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# Examiners' Report
# June 2019

## IGCSE Physics 4PH1 1P

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# Introduction

This was the first examination of paper 1 for the new International GCSE Physics specification. Questions were set to assess candidates' knowledge, understanding and application from all eight topics in the specification.

- Topic 1 - Forces and Motion.
- Topic 2 - Electricity.
- Topic 3 - Waves.
- Topic 4 - Energy Resources and Energy Transfer.
- Topic 5 - Solids, Liquids and Gases.
- Topic 6 - Magnetism and Electromagnetism.
- Topic 7 - Radioactivity and Particles.
- Topic 8 - Astrophysics.

The examination was written to assess across the full range of grades from 1 to 9. Consequently, some questions were written to be challenging whilst others were designed to be more straightforward and accessible. A range of different question types were included in the examination such as objective and multiple choice, calculations and both short and long written responses. Approximately 20% of the marks available in the examination were for candidates' demonstrations of experimental skills and understanding. Three of the eight required practical investigations were assessed in this examination.

Successful candidates were well-acquainted with the content of the specification and could recall facts whilst applying their understanding to new and complex situations. They were competent in performing quantitative work, could recall relevant formulae and rearrange these formulae to obtain the correct answer. Successful candidates also showed evidence of undertaking all the required practicals themselves and could produce detailed, coherent methods whilst recalling the relevant results of these experiments.

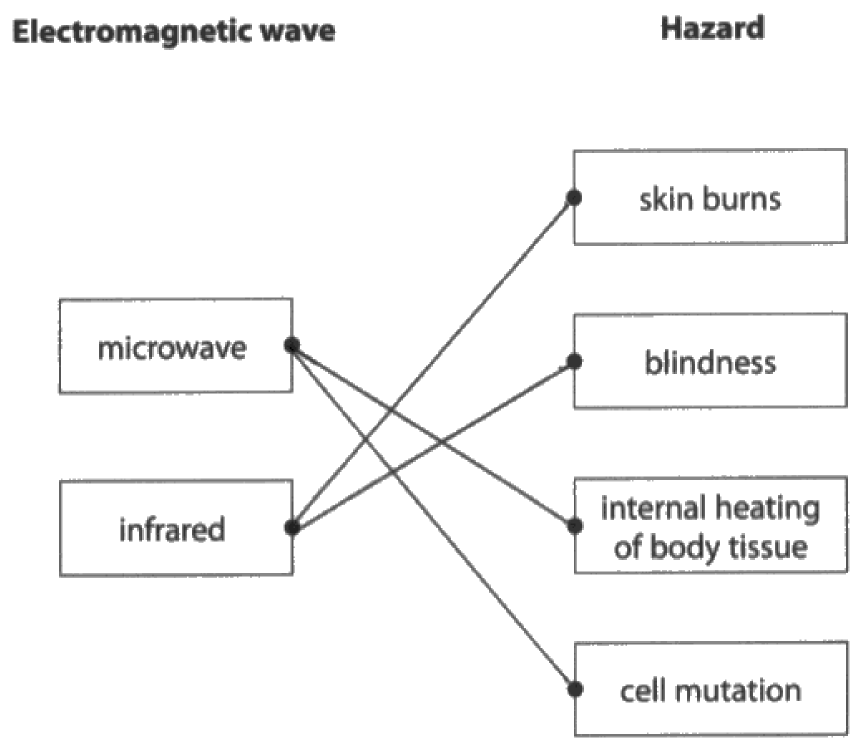
Less successful candidates showed gaps in their knowledge of topics and either had limited experience, or could not recall information from the required practical tasks. These candidates often did not address the demands of the question and overlooked the importance of the command words being used.

## Question 1 (a) (ii)

Candidates were required to pair each named part of the electromagnetic spectrum with one of the given hazards.

(ii) Draw a straight line linking each electromagnetic wave to its correct hazard.

**(2)**

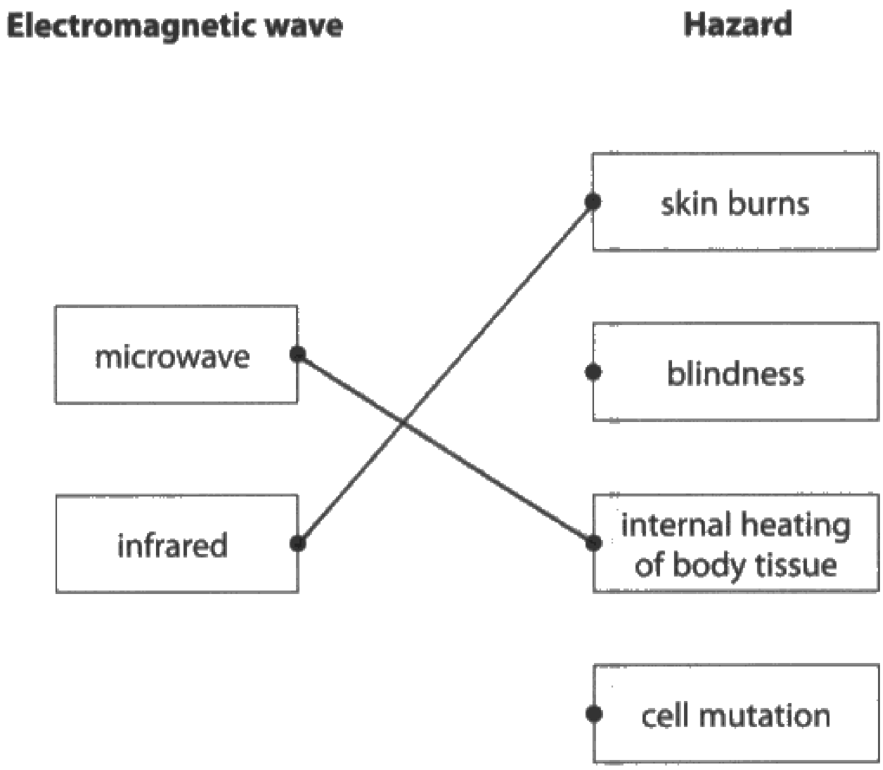



**ResultsPlus**
**Examiner Comments**

Responses like this scored no marks. The candidate has misread the question and assumed that all hazards should be linked to one of the parts of the electromagnetic spectrum.

**ResultsPlus**
**Examiner Tip**

Read questions carefully to ensure the response is appropriate.




**ResultsPlus**
**Examiner Comments**

This candidate has correctly identified the hazard for each part of the electromagnetic spectrum and scored both marks.

# Question 2 (a)

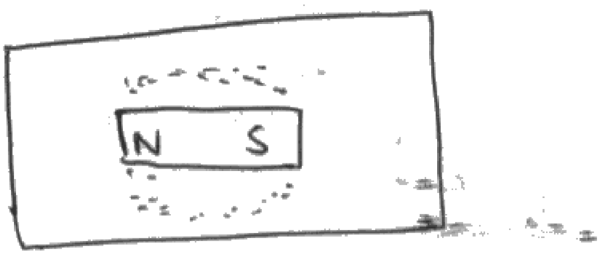
Candidates were asked to write a method for one of the required practicals on the specification. There are two common approaches to this experiment and the mark scheme allowed both to be given full credit. Candidates who described a method using iron filings, often did not state how they would find the direction of the magnetic field and, therefore, were limited to scoring 2 marks. High quality diagrams were capable of being given full credit and often these helped to clarify ideas communicated in poorly worded written responses.

**2** This question is about magnetic fields.

(a) Describe an experiment to investigate the magnetic field pattern around a permanent bar magnet.

You may draw a diagram to help your answer.

**(3)**



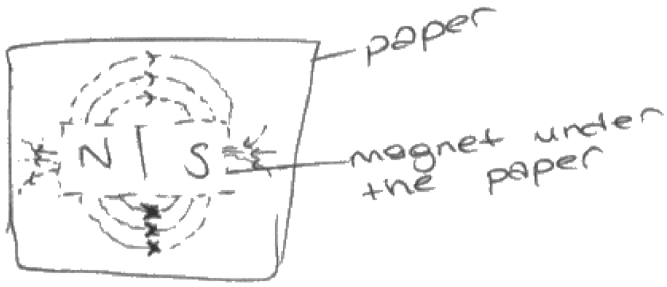

place a piece of paper ontop of a permanent magnet. Sprinkle some iron fillings onto the paper. Tap the paper gently. Iron fillings will produce a pattern which shows the magnetic field.

ResultsPlus
**Examiner Comments**

This response described a method centred around the use of iron filings. The mention of iron filings is awarded the first mark and the additional detail of sprinkling (rather than dropping or placing), gains the second mark. However, there is no description of how to find the direction of the field pattern, so the response is limited to scoring 2 marks only.

You may draw a diagram to help your answer.

**(3)**




- get iron fillings , paper and a bar magnet. place magnet under the paper and spill iron fillings onto the paper . tap and shake the paper gently. iron fillings forms magnetic field on the paper. Also , you can put ~~compasses~~ compass near to the ~~between~~ bar magnet and the needle of the compass shows the direction of magnetic field from north to south.

**ResultsPlus**
**Examiner Comments**

This response scored all 3 marks. This candidate has chosen to describe a method using iron filings, and has also included a method of finding the direction of the field lines by using a compass.

You may draw a diagram to help your answer.

(3)


① Place a permanent magnet on center of page, draw round it.
② Place compass on one of the corner of the magnet and mark where north points to. Then move the compass to this mark and repeat until the path is complete.
③ Repeat this step, by placing the compass on another corner until all magnetic fields lines are drawn.
The direction that north points to is the direction of the current so mark on the line with an arrow.

**ResultsPlus**
**Examiner Comments**

This candidate was also awarded 3 marks. Their response is very clear and the use of a compass to find both the shape and direction of the magnetic field pattern has been described to a high level of detail. The diagram on its own would have scored all 3 marks here. It is clear that a compass is being used and that its direction is being noted, and furthermore that it is being moved to new positions.

