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OCR
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Examiners' report

AS LEVEL

PHYSICS A

OCR Level 3 Advanced Subsidiary GCE in Physics A

H156

For first teaching in 2015

H156/01 Summer 2025 series

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate responses is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from Teach Cambridge.

Paper 1 series overview

This is the first paper of the AS Physics course.

To do well on this paper candidates need to have an in-depth knowledge and understanding of the subject content in Modules 3 and 4 as well as the foundation physics and practical skills in Modules 1 and 2.

Many candidates could have gained more marks by stating definitions correctly and carefully answering the questions set showing all their working. It is important for all candidates to understand key command terms such as state, describe, define, etc.

For numerical questions, candidates should state the equation that is to be used and substitute the data before evaluating an answer.

It is worth reminding candidates that their scripts are scanned and then electronically marked by examiners. It is therefore important that answers are not written outside the space provided for the answers.

There are a number of questions which assess candidates' knowledge and understanding of all of the practical skills that candidates have developed throughout their physics course. These are detailed in Module 1 of the specification.

There were also several 'show' questions on the paper. These 'show' questions do require candidates to clearly indicate their method. The unknown should be the subject of any equation – credit is not given for using the 'show' value and working backwards.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• demonstrated good knowledge of definitions • wrote logical reasoned answers relating to their knowledge and understanding of physics • clearly demonstrated the working to numerical questions substituting in the appropriate numbers into stated equations • considered powers of ten in units • applied their knowledge and understanding to the question set.	• did not know definitions in detail • omitted detail when answering explanation type questions • did not show clear substitution of data into equations in calculation questions • did not use technical terms correctly • did not clearly explain their reasoning • omitted to explain practical procedures.

Section A overview

Candidates appear to have attempted all of the questions.

Candidates should be encouraged to read the instructions and in particular answer the 20 multiple choice questions in about 25 minutes, e.g. each question should be answered in just over one minute. Candidates should be advised not to spend too much time on any one question. If a candidates cannot answer the question, they should move on to the next question and come back at the end to try the question.

High scoring candidates tended to use the white space to write down working and sketch diagrams to help them answer the question. This also assists candidates on checking their work if they have time left at the end.

Question 1

1 A metal wire has cross-sectional area of $4.0 \times 10^{-6}\,m^2$. The number density of charge carriers in the metal is $8.5 \times 10^{28}\,m^{-3}$. The current in the wire is 1.5A.

Calculate the mean drift velocity of the charge carriers.

A $4.4 \times 10^{-6}\,ms^{-1}$

B $2.8 \times 10^{-5}\,ms^{-1}$

C $3.6 \times 10^{-4}\,ms^{-1}$

D $8.2 \times 10^{-4}\,ms^{-1}$

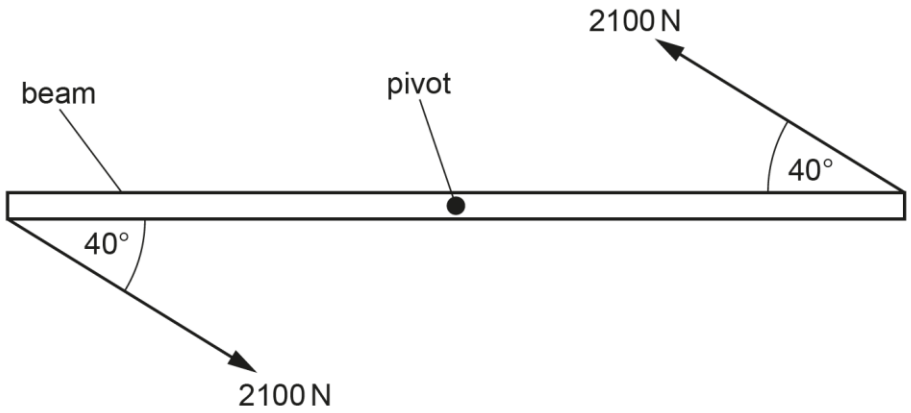
Your answer ☐ **[1]**

This question was answered well. High scoring candidates often wrote an equation in the white space and substituted into their expression the data.

Question 2

2 A beam of length 4.0 m is pivoted at its centre.

Two equal and opposite forces of magnitude 2100 N are applied to opposite ends of the beam, as shown.



What is the torque due to the two forces shown?

A 2700 N m

B 3200 N m

C 5400 N m

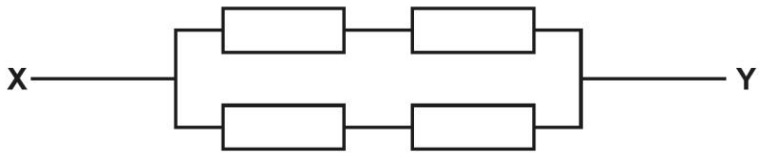
D 6400 N m

Your answer ☐ **[1]**

The majority of the candidates who did not gain the correct answer, selected answer A. These candidates correctly calculated the force but found the moment of the pivot for one of the forces rather than the torque of the two forces shown.

Question 3

3 Four resistors, each of resistance 10 Ω, are connected in a network, as shown.



What is the total resistance between points **X** and **Y**?

A 2.5 Ω

B 10 Ω

C 25 Ω

D 40 Ω

Your answer ☐ **[1]**

Most candidates correctly gave the answer as B. The common distractors for low scoring candidates were either A or D (dividing by four or multiplying by four).

