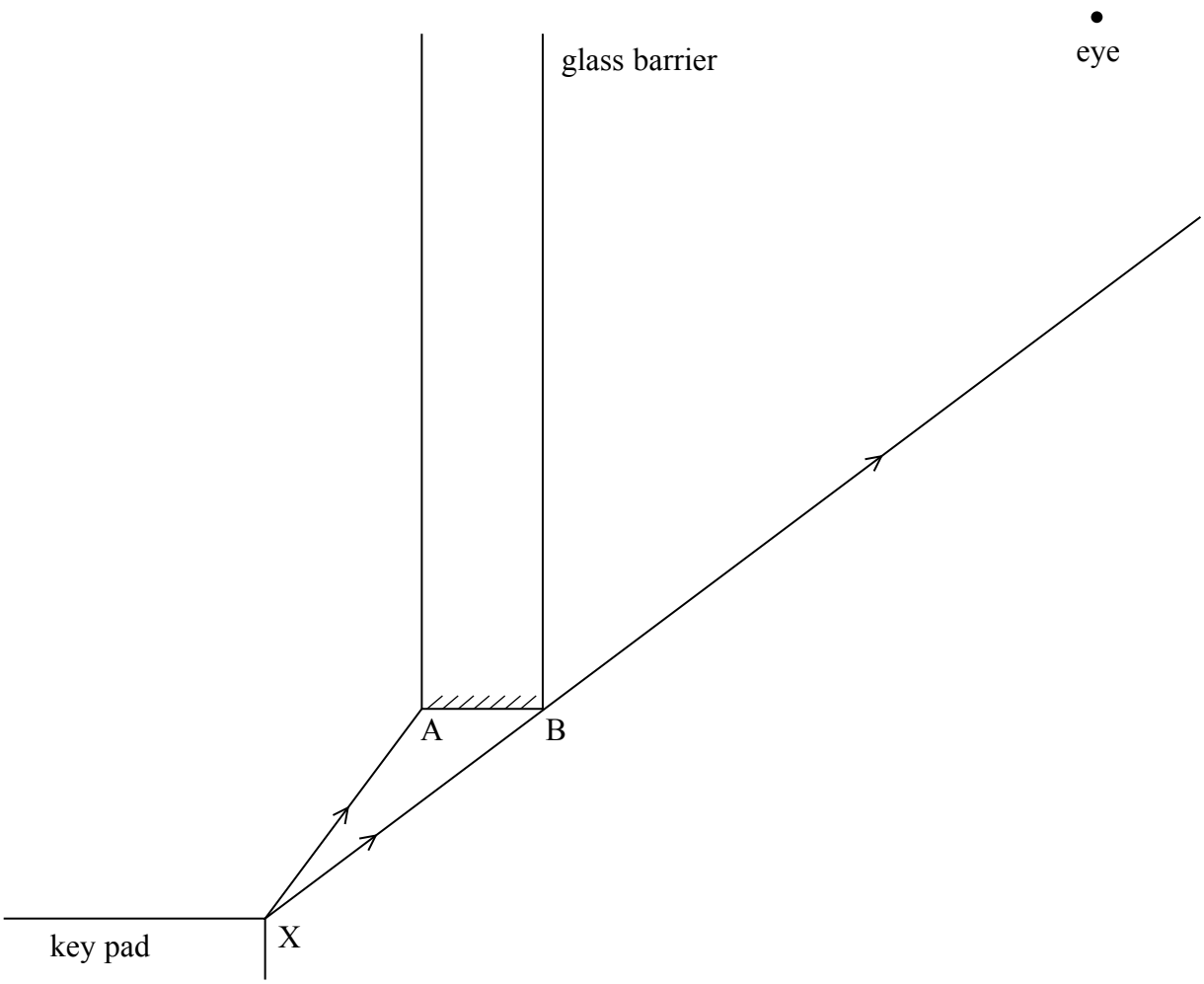
13 A motorist pays for petrol at a filling station using a bank card for which a personal identification number must be entered on a key pad.