ResultsPlus

Examiner Tip

When the option of drawing a diagram is available, marks can always be awarded from the candidate's diagram. Diagrams can help to reinforce ideas communicated in the written response and provide additional details to the examiner.

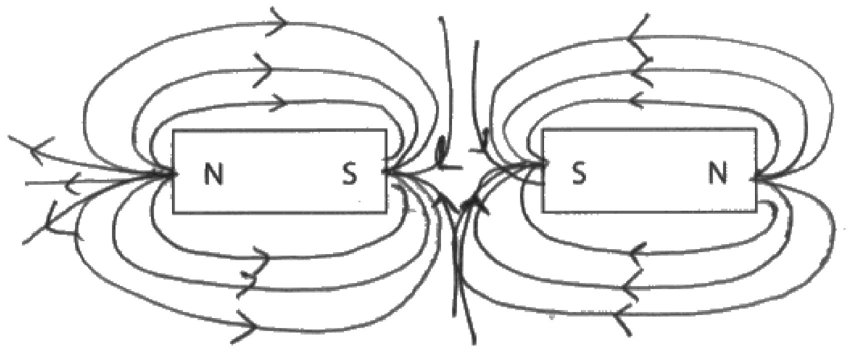
## *Question 2 (b)*

This question required candidates to draw the complete magnetic field pattern around and between the two bar magnets. Most candidates knew that the magnets repelled and that there should be no field lines linking the south poles. However, only the best candidates took time to draw their field patterns carefully in order to avoid field lines touching or crossing each other. A significant number of candidates did not demonstrate that magnetic field lines are directed from north to south.

(b) The diagram shows two bar magnets.

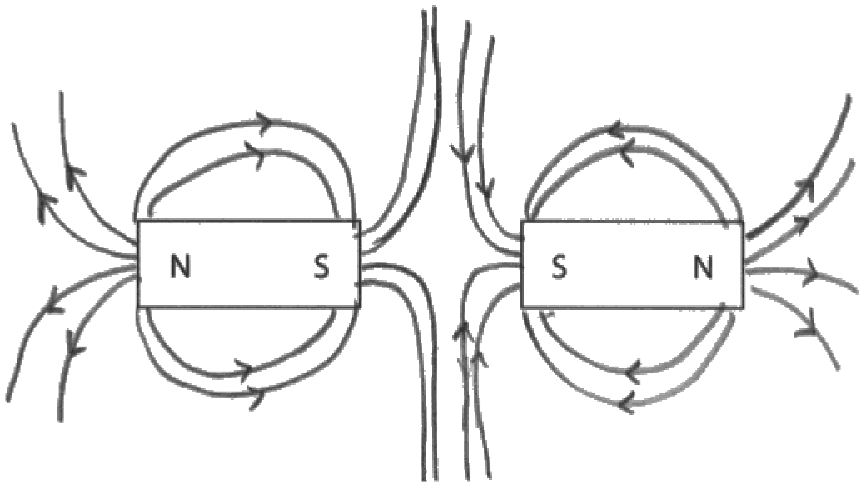
Complete the diagram to show the magnetic field pattern.

**(3)**



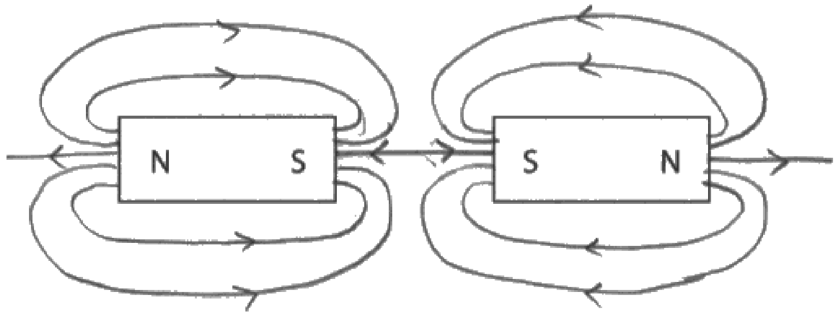

**ResultsPlus**
**Examiner Comments**

This response was awarded 2 marks only. The general shape and direction of the field is correct, but the lines crossing over in the centre of the field pattern is incorrect and resulted in a mark being lost. The field lines emanating from a single point at the poles was condoned, but it is not best practice as these field lines should start at different points on the poles.




ResultsPlus
**Examiner Comments**

This response has been drawn carefully to ensure no field lines touch or cross over each other. There is a clear indication that the field between the magnets is different to the regular field surrounding a single bar magnet, and the directions shown on the field lines are correct. This response is of a high standard and was awarded 3 marks.




ResultsPlus
**Examiner Comments**

The inclusion of a field line linking the two south poles prevented this response from scoring mark point 2. It scored 2 marks in total.

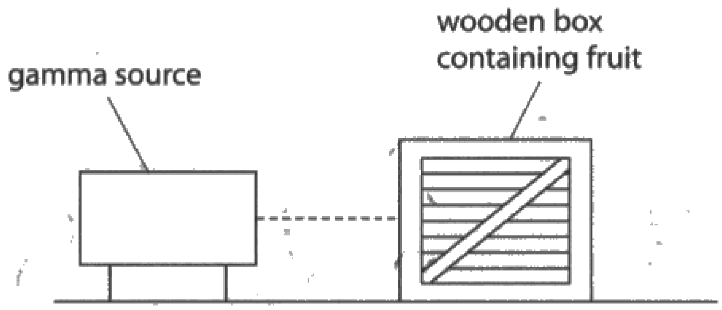
## *Question 3 (a)*

Q03(a) was answered well and the majority of candidates were able to score at least 1 mark. Successful candidates realised that this question required an explanation, so gave a reason to support the fact that only gamma could penetrate the wooden box.

**3** This question is about food preservation.

(a) The diagram shows how gamma radiation is used to irradiate fruit stored in a wooden box.

The radiation kills bacteria on the fruit.




Explain why gamma radiation is used instead of alpha radiation to kill bacteria.

**(2)**

- ~~E~~ Gamma has higher penetrating power

- lower ionising power in gamma radiation

- alpha particles will ionise with air and will not kill the bacteria

**ResultsPlus**
**Examiner Comments**

This candidate has recognised that gamma has the higher penetrating power, but has not linked this sufficiently to the context. The response only scored the first marking point.

Gamma radiation has a more penetrating power and will pass through the wooden box to kill bacteria, where as arpha has a high ionising ability and can be stopped /absorbed by air before reaching the bacteria in the wooden box.

ResultsPlus
Examiner Comments

This response was awarded 2 marks. There is a clear comparison between the penetrating power of gamma and alpha and this is correctly linked to the context by stating that only gamma will be able to penetrate through the wooden box.

ResultsPlus
Examiner Tip

Questions using the command word 'explain' require reasons to support the ideas being given.

## Question 3 (b)

Q03(b) assessed one of the new statements in the specification and required candidates to communicate the difference between contamination and radiation to score both marks. Most responses scored a mark for stating that the bacteria on the fruit had been killed, but only some candidates scored an additional mark for recognising that the fruit had not been contaminated.

(b) The wooden box has this label.

these fruits
have been
irradiated

Explain why fruit irradiated with gamma radiation is safe to eat.

**(2)**

The radiation is exposed from outside. The ~~food~~ fruit does not contein radioactive subtences.

ResultsPlus
**Examiner Comments**

This response was awarded 1 mark for the idea that the fruit does not contain radioactive substances (mark point 2).

Irradiated means the food is not mixed with source . So no effect on the body. As the food is irradiated where ~~it~~ the ~~m~~ gamma rays had destroy the bacteria and the food is sterilised and not contaminated.

**ResultsPlus**
**Examiner Comments**

This is an example of a higher level response that scored 2 marks. The understanding of contamination is clear, and mark point 4 is awarded for the idea that the fruit has not been in contact (mixed) with the source. Mark point 2 is also given for the additional detail that the fruit is not contaminated.

Here, in the fruit no gamma radiation is present. Because, in irradiation only a gamma beam is send through the Fruit. No gamma source is present in the fruit. So no gamma radiation is emitted by fruits So eating these fruits can't cause any cell mutation in the body.

**ResultsPlus**
**Examiner Comments**

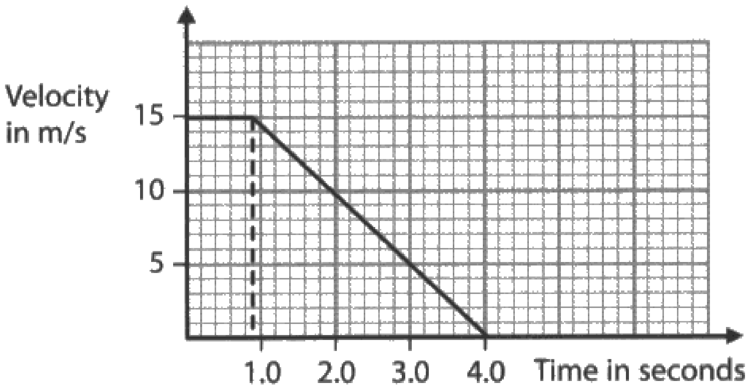
This response was also awarded 2 marks. The candidate scores mark point 4 for the idea that no source is present in the fruit. They then go on to score mark point 3 for the idea that the fruit will not emit radiation.

# Question 4 (a)

Q04(a) was the first opportunity on the paper for candidates to demonstrate their mathematical skills. The question discriminated between ability very well and it was encouraging to see a large number of candidates scoring full marks. Common mistakes included only finding part of the area under the line in Q04(a)(ii), and not including a minus sign in the acceleration calculation in Q04(a)(iii).

**4** A car driver sees a hazard on the road ahead.

The graph shows the velocity of the car from when the driver sees the hazard.




(a) (i) Use the graph to determine the reaction time of the driver.

**(1)**

reaction time = 0.9 s

(ii) Calculate the stopping distance of the car.

**(4)**

distance = speed x time

$\frac{d}{s \times t}$ distance = area of shape

0.9x 15 = 13.5

stopping distance = 13.5 m

(iii) Calculate the acceleration of the car when the car is braking.