Question 4

4 Which is a possible wavelength of ultraviolet radiation?

A 10^{-6} m

B 10^{-8} m

C 10^{-10} m

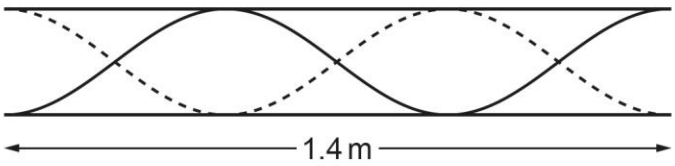
D 10^{-12} m

Your answer ☐ **[1]**

This question was generally answered well, although across the cohort several incorrect responses were observed. These were usually either A (infra-red) or C (X-rays). Candidates should know the orders of magnitude of the wavelengths of the principal radiations of electromagnetic waves in a vacuum.

Question 5

5 The diagram shows a sound wave in an open pipe of length 1.4 m.



The speed of the wave is 330 m s^{-1}.

Calculate the frequency of the wave.

A 160 Hz

B 240 Hz

C 350 Hz

D 710 Hz

Your answer ☐ **[1]**

Most candidates correctly understood that the length of the tube was 1.5 wavelengths and gained the correct answer. Low scoring candidates often assumed that the length of the tube was equal to the wavelength and selected B as their answer.

Question 6

6 Electromagnetic radiation with frequency of 2.2×10^{15} Hz is incident on a clean metal surface. The work function of the metal is 3.7 eV. Photoelectrons are emitted from the surface of the metal.

Calculate the maximum kinetic energy of the photoelectrons.

A 5.9×10^{-19} J

B 8.7×10^{-19} J

C 1.5×10^{-18} J

D 2.1×10^{-18} J

Your answer ☐ **[1]**

A common incorrect answer was A, where candidates had converted 3.7 eV to joule.

Question 7

7 The velocity of an electron is 5% of the speed of light in a vacuum.

Calculate the wavelength of the electron.

A 1.3×10^{-15} m

B 2.6×10^{-14} m

C 2.4×10^{-12} m

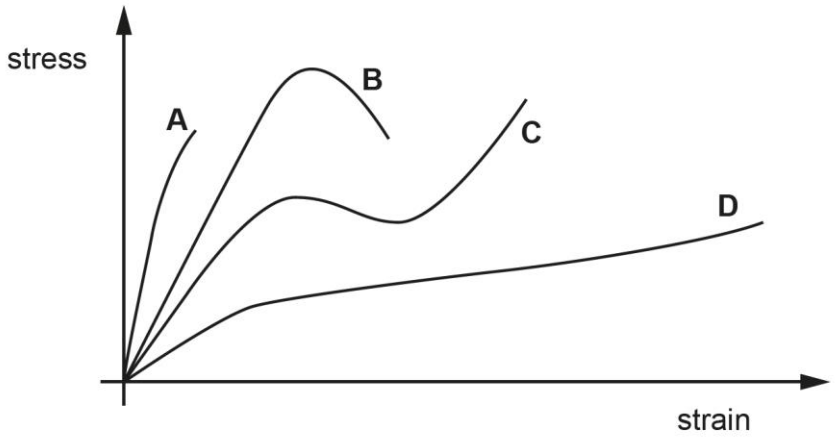
D 4.9×10^{-11} m

Your answer ☐ **[1]**

A range of answers were observed. High scoring candidates effectively used the white space to work out the speed of the electron and then wrote the equation and substituted the data.

Question 8

8 The stress-strain graphs for four materials **A**, **B**, **C** and **D** are shown.



Which material has the greatest ultimate tensile strength?

Your answer ☐ **[1]**

The majority of the candidates correctly identified B. The common distractors were C and D.

Question 9

9 The Young modulus of a material is 2.1×10^9 Pa.

What is 2.1×10^9 Pa numerically equal to?

A 2.1 GPa

B 2.1 kPa

C 2.1 MPa

D 2.1 TPa

Your answer ☐ **[1]**

Where errors were made it was usually selecting D or to a lesser extent C.

Assessment for learning

Candidates should practice using the prefixes and symbols to indicate submultiples and multiples of units and be able to covert form powers of ten to the prefixes and vice versa.

Question 10

10 An object floats in a liquid. A force of upthrust acts on the object.

Which quantity does **not** affect the magnitude of the upthrust?

A density of the liquid

B gravitational field strength

C mass of the object

D volume of the object

Your answer ☐ **[1]**

There were many incorrect answers to this question. A significant minority of candidates selected the gravitational field strength option.

Question 11

11 An object, initially at rest, falls from a height of 4.5 m above the ground.

Assume that air resistance is negligible.

Calculate the speed of the object when it is 2.5 m above the ground.

A $4.4\,m\,s^{-1}$

B $6.3\,m\,s^{-1}$

C $7.0\,m\,s^{-1}$

D $9.4\,m\,s^{-1}$

Your answer ☐ **[1]**

The majority of the candidates correctly identified B as the correct answer. The two common errors from lower scoring candidates were to choose D (ignoring the 2.5 m) or to select C where candidates had found the speed after 2.5 m rather than the speed at 2.5 m.

Some candidates usefully sketched a diagram to show the arrangement of the ball falling which then enabled these candidates to identify the correct distance.

Assessment for learning

When answering questions, it is often useful for candidates to underline the key data and sketch diagrams. In this question underlining '2.5 m above the ground' with a sketch would help determine the correct distance.