There is a thick sheet of glass between the cashier and the motorist, with a gap at the bottom to give access to the key pad.



When standing as shown in the diagram, refraction of light through the glass means that the motorist is unable to see the key pad without moving his head to see under the glass.

QUESTION 13 CONTINUES ON NEXT PAGE



(a) The diagram shows rays from the key pad. The light travelling initially along the path XA, which then passes through the glass, does not reach the motorist's eye. Assume no light passes through the surface AB.

(i) Measure the angle of incidence for the ray travelling along XA and calculate the angle of refraction in the glass.

refractive index of glass = 1.5

(3)

(ii) Add to the diagram to show that light travelling initially along the path XA does not reach the eye of the motorist.

(1)

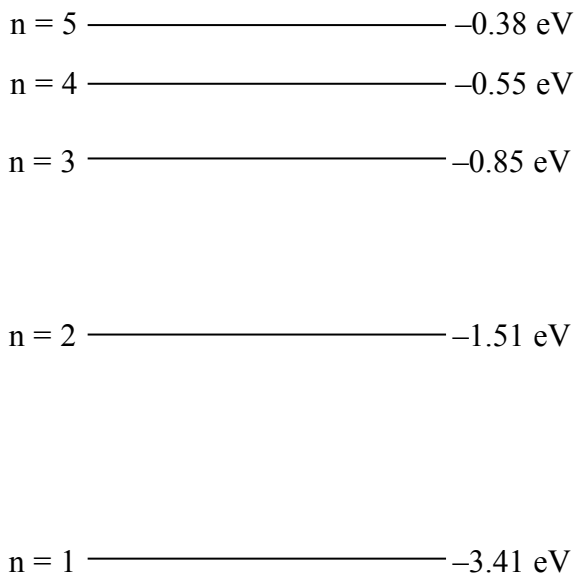
*(b) The refractive index of glass may be determined by measuring angles of incidence and angles of refraction for light passing into a glass block.

Explain how the choice of the width of the ray of light and the range of the angles of incidence can ensure the accuracy of the result.

(6)

(Total for Question 13 = 10 marks)

14 The diagram represents some of the energy levels for an atom.



(a) Calculate the lowest frequency of light that would be absorbed by an electron with energy –0.85 eV in the atom shown.

(3)

Frequency = ...

(b) When the light from a star is dispersed to form a spectrum, dark lines are seen at a number of frequencies. This is known as an absorption spectrum and is caused by the presence of certain elements in the star.

Explain how the absorption spectrum is created.

(3)

(Total for Question 14 = 6 marks)

15 The photograph shows a child's nature observation kit used for observing small creatures such as flies.

The lid has a built-in lens and an additional optional lens to allow the magnification to be increased.

The photographs below show the appearance of a fly using no lens, a single lens and two lenses respectively.

(a) A student reads that the power of a combination of lenses is equal to the sum of the powers of the individual lenses.

$$\text{power}_{\text{combination}} = \text{power}_{\text{lens1}} + \text{power}_{\text{lens2}}$$

The student investigates this relationship using the lenses in the observation kit.

The student records the method and measurements as shown below.

Method

Set up a bulb on one side of the laboratory.
Hold the lens near the opposite wall and vary the distance from the wall until a clear image of the bulb is seen on the wall.
With the other hand, use a ruler to measure the distance of the lens from the clear image formed.
This is the focal length.

Results

Lens	Focal length/cm
Lens in the lid	12
Optional lens	17.5
Combination of both lenses	7

The distance between the light and the opposite wall was 6 m.

(i) Explain **one** way of improving the value obtained for the focal length of the lens.

(2)

(ii) Determine whether the data from this experiment supports the conclusion

$$\text{power}_{\text{combination}} = \text{power}_{\text{lens1}} + \text{power}_{\text{lens2}}$$

Support your answer with a calculation.

(4)

(b) The distance of an object from the combined lenses is 5.0 cm.

Calculate the magnification of the lens.