**(3)**

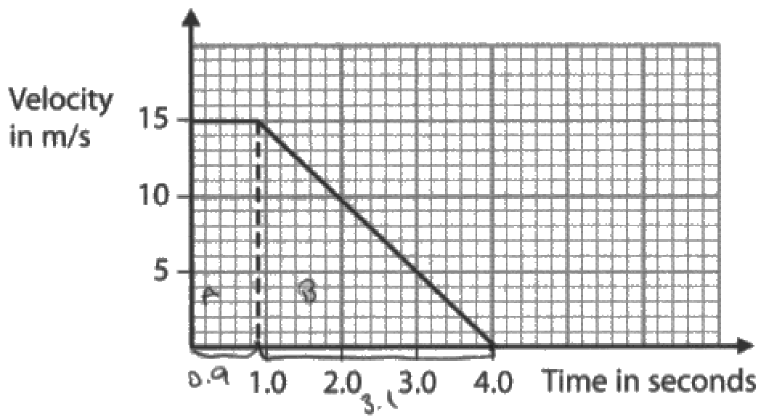
$$\frac{v-u}{t} = \frac{15-0}{3.1} = 4.84$$

$4-0.9 = 3.1$

acceleration = 4.84 m/s²

ResultsPlus
**Examiner Comments**

This candidate has correctly read the graph to score the mark in Q04(a)(i), but has only calculated the first part of the area under the line to score 2 marks in Q04(a)(ii). Their calculation of the acceleration is correct in Q04(a)(iii) but the change in velocity used is the wrong way round, resulting in a positive value for the acceleration, which scored 2 marks only.




(a) (i) Use the graph to determine the reaction time of the driver.

**(1)**

reaction time = 0.9s s

(ii) Calculate the stopping distance of the car.

**(4)**

stopping distance = braking distance + thinking distance

A = 0.9x15

= 13.5

$B = \frac{3.1 \times 15}{2}$

= 23.25

13.5+23.25

= 36.75

stopping distance = 36.75 m

(iii) Calculate the acceleration of the car when the car is braking.

**(3)**

$\text{acceleration} = \frac{(v-u)}{t}$

4.0 - 0.9 = 3.1

$= \frac{0-15}{3.1} = \frac{-15}{3.1} = -4.84$

acceleration = -4.84 m/s²

**ResultsPlus**
**Examiner Comments**

This is an excellent response that was awarded full marks. This candidate realises that they need to find the complete area under the line in Q04(a)(ii) and also gives their value for the acceleration as negative in Q04(a)(iii). The candidate's working is clearly laid out and easy to follow.

## Question 4 (b)

Q04(b) was well-answered and most candidates were able to give at least one factor that affected either thinking or braking distance. Some candidates referred to visibility factors when discussing thinking distance, which did not score due to thinking distance being defined as the distance travelled from seeing the obstacle to applying the brakes. A small number of candidates did not link their given factors to either thinking or braking distance and, therefore, did not score.

(b) The speed of the car affects the thinking distance and the braking distance.

Discuss other factors that affect the thinking distance and the braking distance of the car.

**(4)**

Thinking distance is affected by the age of the driver. His vision, Poor vision will cause to have large thinking distance.
Wheather the driver is ~~a~~ under drugs. Alcohol slows the nervous system and increase the thinking distance.
Braking distance is affected by condition of the roads. A wet road would have higher braking distance than a dry road.
Conditions of tyres and brake pads. A worn of tyres would cause a increase in braking distance.

**ResultsPlus**
**Examiner Comments**

An excellent response that scored 4 marks. The age of the driver and their consumption of alcohol are both factors that are correctly linked to the thinking distance. The condition of the road and the condition of the brakes/tyres are both correctly linked to the braking distance.

## *Question 5 (a)*

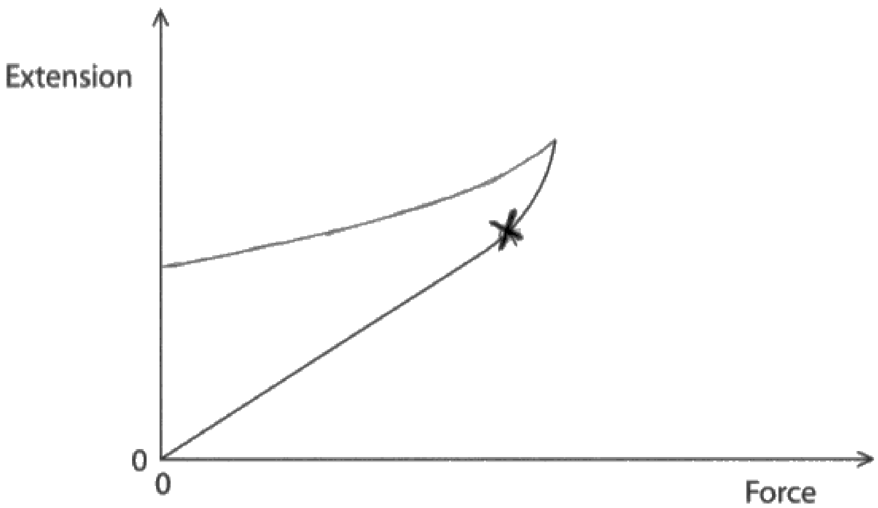
Candidates did not seem familiar with the content of Q05(a) despite it being one of the required practicals in the specification. Whilst most candidates knew that the elastic limit of the spring lay at, or slightly beyond the end of the linear region on the graph, very few knew how to complete the graph to show the unloading data.

**5** This question is about stretching a spring.

(a) The graph shows how the extension of a spring varies when a force is applied to the spring.

The line on the graph shows that the spring has been extended past its elastic limit.

The line has a straight section and a curved section.




(i) Draw a cross on the line to show the elastic limit of the spring.

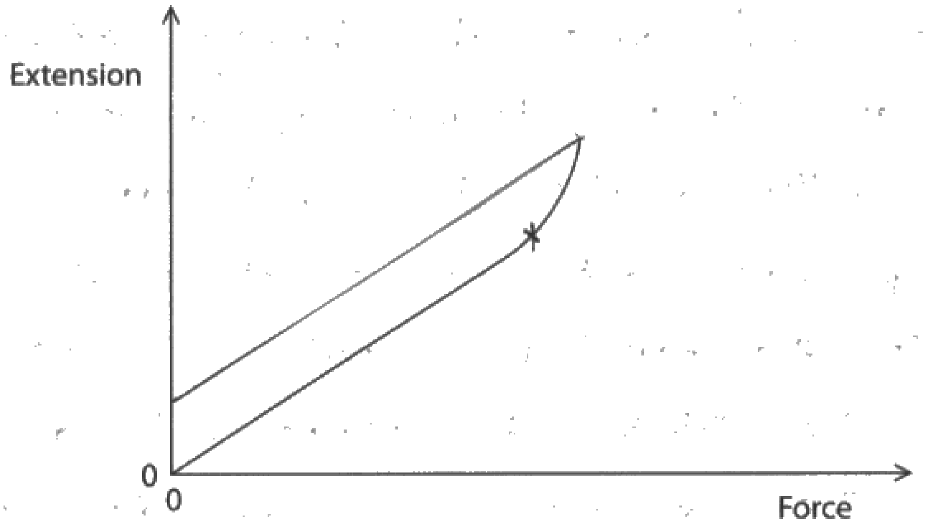
**(1)**

(ii) Sketch another line to show how the extension will change when the force is decreased from its maximum value back to 0.

**(2)**

**ResultsPlus**
**Examiner Comments**

This response gained the mark in Q05(a)(i) and also 1 mark in Q05(a)(ii). The unloading line starts at the end of the original line and shows a decrease in extension as the force is decreased, but is not straight.




ResultsPlus
Examiner Comments

An excellent example that was awarded full marks. In addition to the unloading line being straight, the candidate also knew that it should be parallel to the loading curve.

ResultsPlus
Examiner Tip

Candidates should be aware of the expected results for the required practicals in the specification. This practical investigates how the extension varies with force for springs, rubber bands and metal wires.

## *Question 5 (b) (i)*

More than half of all candidates knew that the elastic store of the spring increases when it is stretched. Some candidates thought that the kinetic store increases and these responses did not gain the mark.

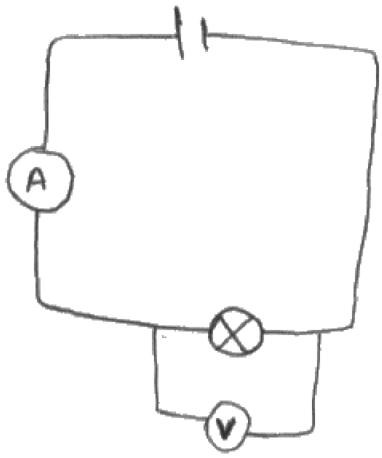
## *Question 6 (a) (i)*

Q06(a)(i) was answered to a high standard and most candidates were able to score either 3 or 4 marks. The majority of candidates knew to include a lamp, power supply, ammeter and voltmeter in their circuit and only a small number of candidates made mistakes when connecting their ammeters and voltmeters appropriately. The most common omission was a component in the circuit that would allow the current through the lamp to be varied.

**6** (a) (i) A student investigates how current varies with voltage for a metal filament lamp.

Draw a diagram of the circuit that a student could use for this investigation.