Question 12

12 Electromagnetic radiation is incident on the surface of a clean metal sheet. The frequency of the radiation is greater than the threshold frequency of the metal. Photoelectrons are released from the surface.

Which of the following quantities affects the rate of emission of photoelectrons?

A the intensity of the radiation

B the thickness of the metal sheet

C the threshold frequency of the metal

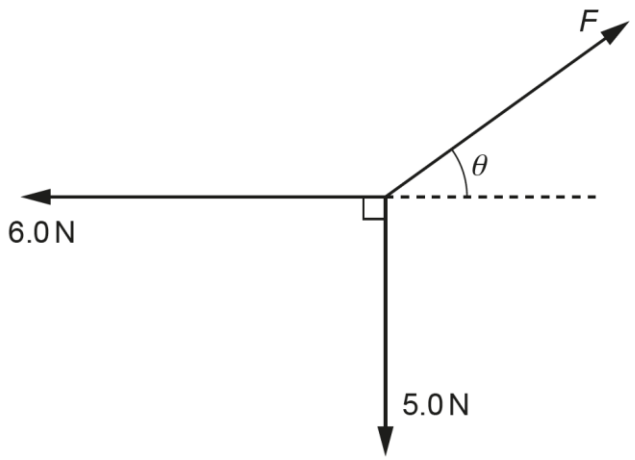
D the work function of the metal

Your answer ☐ **[1]**

This question was assessing a standard learning outcome from the specification. Low scoring candidates often selected either C or D without reference to Einstein's photelectric equation.

Question 13

13 A free-body force diagram is shown below. The system is in equilibrium.



Calculate the magnitude of the force F and the angle θ.

	F / N	θ / °
A	7.8	40
B	7.8	50
C	11	40
D	11	50

Your answer ☐ **[1]**

A few candidates incorrectly selected C – adding the two forces 5.0 N and 6.0 N to equal11 N.

Question 14

14 Two identical particles are travelling at the same speed v in opposite directions.

They collide head on. The collision is elastic.

What happens to the two particles after the collision?

A One particle stops and the other rebounds at speed $2v$.

B They move off together at speed v.

C They rebound in opposite directions, each at speed $\frac{v}{2}$.

D They rebound in opposite directions, each at speed v.

Your answer ☐ **[1]**

The question was answered well. Candidates usually correctly identified that the particles would rebound in opposite directions but the common error was to suggest the speed of the particles would be halved. If this was the case, then the kinetic energy would not be conserved.

Assessment for learning

Candidates should understand in all collisions:

- the total momentum is conserved, and
- total energy is conserved.

Candidates should understand that in an **elastic collision**

- the total momentum and
- the total energy is conserved and
- the total kinetic energy is conserved.

Question 15

15 The mass of a cube of a material is measured to a percentage uncertainty of 8%.

The length of each side of the cube is measured to a percentage uncertainty of 2%.

Calculate the total percentage uncertainty in the calculated density of the material.

A 6%

B 10%

C 14%

D 16%

Your answer ☐ **[1]**

High scoring candidates often used the white space for their working. Often it could be seen that candidates considered that the volume of the cube was given by L^3 where L is the length of one side.

These candidates then wrote $3 \times 2\% = 6\%$ before adding the 6% and the 8% to equal 14%.

Common incorrect answers were B (omitting the information that the 2% referred to the length and not the volume) or D (multiplying 2% by 8%).

Assessment for learning

Candidates should understand when to add absolute uncertainties and when to add percentage uncertainties.

When **adding** or **subtracting** quantities, the **absolute** uncertainties are added.

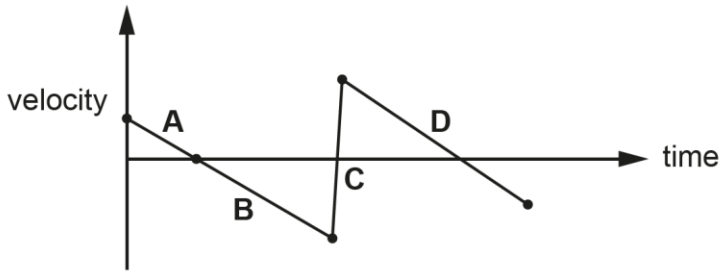
When **multiplying** of **dividing** quantities the **percentage** uncertainties are added.

With quantities to a power, the percentage uncertainty is multiplied by the power.

Question 16

16 A ball is thrown upwards from a height 1 m above the ground. It rises to maximum height, then falls to the ground and bounces once, rises and falls back down to the ground.

The velocity-time graph for this motion is shown below.



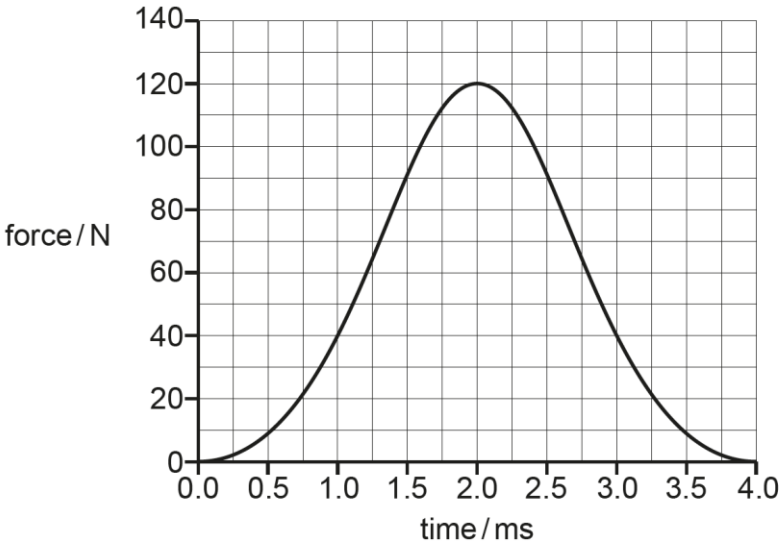
During which section of the graph does the ball experience the greatest rate of change of momentum?