Focal length = 7.0 cm.

(3)

Magnification = ...

(Total for Question 15 = 9 marks)

TOTAL FOR SECTION A = 58 MARKS

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SECTION B

Answer ALL questions.

16 Read the following press release and then answer the questions that follow.

"Lockheed Martin Demonstrates Weapons Grade High Power Fiber Laser

BOTHELL, Wash., Jan. 28, 2014 – Lockheed Martin has demonstrated a 30-kilowatt electric fiber laser, the highest power ever documented while retaining beam quality and electrical efficiency.

The internally funded research and development program culminated in this demonstration, which was achieved by combining many fiber lasers into a single, near-perfect quality beam of light – all while using approximately 50 percent less electricity than alternative solid-state laser technologies. The unique process, called Spectral Beam Combining, sends beams from multiple fiber laser modules, each with a unique wavelength, into a combiner that forms a single, powerful, high quality beam."

(Source: Lockheed Martin Demonstrates Weapons Grade High Power Fiber Laser Wash Bothell, Jan 28, 2014)

Traditional solid state lasers convert about 20% of electrical input energy to light output.

(a) The high power laser uses Spectral Beam Combining involving several beams with different wavelengths instead of a system using coherent beams.

Explain how combining coherent beams could lead to zero intensity in some parts of the combined beam.

(3)

(b) A student uses a laser pointer to measure the internal resistance of a cell.
The laser uses a battery of three small cells.
The student obtains the following results:

Laser switched off	
Potential difference across cells	4.1 V
Current in cells	0 mA
Laser switched on	
Potential difference across cells	3.7 V
Current in cells	14 mA

(i) Calculate the internal resistance of the battery of cells.

(2)

.....

.....

.....

Internal resistance = ...

(ii) The student notices that the manufacturer of the laser pointer claims it is as efficient as industrial lasers. At a distance of several metres the laser pointer produces a circular spot of diameter 6 mm and intensity 140 W m^{-2}.

Max power output < 5mW

Use this data and the data in the passage to evaluate the manufacturer's claim.

(5)

(Total for Question 16 = 10 marks)

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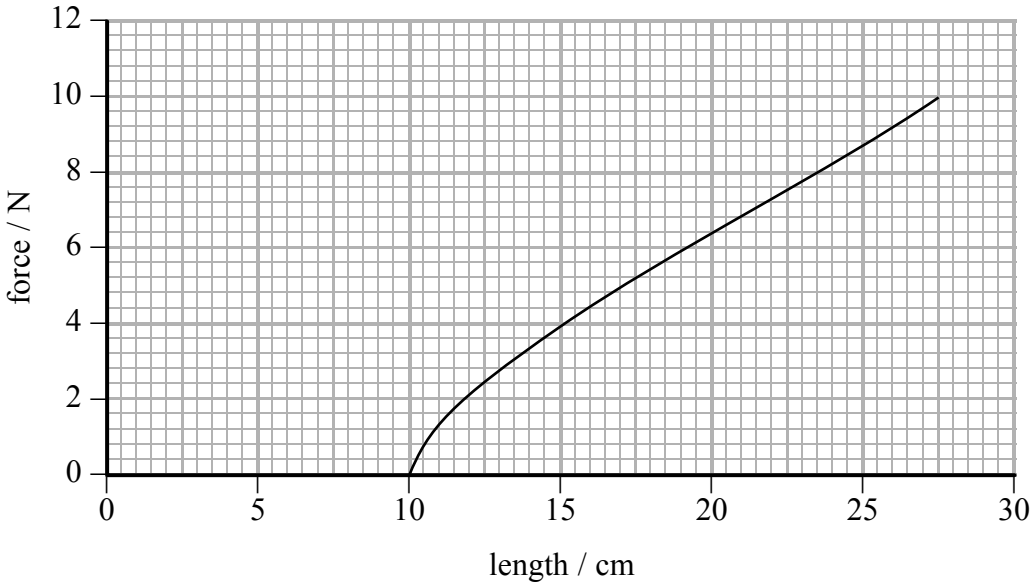
17 The photograph shows a toy that fires rubber bands.