**(4)**

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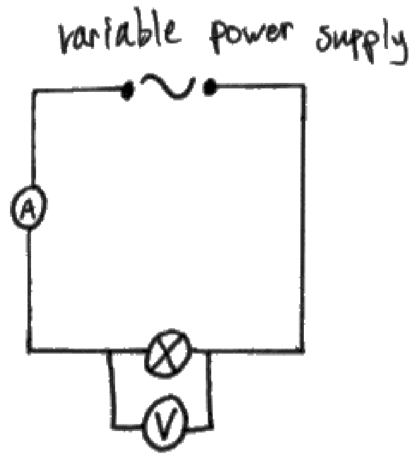
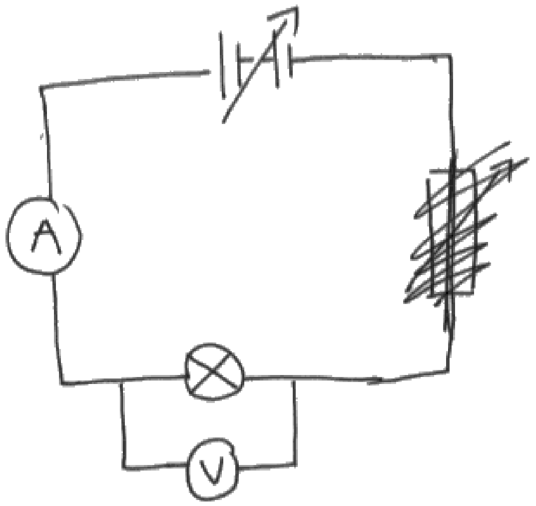
**Examiner Comments**

This was the most common response that was awarded 3 marks. All the essential components are present in the circuit and connected correctly. If the candidate had also included a method of varying the current, they would have been awarded the final mark.



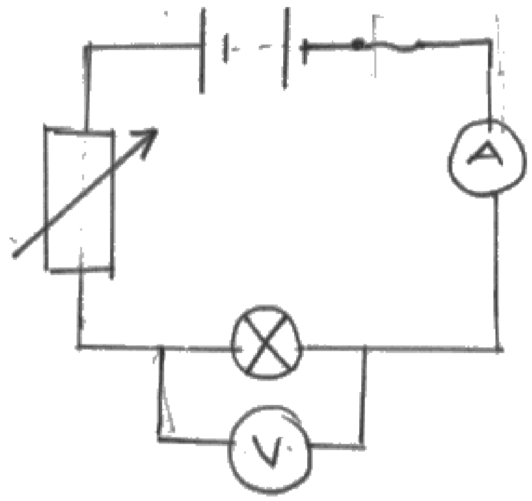

**ResultsPlus**
**Examiner Comments**

This response was awarded 4 marks. The candidate has drawn the correct symbol for a variable power supply, which would allow the current through the lamp to be varied.




**ResultsPlus**
**Examiner Comments**

This response was also awarded 4 marks. This candidate has used the diagonal arrow from the variable resistor symbol to indicate a variable battery. Whilst this symbol is not on the specification, the intention of using a variable number of cells in the battery was clear.




**ResultsPlus Examiner Comments**

This was the most common circuit diagram that gained all 4 marks. The candidate has included a variable resistor in the circuit, which would allow the current through the lamp to be varied.

## Question 6 (a) (ii)

This question discriminated well between candidates with roughly equal numbers achieving each mark in the range. Most candidates knew that reading the ammeter or measuring the current would be required, but a surprisingly high number thought that noting the voltage from the power supply would be sufficient, rather than measuring it with a voltmeter. Candidates who achieved more than 2 marks did so by extending method with additional details, such as taking repeats and obtaining an average and plotting a graph of the voltage and current.

(ii) Describe a method the student could use for their investigation.

**(4)**

Use the variable resistor to change the voltage going through the current. Measure the voltage using a voltmeter in parallel to the filament lamp. Then measure the current using an ammeter* Record the colour of the lamp.

* which is in series.

**ResultsPlus**
**Examiner Comments**

This response is a good example of a typical 2 mark answer to Q06(a)(ii). The candidate has gained marks for measuring the voltage and current and also for referring to the need to change the voltage.

Take a battery, a bulb, a voltmeter, an ammeter ~~and~~ a variable resistor; and a switch. Close the switch and measure the initial voltage (using the voltmeter), and the current (using the ammeter) through the bulb. Now, using the variable resistor, vary different values for voltage and measure the current through the bulb and record the values. Draw a table using the recorded information and plot a graph of current against voltage. Repeat investigation and get an average for each valve before you plot the graph.

**ResultsPlus**
**Examiner Comments**

This is an excellent response, which was awarded all 4 marks. The candidate has provided more details in their method and gained marks for plotting a graph of voltage and current and also for taking repeats to obtain an average.

**ResultsPlus**
**Examiner Tip**

Experimental methods require a high level of detail to gain full marks. Candidates should use the number of marks available to guide them as to the minimum number of steps required in their method.

## *Question 6 (b) (iii)*

An overwhelming majority of candidates knew that red or orange would indicate a temperature cooler than the (yellow) Sun.

## *Question 6 (b) (i) - (ii)*

Q06(b)(i) and Q06(b)(ii) were answered well by most candidates and the majority were able to score at least 2 out of the 3 available marks. The most common error was not giving the answer to 2 significant figures in Q06(b)(ii), which was likely due to not reading the question carefully enough. A small number of candidates also lost a mark due to thinking that I is the unit for current, rather than amps or A.

## Question 7 (a)

Most candidates knew that refraction involved the changing direction or bending of light, but just over half also communicated that this happened when the medium changed in order to gain the mark.

**7** This question is about refraction.

(a) State what is meant by the term **refraction**.

**(1)**

The bending of the light waves as the medium changes.

ResultsPlus
Examiner Comments

This candidate has gained the mark by giving a concise but sufficient statement about refraction.

It is the change of the direction and speed of the light when it enters from a lense dense to more dense medium.

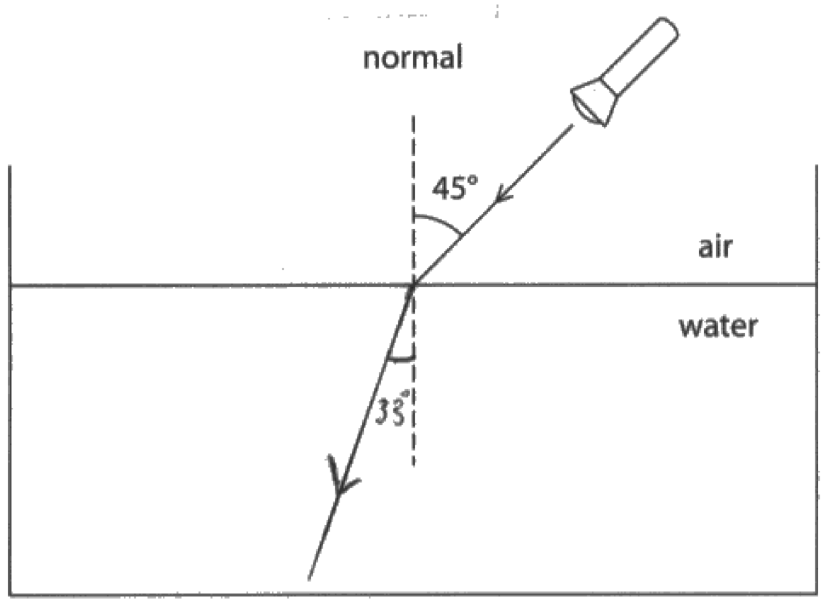
ResultsPlus
Examiner Comments

This response was also awarded the mark and has given a very detailed account of the term **refraction**.

## *Question 7 (b) (i)*

Most candidates were able to draw the ray of light correctly in Q07(b)(i), in addition to incorporating the given angle of refraction of 33 degrees. The majority of candidates drew their lines carefully using a ruler and clearly used a protractor to ensure they had measured the angle of refraction correctly. A small number of candidates drew the ray of light bending away from the normal, most likely due to confusion over which angle on the diagram was the angle of refraction.

(b) The diagram shows a ray of light from a torch incident on the surface of a pool of water.



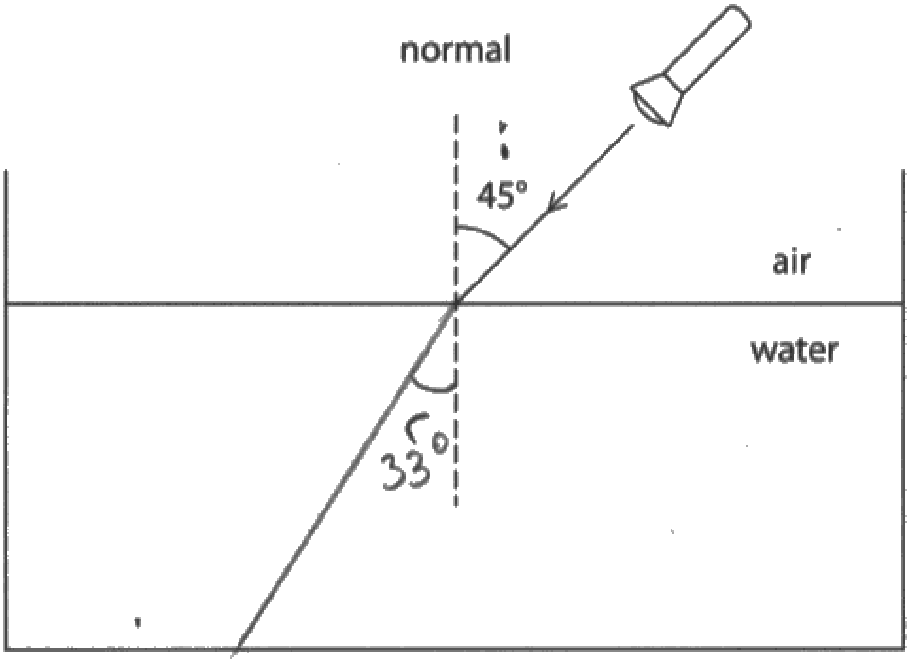

The angle of refraction of the ray of light is 33°

(i) Draw the path of the ray of light in the water.

(2)

**ResultsPlus**
**Examiner Comments**

This response only scored 1 mark. Although the ray of light is bending towards the normal, the candidate has not measured the angle of refraction carefully enough and the ray of light is bending too much.




ResultsPlus
**Examiner Comments**

This is a better response and the candidate scored 2 marks. The angle has been carefully measured with a protractor to ensure the ray of light bends by the correct amount.

ResultsPlus
**Examiner Tip**

Always use a protractor to measure angles.