Your answer ☐ **[1]**

When this question was answered incorrectly, it was often either B or D selected.

Question 17

17 A ball is hit by a racket. The graph shows how the force on the ball changes whilst the racket is in contact with the ball.



Which is the best estimate of the total impulse on the ball?

A 0.20 N s

B 0.24 N s

C 0.48 N s

D 0.50 N s

Your answer ☐ **[1]**

Candidates found this question more challenging. Some candidates realised that the total impulse was given from the area under the graph but then did not calculate the area correctly. Some clearly drew a triangle and gained an answer of 0.24 N s without allowing for the area inside the triangle. Other candidates multiplied.

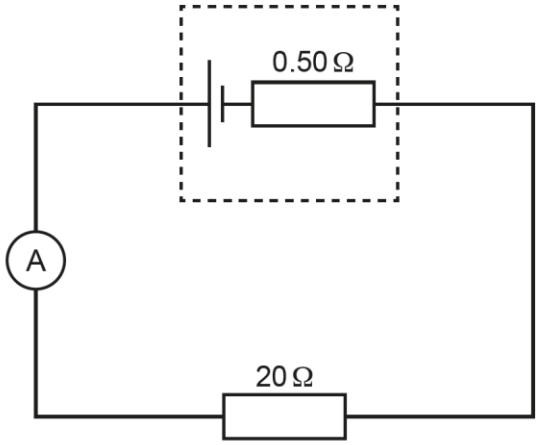
Assessment for learning

Candidates should understand how to calculate the area under a graph:

- work out the physical significance of one small square
- calculate a value for the one small square considering the units
- count the number of whole small squares
- estimate the total number of whole squares by allowing for the part squares
- multiplying the total number of squares by the physical significance of one small square.

Question 18

18 A cell with an e.m.f. of 1.50 V and internal resistance of 0.50 Ω is connected to a resistor of resistance 20 Ω. An ammeter is connected in series.



Calculate the reading on the ammeter.

A 30 mA

B 31 mA

C 73 mA

D 75 mA

Your answer ☐ **[1]**

A significant minority of lower scoring candidates correctly calculated the total resistance of 20.5 Ω but then incorrectly multiplied by 1.5 to give answer B.

Question 19

19 A current flows through a resistor.

Which is a correct definition for the power dissipated in the resistor?

A energy transferred from electrical energy to other forms of energy per unit charge

B energy transferred from electrical energy to other forms of energy per unit time

C energy transferred from other forms of energy to electrical energy per unit charge

D energy transferred from other forms of energy to electrical energy per unit time

Your answer ☐ **[1]**

This question was assessing candidates' knowledge of the definition of power. Many candidates confused the definition of power with the definition of potential difference and gave answer A.

Question 20

20 The amplitude of a wave is doubled.

How does the intensity of the wave change?

A decrease by factor of 4

B decrease by factor of 2

C increase by factor of 2

D increase by factor of 4

Your answer ☐ **[1]**

This question was generally answered well. The common error was selecting C (not understanding that intensity is proportional to amplitude^2) or A (not understanding the direct proportion).

Section B overview

All questions were attempted in Section B, with very few candidates omitting individual question parts.

As candidates work through the paper, they should consider both the amount of answer space and the number of marks available for the question. For example, in Question 24 (c), there are 3 marks available and six answer lines. Candidates should be encouraged to make three distinct points. It is unlikely that a short sentence would score all 3 marks.

There were a number of questions where candidates should have given a conclusion, e.g. Questions 21 (a), 22 (b) and 23 (b). It is important that candidates provide sufficient explanation and give a conclusion based on their explanation. Credit is not normally given where a valid explanation does not lead the candidate's conclusion.

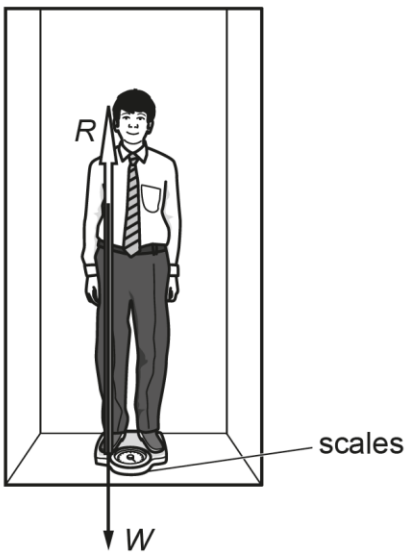
In explanation questions it is important that candidates relate their answers to the question set. For example, Question 23 (c) (i) was about the stationary waves formed in a microwave oven and therefore answers needed to refer to the oven.

There are a number of numerical calculations. Candidates should be encouraged to write down the equation and substitute the data into the equation before evaluating an answer. The advantages of this method are that candidates are less likely to make 'slips', it is easier for candidates to check their work both when answering the question and when reviewing their work if they have time at the end of the examination. It also gives candidates the opportunity of gaining method marks if their final answer is incorrect.