A student investigates the properties of one of the rubber bands and obtains the following graph.



(a) The student wants to determine the mass of one of the rubber bands. He places five rubber bands on a balance and obtains a reading of 2 g. He divides the reading on the balance by five to determine the mass of one rubber band.

Explain how he could improve his result.

(3)

(b) The rubber band is stretched by 17.4 cm when it is placed on the toy.

Show that the work done on the rubber band is about 1 J.

(3)

(c) Calculate the maximum possible value for the initial velocity of the rubber band as it is fired from the toy. Assume the mass of a rubber band is 0.4 g.

(2)

Maximum initial velocity = ...

(d) The student thinks the calculated value of maximum velocity is too high because the band does not travel as far as expected.

Explain how the student could determine the initial velocity with the use of a video camera and why light gates would not be suitable.

(4)

(Total for Question 17 = 12 marks)

TOTAL FOR SECTION B = 22 MARKS
TOTAL FOR PAPER = 80 MARKS

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Paper 2 Mark scheme

Question Number	Acceptable Answers	Additional Guidance	Mark
1	D		**1**
2	B		**1**
3	C		**1**
4	A		**1**
5	B		**1**
6	A		**1**
7	C		**1**
8	C		**1**

(Total for Multiple Choice Questions = 8 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
9	Analyses data by: • use of $v = f\lambda$ **(1)** • $\lambda = 6 \times 10^{-4}$ m **(1)** • stone about 4 mm from photo **(1)** **AND** • concludes this would give sufficient resolution at this frequency because the wavelength is less than half the size of the kidney stone **(1)**	Example of calculation: 1500 m s^{-1} = 2.5 $\times 10^{6}$ Hz $\times \lambda$ $\lambda = 6 \times 10^{-4}$ m	**4**

(Total for Question 9 = 4 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
10 (a)	A description that makes reference to: • for unpolarised waves – oscillations/vibrations in many directions **(1)** • after undergoing polarisation – oscillations/vibrations in a single direction **(1)** • which is perpendicular to direction of propagation **(1)** **OR** • for unpolarised waves – oscillations/vibrations in many planes **(1)** • after undergoing polarisation – oscillations/vibrations in a single plane **(1)** • and this plane includes direction of propagation **(1)**	Marks should be awarded from one sequence only.	**3**
10 (b)	An explanation that makes reference to: • microwaves from source are polarised **(1)** • plane of polarisation of filter and the plane of polarisation of the waves are parallel at first, therefore microwaves pass through **(1)** • plane of polarisation of filter and the plane of polarisation of the waves are perpendicular to each other after rotation, therefore microwaves are absorbed **(1)**		**3**

(Total for Question 10 = 6 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
11 (a)	• use of mass = density × volume **(1)** • use of upthrust = weight of fluid displaced = $m \times g$ **(1)** • upthrust = 8.3×10^{-4} N **(1)**	Example of calculation: mass of liquid displaced = 1300 kg $m^{-3} \times 6.5 \times 10^{-8}$ m^3 mass of liquid displaced = 8.45×10^{-5} kg upthrust = 8.45×10^{-5} kg × 9.81 m s^{-1}	**3**
11 (b)	• viscous force = weight – upthrust **(1)** • use of $F = 6\pi\eta rv$ **(1)** • viscosity = 18 (kg m^{-1} s^{-1}) **(1)**	Example of calculation: viscous force = W - U = 4.8×10^{-3} N - 8.3×10^{-4} N = 3.97×10^{-3} N $\eta = 3.97 \times 10^{-3}$ N / ($6 \times 3.14 \times 4.6 \times 10^{-3}$ m $s^{-1} \times 2.5 \times 10^{-3}$) η = 18 kg m^{-1} s^{-1}	**3**