## Question 7 (b) (ii) - (iii)

It was very encouraging to see candidates make such good attempts at this question. The formula linking refractive index, angle of incidence and angle of refraction is one of the formulae from the specification that candidates find difficult to recall. However, nearly two thirds of all candidates wrote the formula correctly in Q07(b)(ii) and used it correctly in Q07(b)(iii). Candidates who lost marks usually did not include sine functions in their formula or only showed partial working to show that the refractive index was approximately 1.3. The best candidates recognised that the command word in the question was 'show' and, therefore, took time to structure their working carefully and give their final answer to more decimal places than the value given in the question.

(ii) State the formula linking refractive index, angle of incidence and angle of refraction.

**(1)**

$$n = \frac{\sin i}{\sin r}$$

(iii) Show that the refractive index of water is about 1.3

**(2)**

$$n = \frac{\sin 45^\circ}{\sin 33^\circ}$$

$$= 1.3$$

**ResultsPlus**
**Examiner Comments**

This response scored 1 mark in Q07(b)(ii), but only 1 mark in Q07(b)(iii). In calculations where the final answer is given in the question, it is essential that the candidate's evaluation is given to more decimal places than the given value. In this case, candidates were expected to evaluate their working to give a value of the refractive index to at least two decimal places.

**ResultsPlus**
**Examiner Tip**

Candidates should evaluate their calculations to at least one more decimal place than the value given in the question when the command word used is 'show'.

(ii) State the formula linking refractive index, angle of incidence and angle of refraction.

**(1)**

$n = \frac{\sin i}{\sin r}$

$\text{refractive index} = \frac{\sin(\text{angle of incidence})}{\sin(\text{angle of refraction})}$

(iii) Show that the refractive index of water is about 1.3

**(2)**

$n = \frac{\sin i}{\sin r}$ $n = \frac{\sin 45}{\sin 33} = 1.298$

$n = ?$

$i = 45°$

$r = 33°$

$1.298 \approx 1.3$

ResultsPlus
Examiner Comments

This response was awarded full marks. The working in Q07(b)(iii) is clearly laid out and the candidate has recognised all the demands of the question.

# *Question 7 (c) (i)*

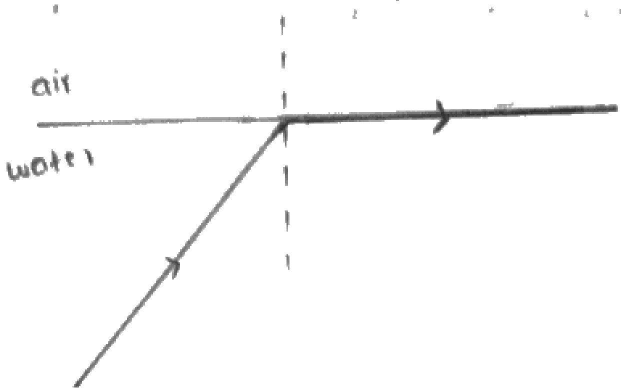
This question produced a wide range in the quality of the responses; although some were accompanied with diagrams that helped gain marks where the answer was ambiguous. A significant proportion of candidates failed to state that the critical angle is a specific value of the angle of incidence, and many confused it with being the angle at which total internal reflection would occur.

(c) The torch is moved below the surface of the water. Light from the torch is incident on the water surface at an angle greater than the critical angle.

(i) Explain the meaning of the term **critical angle**.

You may draw a diagram to help your answer.

**(2)**



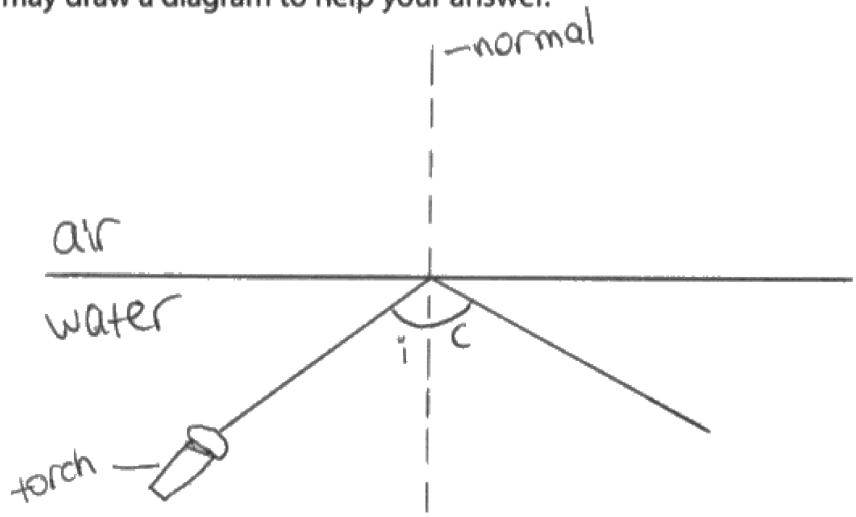

Critical angle is an angle ~~where~~ when ~~an angle~~ a ~~sv~~ light ~~striked~~ strikes ~~to~~ the surface of the medium and all the light ray are refracted along the boundary or medium.

ResultsPlus
Examiner Comments

This response received 1 mark. It is not clear that the critical angle is the angle of incidence, but the candidate has provided the correct effect when light meets the boundary at the critical angle.

You may draw a diagram to help your answer.

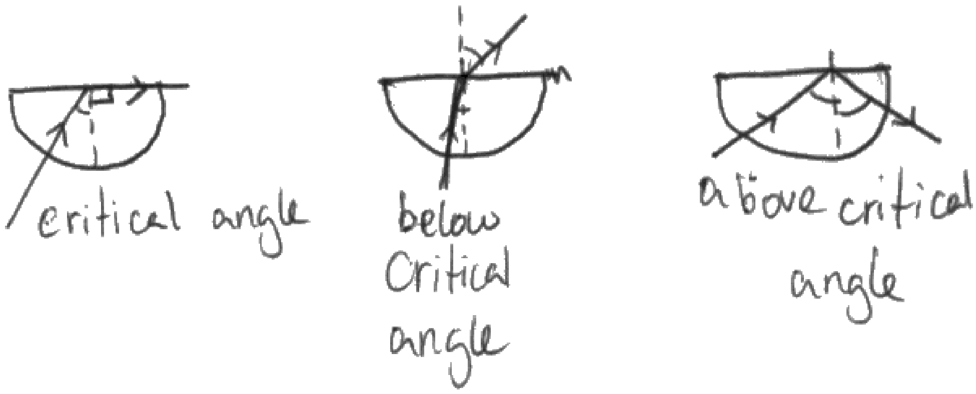
**(2)**




The critical angle is the smallest possible angle of incidence which total internal reflection happens.

ResultsPlus
Examiner Comments

This response also received 1 mark. This candidate knows that the critical angle is an angle of incidence, but the effect they have described is incorrect. Total internal reflection happens when the angle of incidence is **greater than** the critical angle.




The critical angle represents the angle of incidence for which the angle of refraction is 90°. Above the critical angle, total internal reflection occurs.

**ResultsPlus**
**Examiner Comments**

This is an excellent and comprehensive 2 mark response. The candidate demonstrates a clear understanding of the critical angle and has correctly described all possible phenomena associated with it. The diagrams on their own would be sufficient for both marks to be awarded.

## *Question 7 (c) (ii) - (iii)*

Those candidates who could recall the formula linking critical angle and refractive index usually went on to achieve full marks in this question. The most common mistake was the omission of the sine function in either the formula in Q07(c)(ii), or the calculation in Q07(c)(iii).

## *Question 7 (c) (iv)*

This question required candidates to understand that the angle of incidence at the boundary between water and air exceeded the critical angle and, therefore, total internal reflection would occur. Less than half of all candidates drew the ray of light reflecting and a small number of those who did only scored 1 mark because their ray of light did not obey the law of reflection. For 2 marks, examiners expected to see a reflected ray of light drawn with an angle of reflection equal to the angle of incidence.

## *Question 8 (a) (i)*

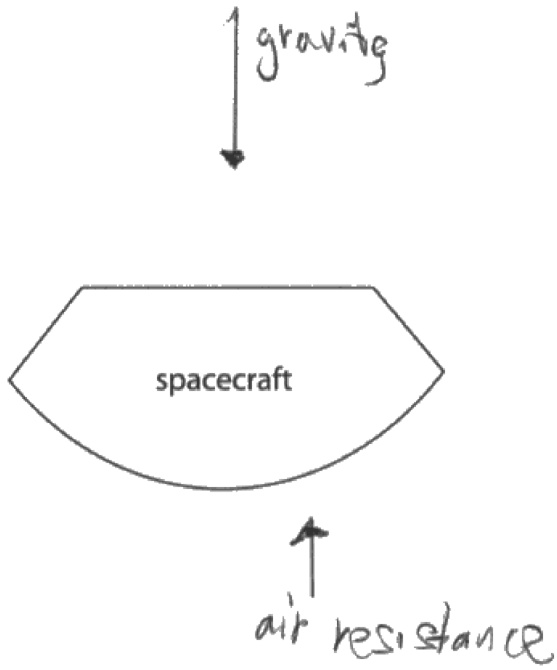
Q08(a)(i) required candidates to draw a force diagram for a falling object as it decelerates. Most candidates understood that there was a force of air resistance or drag acting on the spacecraft and this was correctly labelled on the candidates' diagrams. Candidates typically lost marks for labelling the force of weight as 'gravity' or, most commonly, for not understanding that the length of the force arrows represents the magnitude of the forces. Examiners expected the upwards arrow for air resistance to be longer than the downward arrow of weight, to communicate the idea that there is an upwards resultant force in this situation.

**8** Schiaparelli is a spacecraft that was sent to Mars in 2016.

(a) Schiaparelli slowed down as it fell vertically through the atmosphere of Mars.

(i) Draw labelled arrows on the diagram to show the forces acting on Schiaparelli as it fell.