Question 21 (a)

21 A student stands on a set of scales while travelling in a lift. The scales are calibrated in newtons. When the lift is stationary the scales read 700 N.

The diagram shows the two forces acting on the student, the normal contact force *R* and the weight *W*.



(a) When the lift is stationary, $W = R$. Discuss whether these two forces form a force pair according to Newton's third law.

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..... **[3]**

Many candidates understand the basic detail of Newton's third law but do not appreciate the finer detail that it applies to two bodies and that the forces have to be of the same type. The states that there are two forces are acting on the student, so therefore only one body. Candidates should also have realised that the force of gravity or weight is a non-contact force and that the normal contact force is a contact force.

A significant minority of candidates gave an incomplete answer where they referred to one of the two reasons as why the forces did not form a force pair without thinking about the answer space or the number of marks for the question.

A few candidates did not state whether or not a force pair was formed.

Candidates should be encouraged to think about the space to answer and the number of marks for each question. In this case there were 3 marks available so three distinct points should be included in their discussion.

Assessment for learning

Many candidates can quote the basic Newton's third law.

Candidates should understand how the law applies to two bodies and how the law applies to forces of the same type.

Question 21 (b) (i)

(b) The lift accelerates upwards, from rest, with acceleration of $2.4\,m\,s^{-2}$.

(i) Calculate the expected reading on the scales.

reading on scales = ... N **[3]**

The majority of the candidates correctly calculated the mass of the student and used this value to calculate the resultant force causing the acceleration. Most candidates either gave this resultant force as their final answer or subtracted it from the weight.

Assessment for learning

Candidates should be encouraged to show clear logical working.

This question is a multi-stage calculation question where there were several calculations to complete to gain the final answer.

For this question, ideally candidates should be encouraged to answer as follows:

Mass = 700 ÷ 9.81 = 71.4 kg

$F = ma$ = 71.4 × 2.4 = 171.3 N

Reading on scale = 700 + 171.3 = 870 N

It should be noted that it is good practice to show the units so that any power of ten can be identified.

By showing working in this way, it enables some marks to be awarded if there is an arithmetic error moving through the work. For example, the candidate who writes an answer of 770 (N) without any working would not score any marks since the candidate has not demonstrated any physics. However, the candidates who writes down the first two lines in the example above and then makes a slip in adding 171.3 to 700 to make 770 scores two marks because of the physics that has been demonstrated.

Assessment for learning

Candidates should use the values given on the data sheet for constants when answering questions.

Candidates should use the value of 9.81 $m\,s^{-2}$ not 10 $m\,s^{-2}$ for the acceleration of free fall.

Question 21 (b) (ii)

(ii) Calculate the time taken by the lift to reach a height of 8.5 m.

time = ... s **[3]**

This question was generally well answered. High scoring candidates correctly stated the appropriate equation of uniform motion and then substituted in the data.

Some candidates were confused as to when to use the acceleration of 2.4 $m\,s^{-2}$ and when to use 9.81 $m\,s^{-2}$.

Question 21 (c)

(c) The lift moves downwards at a constant speed. The student remains standing on the scales.

State and explain the expected reading on the scales.

.....

.....

.....

..... **[2]**

The command word 'state' in the question meant that candidates needed to state a value (700 N) for the reading on the scales. It was not good enough to simply state that the reading would be the same.

The explanation needed to refer to the resultant force being zero. The term 'equilibrium' is not quite enough – it implies that the resultant force is zero but soes not demonstrate that the candidate understand that the resultant force is zero.

Question 22 (a) (i)

22 A scientist takes measurements to identify a piece of glass.

(a) They measure the refractive index of the glass using the following procedure:

1 Submerge the glass in a clear liquid with a known refractive index.

2 If the glass is not visible when submerged in the liquid, conclude that the refractive index of the glass is equal to the refractive index of the liquid.

3 Otherwise, clean the glass and return to the first step using a liquid with a different refractive index.

(i) Suggest why the scientist must clean the glass in step **3**.

.....

..... **[1]**

This was a challenging question in that there were many vague answers that did not state that by not cleaning the glass the refractive index could be different.

Question 22 (a) (ii)

(ii) Suggest **one** other factor that the scientist needs to control.

.....

..... **[1]**

This was a challenging question designed to assess a candidate's understanding of refractive index. Very few candidates were able to state that the frequency or wavelength of the light used. There are several vague responses in terms of the intensity of the light or temperature. However, examiners allowed the temperature of the liquid or the density of the liquid.

Question 22 (b)

(b) The table shows the refractive index n for three different types of glass.

Type of glass	Refractive index, n
X	$1.47 < n < 1.49$
Y	$1.49 < n < 1.50$
Z	$1.51 < n < 1.54$

The scientist measures the refractive index of the piece of glass as 1.52 ± 1.5%.

They conclude that the glass is type **Z**.

Evaluate this conclusion.

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.....

..... **[3]**

This question required candidates to calculate the minimum and maximum values before stating whether the conclusion is valid.

High scoring candidates clearly demonstrated the maximum and minimum values of the refractive index before stating that the range included both glass Y and glass Z. Since glass Y was between 1.49 and 1.50, candidates should be calculating the minimum value of 1.497.

Vague responses in terms of it being more likely to be glass Z did not gain credit.

Question 22 (c) (i)

(c) A student makes measurements to determine the refractive index of a liquid by measuring the critical angle.

(i) Describe what **critical angle** means.