(Total for Question 11 = 6 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
12 (a)	An explanation that makes reference to: • waves/light passing through a narrow gap spread/s out **(1)** • light reaches the wall from each part of the slit with differing phase relationships **(1) OR** light reaches the wall from each part of the slit with differing path lengths **(1)** • when the waves meet superposition takes place and if the waves are in antiphase it results in destructive interference so a dark spot is seen **(1) OR** when the waves meet superposition takes place and if the waves are in phase it results in constructive interference so a bright(er) region is seen **(1)**	Accept relevant reference to Huygen's construction for first mark.	**3**
12 (b)	An explanation that makes reference to: • green light has a shorter wavelength than red light **(1)** **OR** red light has a longer wavelength that green light **(1)** • so green light diffracts less than red light **or** red light diffracts more than green light **(1)** • so the dark points would be closer to the centre or more dark points would be seen in the same space on the wall or central fringe narrower **(1)**	Accept a diagram clearly to the same scale and showing a narrowed pattern. MP2 and MP3 may be awarded if reference is made to frequency difference rather than wavelength.	**3**

Question Number	Acceptable Answers	Additional Guidance	Mark
12 (c)	• use of trigonometrical functions to calculate θ **(1)** • calculate diffraction grating spacing **(1)** • wavelength = 5.1×10^{-7} m **(1)**	Example of calculation: $\theta = \tan^{-1}$ (0.23 m/1.5 m) = 8.7° $d = 10^{-3}/300 = 3.3 \times 10^{-6}$ m $\lambda = 3.3 \times 10^{-6}$ m × sin 8.7° $= 5.1 \times 10^{-7}$ m	**3**

(Total for Question 12 = 9 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
13 (a)(i)	• measure angle of incidence at edge (53°) **(1)** • use of $n_1 \sin\theta_1 = n_2 \sin\theta_2$ **(1)** • value of angle in glass = 32° **(1)**	±1° tolerance Allow ecf for candidate's value Example of calculation: $1 \times \sin 53° = 1.5 \times \sin\theta_2$ $\theta_2 = 32°$	**3**
13 (a)(ii)	• show refraction towards normal entering glass and how refraction away from normal exiting glass **(1)**		**1**

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>13 (b)*</td>
<td>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.

<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded fo indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5 - 4</td><td>3</td></tr>
<tr><td>3 - 2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
</td>
<td>Guidance on how the mark scheme should be applied:

The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points which is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).

If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</td>
<td></td>
</tr>
</table>

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>13 (b)*

Continued</td><td>The following table shows how the marks should be awarded for structure and lines of reasoning.

<table>
<tr><td></td><td>Number of marks awarded for structure of answer and sustained line of reasoning</td></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr>
</table>
</td><td></td><td>6</td></tr>
</table>

Question Number	Acceptable Answers	Additional Guidance	Mark
13 (b)* **Continued**	**Indicative content** • a narrow ray should be used • because it reduces uncertainty in the position (angle) of the ray (accept allows position to be determined with greater precision) • a range of large angles should be used • because the precision of the measurement will be determined by the protractor • for larger angles the percentage uncertainty will be smaller • a smaller uncertainty in the final answer from sin *i*/sin *r* (and thus greater accuracy) **OR** graph		**6**

(Total for Question 13 = 10 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
14 (a)	• use of difference in energy levels in eV and use of $W = QV$ for conversion to Joule **(1)** • use of $E = hf$ **(1)** • frequency = 7.2×10^{13} Hz **(1)**	Example of calculation: difference in energy levels = –0.55 eV – (–0.85 eV) = 0.3 eV = 0.3 V × 1.6×10^{-19} C = 4.8×10^{-20} J f = 4.8×10^{-20} J ÷ 6.63×10^{-34} Js = 7.2×10^{13} Hz	**3**
14 (b)	An explanation that makes reference to: • if photon energy equal to an energy level difference in the elements present **(1)** • then the photon can be absorbed by an electron and the electron is excited/moves to higher level **(1)** • so the absorption spectrum is created because the frequencies of the absorbed photons are missing from the continuous spectrum produced by the star **(1)**	Accept references to re-emission in all directions.	**3**