**(3)**

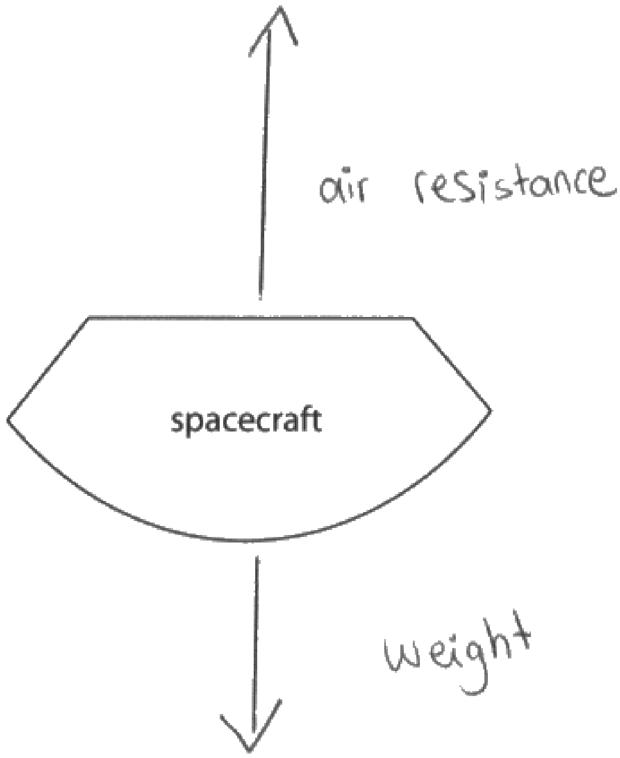



**ResultsPlus**
**Examiner Comments**

This response only scored 1 mark. 'Gravity' was not credited as the name of the downwards force and the upwards arrow was shorter than the downwards arrow so the third mark was withheld. Note that examiners did not assess the position of the force arrows on this occasion.

ResultsPlus
Examiner Tip

Candidates should remember that the name of the force due to gravity is 'weight'.




ResultsPlus
Examiner Comments

This response was awarded all 3 marks. The force of air resistance is clearly larger than the force of weight, therefore communicating the idea that there is an upwards resultant force.

## *Question 8 (a) (ii)*

More than half of all candidates were able to score at least 2 marks in Q08(a)(ii) due to memorising standard explanations of how a falling object reaches terminal velocity. Only the more able candidates were able to interpret the context correctly to give correct additional details in their explanations that earned them additional marks. The vast majority of candidates were awarded mark point 5 for the idea that the forces should be balanced when an object reaches terminal velocity.

(ii) Schiaparelli then opened a parachute to slow down.

Explain how the spacecraft reached a low terminal velocity after opening its parachute.

Use ideas about forces in your answer.

**(4)**

Opening the parachute caused the upward drag force to increase. This resulted in an upward unbalanced force, causing the spacecraft to decelerate. As it decelerated, its velocity decreased. As the velocity decreased, the drag force decreased until it was equal to the weight force again. The forces were balanced so the spacecraft stopped accelerating and maintained a new, lower terminal velocity.

**ResultsPlus**
**Examiner Comments**

This response demonstrates a comprehensive, detailed explanation to gain all 4 marks.

- Mark point 1 is awarded for the idea of the drag force increasing.
- Mark point 3 is awarded for the mention of the resultant force being upwards.
- Mark point 4 is awarded for the correct idea that the drag decreases as the speed decreases.
- Mark point 5 is awarded for the idea that the forces were balanced once terminal velocity was reached.

## *Question 8 (b)*

Q08(b) assessed one of the new Forces and Motion formulae included in the new specification. Candidates were expected to use the formula linking final speed, initial speed, acceleration and distance (given on the formulae sheet), to obtain the final speed of the falling spacecraft. It was very encouraging to see that the majority of candidates who knew which formula to use went on to obtain a fully correct final answer, except for a minority who forgot to take the square root as the last step in their working. Most candidates who did not score any marks used an incorrect formula or invalid method. A small number of candidates opted to apply a conservation of energy method, which would have been successful had they not omitted the initial kinetic energy of the spacecraft.

(b) The parachute was disconnected when Schiaparelli was at a height of 2.0 m from the surface of Mars and travelling at a speed of 0.45 m/s.

Calculate the speed of the spacecraft just before it hits the surface of Mars.
[acceleration of free-fall on Mars = 3.4 m/s²]

**(4)**

$v^2 = u^2 + 2as$

$= 0.45^2 + 2(3.4)(2)$

$v^2 = 2.754$ m/s

$v = 1.6595$ m/s

speed = 1.6595 m/s

**ResultsPlus**
**Examiner Comments**

This candidate was awarded 2 marks. They scored the first mark for choosing the correct formula for this calculation and were awarded the second mark for substituting all the values into it correctly. They have then made a mistake when attempting to rearrange their equation.

**ResultsPlus**
**Examiner Tip**

Candidates should substitute values into a formula as the first step in their working if they are not confident rearranging formulae. The substitution will usually be worth at least 1 mark.

(4)

$v^2 = u^2 + 2as$

$v^2 = 0.45^2 + (2 \times 3.4 \times 2)$

$v^2 = 0.2025 + 13.6$

$= 13.8025$

$v = \sqrt{13.8025} = 3.72$

speed = 3.72 m/s

ResultsPlus
Examiner Comments

This candidate scored all 4 marks. Their working is clear and easy to follow, resulting in the correct final answer.

## Question 8 (c)

Just under half of all candidates could offer a suitable suggestion for why the gravitational field strength on Mars is less than Earth. The vast majority of erroneous responses attributed the lower gravitational field strength to Mars being further away from the Sun.

## *Question 9 (a)*

Q09(a) offered good discrimination across the full grade range. Most candidates were able to name a suitable material for the shielding and the fuel rods, but candidates found recalling the function of the control rods and moderator more challenging. The function of the fuel rods was the least well known part of the question and more than half of all candidates could not communicate that they provide the material for fission.

| Part | Function | Suitable material |
|---|---|---|
| control rod | ~~cont~~ absorbs neutrons and controls the number of neutrons in the medium | boron |
| moderator | slow down fast moving neutrons | graphite |
| shielding | prevents irradiation of workers | lead |
| fuel rod | supply fuel for the fission process. | Uranium-235 |

**ResultsPlus**
**Examiner Comments**

This answer received 5 marks. There is a clear response given for each of the five entries in the table.

## Question 9 (b) (i)

The standard definition of the term **isotope** was well-known and most candidates produced an answer that gained both marks. A small number of candidates only scored one mark as they thought that the number of electrons differed between isotopes, rather than the number of neutrons.

(b) Heavy water is a compound of oxygen and an isotope of hydrogen called deuterium.

Deuterium is formed by the fusion of protons.

(i) State the meaning of the term **isotope**.

(2)

having same number of proton but different number of neutrons.

**ResultsPlus**
**Examiner Comments**

This response scored 2 marks and demonstrates a very concise, but correct definition of the term **isotope**.

It is the atom of the same element that has the same atomic number but different mass numbers.

**ResultsPlus**
**Examiner Comments**

This response also scored two marks. The use of the terms **atomic number** and **mass number** are more frequently seen in Chemistry, but are still relevant in this definition in Physics.

## *Question 9 (b) (ii)*

Nuclear fusion is one of the new topics introduced into the Physics specification and most candidates understood that it described the process of two nuclei joining together to make a single heavier nucleus. However, imprecise vocabulary resulted in few candidates being awarded both marks in this question as they referred to atoms, cells or molecules, rather than nuclei when describing nuclear fission.

(ii) Explain the difference between nuclear fission and nuclear fusion.

(2)

Nuclear fission is when a neutron collides with an atom and the atom splits. Nuclear fusion is when atoms and neutrons are ~~forces~~ forced back into a single atom under extreme heat & pressure.

**ResultsPlus**
**Examiner Comments**

This response received 0 marks. The candidate has the right general idea about fission and fusion but the language used is imprecise and, since the nucleus or nuclei were not referred to, no marks could be given.

**ResultsPlus**
**Examiner Tip**

Nuclear fission and nuclear fusion are nuclear processes because they are associated with the nucleus of an atom. Candidates should always refer to the nucleus when describing fission or fusion.

- fission is the splitting of a nucleus to form two daughter nuclei, which are radioactive
- whereas fusions is the binding of two nuclei to form one nucleus, under high pressure.

**ResultsPlus**
**Examiner Comments**

An excellent response that was awarded 2 marks. The language used is precise and clear throughout.

## Question 9 (b) (iii)

Slightly more than half of all candidates knew where nuclear fusion takes place and the majority of correct responses gave a star as their answer. A significant number of candidates referred to a nuclear reactor, but this was not specific enough to be awarded the mark. Only named fusion reactors, such as JET or ITER, were worthy of credit.

## Question 9 (b) (iv)

Candidates found Q09(b)(iv) challenging. Most candidates did not interpret the question correctly and failed to explain why low temperature and low pressure prevent fusion from taking place. The best answers used accurate terminology when decribing the repulsion between nuclei. Most candidates who were awarded a mark knew that temperature affected the speed of the nuclei.

(iv) Explain why fusion cannot take place at low temperature or low pressure.

(2)

Because there is strong repulsion forces between the nuclei therefore when the temperature and pressure is increased the atoms (nuclei) gain more kinetic energy and collide more with each other ~~more~~ and with a stronger force, overcoming the strong repulsion forces to under-go fusion

ResultsPlus
Examiner Comments

This response scored 2 marks. The candidate was awarded mark point 3 for the clear idea that nuclei repel each other and also mark point 1 for the idea that the kinetic energy of the nuclei increases as the temperature increases.

At low temperature particles have less kinetic energy to overcome the repulsive force between the nuclei. And at low pressure particles do not have a greater particle density to maintain a higher collision rate. so fusion cannot takes place since joining up of two light nuclei is difficult due to repulsive force between nuclei.

**(Total for Question 9 = 12 marks)**

ResultsPlus
Examiner Comments

This response scores 2 marks (mark point 1 and mark point 3) for the first two lines. The rest of the response simply adds additional detail and mark point 2 is also covered by the idea that the collision rate is reduced at low pressure.