.....

..... **[1]**

Many candidates answered this question by stating that the critical angle is the angle at which total internal reflection occurs.

High scoring candidates stated it was the angle of incidence which gives an angle of refraction of 90°. Examiners on this occasion allowed where the refracted ray travelled along the boundary.

Some candidates were confused with terminology between reflection and refraction.

Misconception

Understanding the difference between critical angle and the criteria for total internal reflection.

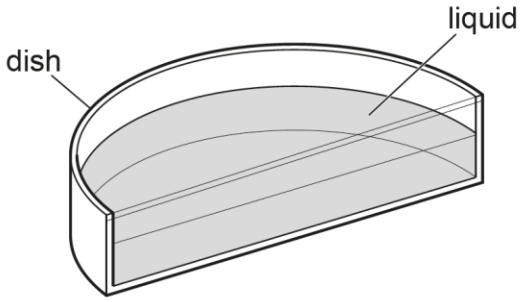
One of the criteria for total internal reflection is that the angle of incidence has to be greater the than the critical angle.

The critical angle is when the angle of refraction is equal to 90°.

Question 22 (c) (ii)

(ii) The student pours liquid into a shallow, semicircular glass dish.

Refraction due to the thin glass walls of the dish can be ignored.



Describe how the student could accurately measure the critical angle using a ray box.

You may draw diagrams to support your answer.

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.....

.....

..... **[4]**

As part of their practical skills candidates should be able to design experiments and describe the techniques to carry out a safe experiment within a school laboratory setting.

Most lower scoring candidates drew diagrams where the ray of light either entered the straight edge of the container or was reflected from the curved surface.

High scoring candidates drew helpful diagrams, clearly showing an incident ray on the curved surface travelling towards the centre of the straight edge with the ray splitting into a reflected ray and a ray refracted at 90°. Other high scoring candidates drew three diagrams showing the three cases of an angle of incidence less than the critical angle, equal to the critical angle and greater than the critical angle.

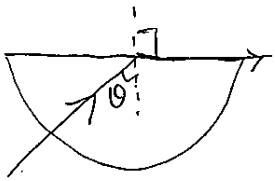
When carrying out the experiment, the angle of incidence needed to be adjusted until the critical case is observed. Candidates needed to state then the critical angle would be measured using a protractor.

Further credit was available for discussions of drawing around the container and/or indicating how the rays would be marked.

Exemplar 1

Describe how the student could accurately measure the critical angle using a ray box.

You may draw diagrams to support your answer.



draw ~~or~~ normal line on flat surface. Shine light from the semicircle side, adjust angle of light until ~~refraction~~ angle of refraction reaches 90°, just before total internal reflection occur. ~~Mark~~ Draw the line ~~where~~ ~~light~~ of angle of incidence and measure angle using protractor, ~~or~~ ~~[illegible]~~ [4]

This candidate has stared answering the question by drawing a diagram of the semicircular glass dish. The incident ray of light is indicated entering the curved surface and refracted at 90° at the centre of the curved surface.

The text clearly states that the angle needs to be changed until the angle of refraction reaches 90° and that the critical angle will be measured with a protractor.

The candidate clearly answers the question set with a practical plan.

Question 22 (c) (iii)

(iii) The student measures the critical angle as 42°.

Calculate the refractive index of the liquid.

refractive index = ... **[2]**

This question was generally well answered. High scoring candidates usually wrote down the equation and substituted data.

Question 23 (a)

23 Some information about a microwave oven is shown in the table.

Frequency of microwaves / GHz	2.45
Input voltage / V	230
Input current / A	5
Output power / W	700

(a) Calculate the percentage efficiency of the microwave oven.

percentage efficiency = ... % **[3]**

This question was usually answered well.

Since this was a multi-stage calculation candidates should be encouraged to show all their working in their answers. In this question high scoring candidates showed the calculation of input power before substituting the data into the efficiency equation.

Question 23 (b)

(b) The microwave oven is used to heat some soup.

The internal energy of the soup needs to increase by 100 kJ to reach the correct temperature for eating.

The soup packet claims that the soup should be heated for at least 3 minutes.

Deduce whether the claim is correct.

[3]

There were many different ways to answer this question which required candidates to demonstrate their knowledge and understanding of the definition of power.

Candidates needed to demonstrate the use of this equation with appropriate conversion of units, including time.

To gain full credit candidates needed to explain whether their calculation showed whether the claim was correct.

Question 23 (c) (i)

(c) The soup packet advises that the soup should be stirred halfway through heating to ensure it is heated evenly.

The microwave oven heats the soup unevenly because stationary waves are formed inside the microwave oven.

(i) Explain how stationary waves are formed inside the microwave oven.

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..... **[2]**

Many candidates discussed the general conditions for stationary waves or described stationary waves. High scoring candidates related their answers to the microwave oven by stating that the emitted microwaves would reflect from the metal walls of the oven and that the emitted and reflected waves would interfere or superpose.

Lower scoring candidates did not always use correct terms.

Question 23 (c) (ii)

(ii) Explain why the formation of stationary waves causes the soup to be heated unevenly.

.....