(Total for Question 14 = 6 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
15 (a)(i)	An explanation that makes reference to: **EITHER** • holding the lens steady in your hand would be difficult and would make the distance measurement inaccurate **(1)** • so the lens should be in a holder on a stable surface to make the measurement accurate **(1)** **OR** • holding the ruler steady parallel to the principal axis would be difficult and make the distance measurement inaccurate **(1)** • so the ruler should be on a stable surface to make the measurement accurate **(1)** **OR** • focal length is image distance when object distance is infinite **(1)** • this is not at infinity so lens formula should be used **(1)**	These marks can be awarded only for answers in the context of the method described in the question. Reference to use of an optical bench is acceptable. Reference to use of a clamp is acceptable.	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
15 (a)(ii)	• use of power = 1/focal length **(1)** • calculates at least two powers correctly **(1)** • analyses data to compare powers or focal lengths **(1)** • draws a conclusion that is consistent with calculated values about how well the relationship is supported **(1)**	This is a comparison, so use of cm not penalised if used for all and unit D is not required. MP3 calculates combined power and uses it to calculate focal length for the combination and compares this with the measured value of focal length. Example of calculation: $P = 1/f$ power $_{lid} = 1/0.12 = 8.3$ D power $_{optional} = 1/0.175 = 5.7$ D power $_{combined} = 1/0.07 = 14$ D $8.3 + 5.7 = 14$ D	**4**
15 (b)	• use of $1/v + 1/u = 1/f$ **(1)** • use of magnification = v/u **(1)** • magnification = 3.5 **(1)**	Example of calculation $1/v = 1/7.0 – 1/5.0$ $v = 17.5$ cm $M = 17.5 / 5.0 = 3.5$	**3**

(Total for Question 15 = 9 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
16 (a)	An explanation that makes reference to: • coherent means there is a constant phase relationship **(1)** • for some parts of the beam the phase difference could be 180°/in antiphase **(1)** • causing destructive interference and therefore zero amplitude **(1)**		**3**
16 (b)(i)	• state or use of $\mathcal{E} = V + Ir$ **(1)** • $r = 28.6\ \Omega$ **(1)**	Example of calculation: $4.1\ \text{V} = 3.7\ \text{V} + 0.014\ \text{A} \times r$ $r = 28.6\ \Omega$	**2**
16 (b)(ii)	• use of $I = P/A$ **(1)** • use of $P = IV$ **(1)** • calculation of efficiency of pointer **(1)** • analysis of data in passage to give efficiency of laser as approximately 40% **(1)** • comparing data analysed to draw a conclusion that the claim is not justified. **(1)**		**5**

(Total for Question 16 = 10 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
17 (a)	An explanation that makes reference to: • balance measures to 1 g **(1)** • more rubber bands should have been placed on the balance to obtain a reading of at least 10 g **(1)** • so that a more precise reading is obtained **(1)**		**3**
17 (b)	• use of area under graph to represent work done **(1)** • uses area accurately between line and distance axis to determine work done **(1)** • 0.97 J (range from printed graph) **(1)**	Do not award first mark for use of E=1/2Fx	**3**
17 (c)	• use of ke = ½ mv^2 **(1)** • v = 70 m s^{-1} **(1)**	Example of calculation: 0.97 J = ½ mv^2 = ½ 0.0004 kg × v^2 v = 70 m s^{-1}	**2**
17 (d)	An explanation that makes reference to: • video the band over a short distance so it determines the initial speed **(1)** **OR** because its speed will rapidly reduce because of air resistance **(1)** • include a scale or object of known length in the area filmed **(1)** • analyse the video to determine the time taken to travel the known distance **AND** calculate the speed using the measured time in speed = distance/time **(1)** • (light gates would not be suitable because) the band is not sufficient in size to interrupt the light gate beam **(1)**		**4**

(Total for Question 17 = 12 marks)

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