Because fusion is done by hydrogen nuclei. They repell each other. So they need high energy for the two nuclei to be brought closer enough to fuse. So, high temperature and high pressure will be needed.

ResultsPlus
Examiner Comments

This response also scores 2 marks. The candidate was awarded mark point 3 for the nuclei repelling and also mark point 4 for the idea that the nuclei need to be close together which only happens at high pressure.

## *Question 10 (a)*

Q10(a) required candidates to apply a two-step calculation to solve a series circuit problem. Two methods could have been used to obtain the voltage of resistor R:

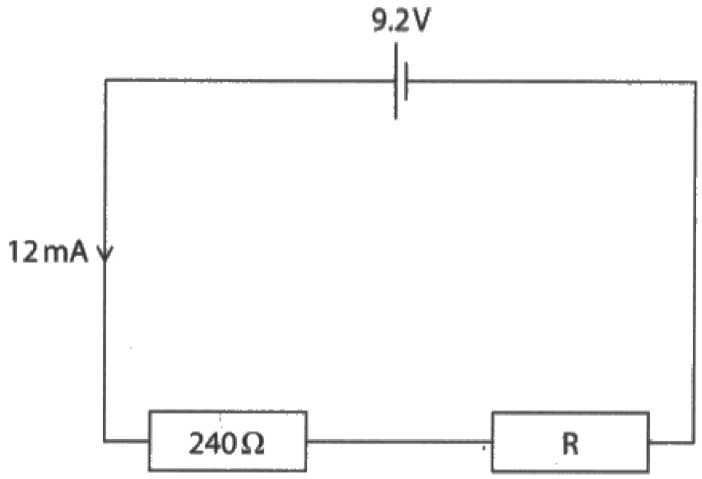
- Finding the voltage across the 240Ω resistor first and then subtracting this from the total voltage of 9.2V.
- Finding the total resistance of the circuit and then subtracting 240Ω from this.

The first method was preferred by candidates and it was encouraging to see the majority get at least halfway through the calculation by finding the voltage across the 240Ω resistor. Only some candidates knew to then subtract this from the total voltage to obtain their final answer.

A small number of candidates did not convert the current from mA to A and this restricted the progress they could make in the calculation. Some candidates did not know which formula to use or made mistakes in rearranging it.

**10** This question is about voltage and current.

(a) The diagram shows two resistors connected to a battery.




Calculate the voltage across resistor R.

**(4)**

$V = IR$

$9.2\,V = 12 \times R$

$R = \dfrac{9.2}{12\times10^{-3}}$

$R = 766.66$

$12\times10^{-3} = A$

$= \cancel{766.6}$

$V = 12\times10^{-3} \times 526.6$

$= 6.32$

$R = 766.6 - 240$

$= 526.6$

voltage = 6.32 V

**ResultsPlus**
**Examiner Comments**

This response was awarded all 4 marks and shows the less common approach of finding the total resistance of the cicruit as the first step. The candidate's working is clearly laid out and easy to follow.

Calculate the voltage across resistor R.

**(4)**

$12 \times 10^{-3}$

$0.012$ A

voltage = current x resistance.

$9.2 = 0.012 \times r$

voltage = current x resistance

$0.012 \times 240$

$= 2.88$

$9.2 - 2.88$

voltage = 6.32 V

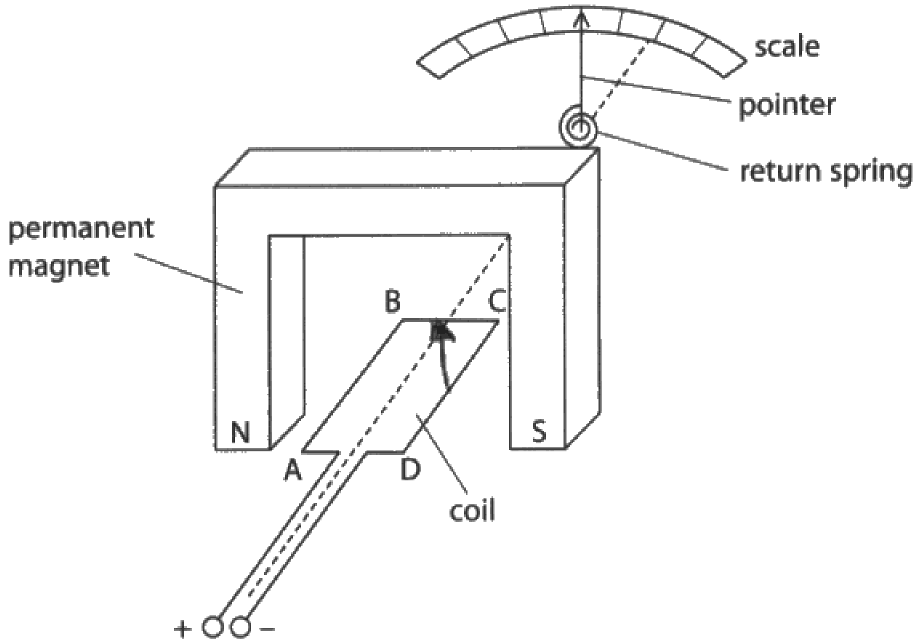
**ResultsPlus**
**Examiner Comments**

This response was also awarded all 4 marks. The candidate appears unsure at first which method to use, but successfully uses the more common approach of finding the voltage across the 240Ω resistor before obtaining the voltage across resistor R.

## *Question 10 (b) (i)*

Q10(b)(i) required candidates to apply their knowledge of the motor effect to this analogue ammeter. A small minority of candidates misinterpreted this question's context as one of electromagnetic induction and these candidates did not score. Candidates who realised that this was a demonstration of the motor effect usually produced well-rehearsed explanations referring to the magnetic field of the coil and its interaction with the magnetic field of the permanent magnet, resulting in a force on the coil.

(b) The diagram shows the parts of an ammeter.
The pointer is connected to the coil so they can move together.




(i) Explain what happens when there is a current in the coil.

**(3)**

The current in the coil cuts the magnetic field lines so a force is produced which ~~turns the coi~~ acts on the coil and pointer, moving them. ~~This~~ The pointer moves to point at the amount of current on the scale.

**ResultsPlus**
**Examiner Comments**

This response scored 2 marks. The candidate was awarded mark point 3 for the correct reference to a force on the coil and mark point 5 for knowing that the pointer will move. However, the origin of the force on the coil is confusing and it is not clear whether the candidate is describing the motor effect or electromagnetic induction.

(i) Explain what happens when there is a current in the coil.

(3)

A magnetic field is created around the coil which interacts with the field of the permanent magnet. One side of the coil experiences a force pushing down and the other side experiences a force pushing up (motor effect). The coil begins to turn, causing the pointer to turn on the scale.

**ResultsPlus**
**Examiner Comments**

This response illustrates a model answer and was awarded the maximum 3 marks. The candidate has concisely referred to every point on the mark scheme to produce their comprehensive explanation of what happens when there is a current in the coil.

## Question 10 (b) (ii)

Candidates typically find applying Fleming's left hand rule challenging and less than a third of all candidates knew that the force acting on side CD of the coil would be acting upwards.

## Question 10 (b) (iii)

Most candidates found this question very challenging and thought that the ammeter generates currents, rather than detecting them. Therefore, a significant number of candidates erroneously described changes such as decreasing the strength of the magnets or reducing the number of turns on the coil. Only the most able candidates understood that there was a need for the pointer to move to a greater extent to detect smaller currents. These candidates scored several marks by describing numerous changes that would facilitate this, but very few candidates could explain why these changes would be effective. A common suggestion of adding more marks to increase the resolution of the scale was not given credit.

(iii) Explain how the ammeter could be changed so that it could measure smaller currents.
**(3)**

Add a greater number of increments to the scale then use a weaker bar magnet and a weaker spring so there will be less force driving the coil. Use a finer pointer to measure smaller readings more accurately. Decrease the voltage of the power supply because voltage = current × resistance. Decrease the strength of the return spring.

**ResultsPlus**
**Examiner Comments**

This response scored 1 mark. The majority of the candidate's response would have the opposite effect than intended and the candidate appears to think that the machine generates currents instead of detecting them. However, the suggestion at the very end of using a weaker return spring to allow the pointer to move more freely was given credit.

The number of turns of the coil can be increased and a stronger permanent magnet can be used. This will increase the size of the force, allowing a larger force to be created by small currents, allowing small currents to be measured.

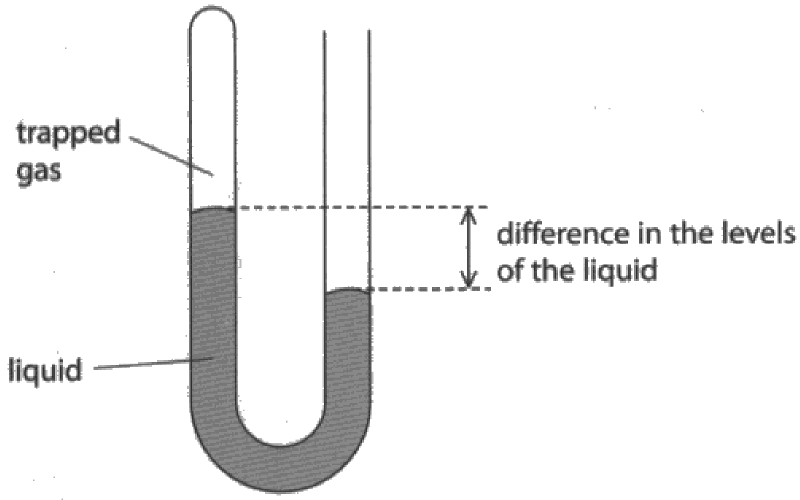
**ResultsPlus**
**Examiner Comments**

This response was awarded all 3 marks since it gives a comprehensive explanation of how the ammeter could be modified to detect smaller currents.