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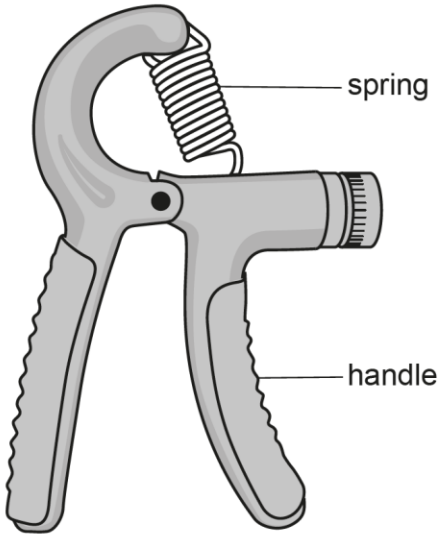
..... **[2]**

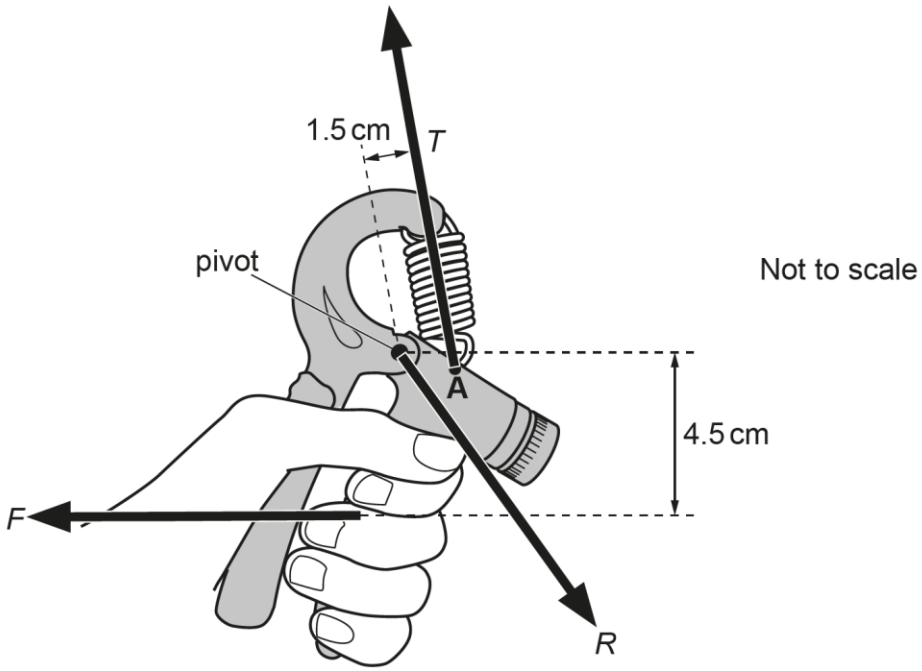
Candidates needed to relate their answers to nodes and antinodes. To gain full credit candidates needs to explain what was meant by a node and an antinode in terms of amplitude or intensity and then relate the nodes and antinodes to whether there was transfer of energy to the soup.

Question 24 (a)

24 The figure shows a device used to increase the strength of finger muscles.



When a force *F* is applied to the handle, the system is maintained in equilibrium by a tension *T* in the spring and a reaction force *R* acting at the pivot.



Not to scale

(a) State the **principle of moments**.

.....

.....

..... **[2]**

The majority of the candidates were able to state the principle of moments in terms of the sum of the clockwise moments and the sum of the anticlockwise moments being equal. Higher scoring candidates stated that this occurred when a body was in (rotational) equilibrium to gain full marks.

Where marks were not scored, it was usually because candidates omitted the 'sum of' clockwise moments, etc. or stated the definition of a moment of a force.

Question 24 (b) (i)

(b) A force F of 340 N is applied to the handle. The spring extends by 12 mm.

The perpendicular distance from F to the pivot is 4.5 cm.

The perpendicular distance from T to the pivot is 1.5 cm.

(i) Show that the force constant k of the spring is approximately 90 000 N m^{-1}.

[3]

In this calculation it is essential that candidates show all stages of the calculation. Candidates needed to apply the principle of moments using the distances to give a value for the tension T. This value was then used in the equation to determine the force constant k. To gain full credit the value of 85000 needed to be seen.

High scoring candidates clearly wrote down relevant equations and substituted into the equations the data provided.

A common error made by some low scoring candidates was to subtract the distances.

Exemplar 2

$\Sigma M_{clockwise} = \Sigma M_{anticlockwise}$

$(340)(4.5\times10^{-2}) = (T)(1.5\times10^{-2})$

$T = 1020\ N$

$F = kx$

$k = \frac{F}{x}$

$= \frac{1020}{12\times10^{-3}}$

$= 85000\ N\ m^{-1}$

$\approx 90000\ N\ m^{-1}$

This candidate has clearly demonstrated knowledge and understanding. They have stated the principle of moments, substituted in the data and converted the distances correctly to metres to determine a value for the tension in the spring. The candidate has then stated an equation relating the force constant to the force and extension, rearranged the equation and substituted in the data to calculate an answer. This answer has then been used to get to the value given in the question.

Question 24 (b) (ii)

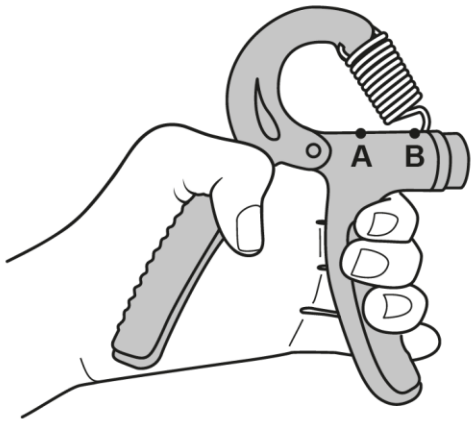
(ii) Calculate the elastic potential energy stored in the spring.

elastic potential energy = ... J **[2]**

This question was generally well answered. Where errors occurred, it was often not squaring the extension.