## *Question 11 (a)*

Q11(a) was answered to a high standard and most candidates were awarded at least two marks. The most common reason for not scoring full marks was failing to convert the height value into standard units.

**11** The diagram shows a manometer, a device used for measuring differences in pressure.




(a) One side of the manometer has some trapped gas. The other side is left open to the atmosphere.

The difference in pressure can be calculated using this formula.

[difference in pressure = height × density × 10]

The density of the liquid is $1.3 \times 10^4$ kg/m$^3$.

The difference in the levels of the liquid is 3.8 cm.

Calculate the difference in pressure between the atmosphere and the trapped gas.

**(3)**

$P = 3.8 \times 1.3 \times 10^4 \times 10$

$= 494\,000$

difference in pressure = 494 000 Pa

**ResultsPlus**
**Examiner Comments**

This candidate has written their working clearly, but has not changed the height value from centimetres to metres. This response scored 2 marks.

**ResultsPlus**
**Examiner Tip**

Most formulae require variables to be substituted in SI units.

Calculate the difference in pressure between the atmosphere and the trapped gas.

**(3)**

$1.3 \times 10^4 = 13,000$ kg/m3

3.8 cm = 0.038 m

difference in pressure = 0.038 × 13,000 × 10

= ~~4~~940

difference in pressure = 4940 Pa

**ResultsPlus**
**Examiner Comments**

This candidate has recognised that the value for height must be converted to metres before it is substituted into the formula. The rest of their working is also correct and the response was awarded 3 marks.

## *Question 11 (b) (i)*

Candidates made some excellent attempts at answering Q11(b)(i) and the quality of written communication was high. The majority of candidates understood that the particles would move faster when the temperature of the gas increases and scored the first mark. Although most candidates also understood that the number of collisions would increase, there was some confusion over what the particles were colliding with; only the most able candidates knew that they would collide with the walls of the container more frequently.

(b) The temperature and pressure of the trapped gas increase when it is warmed.

(i) Explain, in terms of particles, why the pressure of the trapped gas increases.

**(3)**

When a gas ~~is heate~~ gains thermal energy it's particles gain more kinetic energy. This means that the particles will collide more often with the wall of the container so the force exerted on the wall will increase.

**ResultsPlus**
**Examiner Comments**

This response was awarded 3 marks. The candidate has been very clear in their response and the language used is of a high level. The second mark was only awarded if the collisions with the walls were recognised as being **more frequent**, but this is clear in this candidate's response.

## Question 11 (b) (ii)

A significant number of responses to this question showed no attempt at converting the temperatures to kelvin, which immediately halved the number of marks available due to it being a significant error. Overall, despite this, the responses were often laid out logically and were easy to follow, displaying a familiarity and confidence with answering these types of question. Most candidates were awarded at least 2 marks in this question, but only the most able secured all 4 marks for correctly converting their temperatures to kelvin.

(ii) The pressure of the trapped gas in the manometer is $9.95 \times 10^4$ Pa and the temperature is 16 °C.

Calculate the new pressure of the trapped gas if the temperature increases to 32 °C.

[assume volume of the trapped gas remains constant]

(4)

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{9.95 \times 10^4 \text{ Pa}}{16\,°\text{C}} = \frac{P_2}{32\,°\text{C}}$$

$$32\,°\text{C} \times \frac{9.95 \times 10^4 \text{ Pa}}{16\,°\text{C}} = P_2.$$

new pressure = 199000. Pa

**ResultsPlus**
**Examiner Comments**

This response is an example of the most commonly seen answer and was awarded 2 marks. The candidate has used the formula linking pressure and temperature correctly, but has not converted either temperature to kelvin. Since this formula is only valid for kelvin temperatures, responses like this were limited to 2 marks maximum.

[assume volume of the trapped gas remains constant]

**(4)**

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$16 + 273 = 289$

$32 + 273 = 305$

$$\frac{9.95 \times 10^4}{289} = \frac{P_2}{305} = \frac{9.95 \times 10^4 \times 305}{289} = 105008.6\ \text{Pa}$$

new pressure = 105008.6 Pa

**ResultsPlus**
**Examiner Comments**

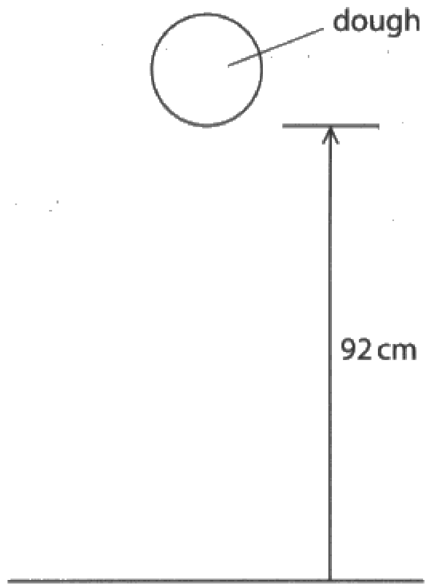
This candidate knew that temperatures had to be converted to kelvin before using the correct formula. They have shown how they have done this in their working and then used these values correctly to obtain the correct answer. This response was awarded all 4 marks.

## *Question 12 (a)*

Q12(a) was the last calculation on the paper and candidates were expected to know which formula to use without previously being asked to recall it. The calculation also featured two quantities that needed to be converted to SI units and candidates found the question challenging. Despite this, it was pleasing to see over a third of all candidates gained full marks and the quality of their mathematical ability was very high. Common errors included:

- Not converting one, or both of the mass and height values into SI units.
- Not knowing which formular to use and just multiplying or dividing quantities at random.

**12** (a) The diagram shows a ball of dough, of mass 580 g, held at a height of 92 cm above the floor.




Calculate the increase in gravitational potential energy (GPE) stored in the ball of dough when it is above the floor.

(3)

GPE = mgh

= 580 x 10 x 92

GPE = 533 600 J

**ResultsPlus**
**Examiner Comments**

This response scored 1 mark. The candidate clearly knows which formula to use, but has not converted either mass or height into SI units.

Calculate the increase in gravitational potential energy (GPE) stored in the ball of dough when it is above the floor.

(3)

GPE = mass × gravitational field strength × height.

= 580 × 10 × 0.92

= 5336 J

92 cm ⇒ 0.92 m

GPE = 5336 J

**ResultsPlus**
**Examiner Comments**

This response scored 2 marks. The candidate knows which formula to use and has also converted height correctly from centimetres to metres. However, they have not converted mass into SI units and so lose 1 mark.

Calculate the increase in gravitational potential energy (GPE) stored in the ball of dough when it is above the floor.

**(3)**

mass × g × h

0.58 × 10 × 0.92

GPE = 5.336 J

ResultsPlus
Examiner Comments

This candidate scored all 3 marks. Although their evidence of working is limited, it is sufficient to show that they have converted mass and height into SI units and multiplied the quantities correctly to achieve the correct final answer.

## *Question 12 (b)*

The expected language surrounding energy in Physics has been revised for the new specification in line with guidance issued by the Institute of Physics. Candidates are now expected to refer to 8 energy stores and 4 methods of energy transfer to describe common situtations. Q12(b) assessed the ability of candidates to decribe the energy transfers associated with a falling ball of dough from before it was dropped, to after it has hit the floor.

The majority of candidates described the situation using energy terminology from the previous specification, which was still given credit. However, it was encouraging to see that some candidates had been taught the new terminology and could use it successfully to describe the situation. Most candidates knew that energy was transferred from the dough's gravitational potential store to its kinetic store as it fell to the floor. Some candidates also included that this energy transfer happened mechanically. Candidates struggled to describe what happened after the dough had hit the floor. Most candidates thought it was sufficient to say that energy had been lost as heat and sound, but this was not credited unless it was clear **where** that energy had been transferred to. The most able candidates knew that energy had been transferred into the thermal store of the surroundings and also that energy had been transferred at this stage by radiation.

Candidates will continue to be given credit for using the previous energy terminology in these questions, but centres are encouraged to adopt the new terminology so as not to embed misconceptions at this stage in a candidate's education of Physics.

(b) The ball of dough hits the floor and does not rebound.

Describe the energy transfers taking place from when the dough is dropped to after it has hit the floor.

You should refer to energy stores as well as transfers between energy stores at these stages.

- before the dough is dropped
- just before the dough hits the floor
- after the dough has hit the floor

**(4)**

Energy is stored as gravitational potential energy ~~as~~ just before it is dropped which is transferred mechanically to ~~the~~ ~~kine~~ kinetic energy store just before it hits the floor which is then transferred by radiation ~~to~~ (by sound) to the surroundings as it makes a noise when it hits the ground.

ResultsPlus
Examiner Comments

This response has used the new energy terminology to score 4 marks. Mark point 1, mark point 2 and mark point 3 were awarded for energy being transferred mechanically from a gravitational to a kinetic store. The candidate also gained mark point 6 for the idea that energy had been transferred to the surroundings by radiation.

The gravitational potential energy is mechanically transferred into kinetic energy as it falls until just before the dough hits the floor it only has kinetic energy. When the dough hits the floor the energy is mechanically changed into sound and a bit of heat energy that is dissapated into the atmosphere

ResultsPlus
Examiner Comments

This response also scored 4 marks, but using the previous energy terminology. The candidate gained mark point 1, mark point 2 and mark point 3 for gravitational potential energy being mechanically transferred to kinetic energy. They also gained mark point 4 for recognising that heat energy had been transferred to the surroundings.

# Paper Summary

Based on their performance on this paper, candidates are offered the following advice:

- Take note of the number of marks available for each question and use this as a guide for the amount of detail expected in the answer.
- Take note of the command word used in each question to determine how the examiner expects the question to be answered, for example, whether to give a description or an explanation.
- Be familiar with the formulae listed in the specification and be able to use them confidently.
- Know the SI units for physical quantities and be able to convert from non-SI units to SI units when required.
- Show all working so that some credit can still be given for answers that are only partly correct.
- Take advantage of opportunities to draw labelled diagrams as well as, or instead of, written answers.

# Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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