Question 24 (c)

(c) The point of attachment of the spring is moved from **A** to **B**, as shown below.



Discuss how the force *F* must change to produce the same extension in the spring.

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.....

..... **[3]**

This question was challenging.

Candidates needed to identify that for the extension to remain constant, the tension needed to remain the same but the perpendicular distance between the pivot and the line of action of *T* had increased so that the moment due to *T* increases. Thus, the moment for *F* needs to increase. Since the perpendicular distance between the pivot and the line of action of *F* has stayed the same, the force *F* must be larger.

Many candidates did not refer to *T* remaining constant. Other candidates did not refer to perpendicular distances.

Exemplar 3

Discuss how the force *F* must change to produce the same extension in the spring.

①. As force constant k is unchanged, $T=kx$, where x is the same, T should be unchanged ②. $T=\frac{Fx_1}{x_2}$ according to $Tx_2=Fx_1$ ③. As the attachment moved from A to B, the perpendicular distance from F to the pivot ~~increases~~ unchange while the perpendicular distance from T to the pivot increases. ④. $T=\frac{\uparrow Fx_1}{x_2\uparrow}$ therefore Force F should increases

This candidate has clearly explained their answer and included relevant equations. A step-by-step approach has been included and at each stage there is a clear explanation of the physics.

Question 25 (a)

25 Electromagnetic waves can be polarised.

(a) Explain what **plane polarised wave** means.

.....

.....

..... **[2]**

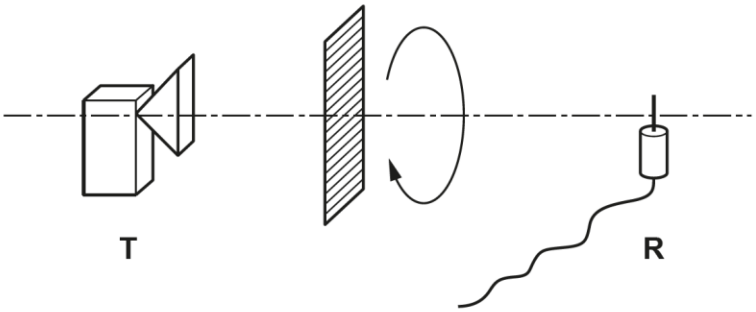
To gain full credit for this question, candidates needed to understand that only transverse waves could be polarised and thus the oscillations of vibrations of the wave were perpendicular to the direction of the wave. The majority of the candidates were able to state that in a plane polarised wave the oscillations are only in one direction or plane .Some candidates omitted any references to the oscillations or vibrations of the wave but instead answered the question in terms of 'a wave travelling in a single plane'. Other lower scoring candidates stated that 'polarising blocks some waves'.

Question 25 (b) (i)

(b) A microwave transmitter **T** and receiver **R** are placed facing each other, as shown in the diagram.

When set up as shown in the diagram, **T** and **R** emit and detect plane polarised microwaves with the same polarisation.

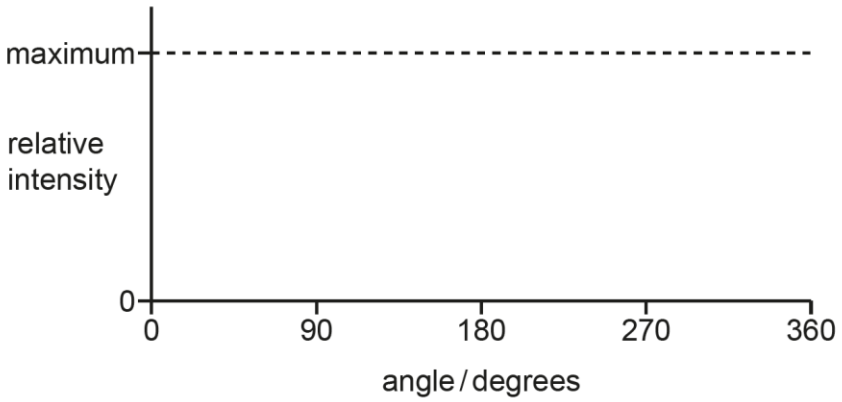
A metal grille is inserted between **T** and **R**.



Initially **R** records a maximum intensity.

(i) The grille is then slowly rotated through 360° about the axis joining **T** and **R**.

Sketch a graph to show how the intensity detected by **R** changes as the grille is rotated.



[3]

Most candidates correctly understood that maximum intensity occurred at 0° 180° 360° and that the minimum values would be at 90° and 270°. Many candidates incorrectly drew straight lines between the maximum and minimum values. While Malus' law is not part of the specification a qualitative understanding of the how the intensity changes when a polariser is used is expected.

Question 25 (b) (ii)

(ii) **T** is now rotated by 45° about the axis joining **T** and **R**. The grille is returned to its initial position, as shown in the diagram. The procedure described in **(i)** is now repeated.

Suggest and explain, without calculation, how the pattern of intensity detected by **R** will change.

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.....

.....

..... **[2]**

Most candidates discussed that the pattern would be shifted without realising that the maximum intensity of the pattern would be reduced. Very few candidates explained that the reason for the decrease maximum intensity was due to the detector receiving a smaller component of the transmitted wave.

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