edexcel
advancing learning, changing lives

ResultsPlus

Examiners' Report
January 2010

GCE Physics 6PH01

ResultsPlus
look forward to better exam results
www.resultsplus.org.uk

Edexcel Limited. Registered in England and Wales No. 4496750
Registered Office: One90 High Holborn, London WC1V 7BH

A PEARSON COMPANY

Edexcel is one of the leading examining and awarding bodies in the UK and throughout the world. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers.

Through a network of UK and overseas offices, Edexcel's centres receive the support they need to help them deliver their education and training programmes to learners.

For further information, please call our GCE line on 0844 576 0025, our GCSE team on 0844 576 0027, or visit our website at www.edexcel.com. If you have any subject specific questions about the content of this Examiners' Report that require the help of a subject specialist, you may find our **Ask The Expert** email service helpful.

Ask The Expert can be accessed online at the following link:

http://www.edexcel.com/Aboutus/contact-us/

Alternatively, you can speak directly to a subject specialist at Edexcel on our dedicated Physics telephone line: 0844 576 0037

ResultsPlus

ResultsPlus is our unique performance improvement service for you and your students.

It helps you to:

- **Raise attainment** - by providing in-depth analysis of where your class did well and not so well, enabling you to identify areas to focus on/make improvements.
- **Spot performance trends** at a glance by accessing one-click reports. You can even choose to compare your cohort's performance against other schools throughout the UK.
- **Personalise your students' learning** by reviewing how each student performed, by question and paper you can use the detailed analysis to shape future learning.
- **Meet the needs of your students on results day** by having immediate visibility of their exam performance at your fingertips to advise on results.

To find out more about ResultsPlus and for a demonstration visit http://resultsplus.edexcel.org.uk/home

January 2010

Publications Code US022970

General Comments

This paper gave candidates opportunities to demonstrate their understanding of the full range of topics in this unit, showing good progression from GCSE. All questions evinced responses across the range of allowable marks, although full marks were rarer for some of the longer explanations than they were for the longer calculations. Candidates showed performance ranging from basic interpretations using simpler terminology and carrying out single step calculations to full explanations with scientific terminology and carrying out unstructured calculations involving several steps.

Candidates applied themselves well to answering the whole paper, spending appropriate times on the multiple choice and the free-response parts of the paper. The space allowed for responses was usually sufficient, although candidates are not advised to use it as a guide for the required length of response as writing sizes and styles differ. Candidates should remember to indicate clearly on the paper the location of responses which extend beyond the space provided.

There were few unit errors, except for the power calculation. Candidates could usually set out their answers logically, but they could sometimes benefit from more structured approaches such as setting out explanations as a set of simple bullet points. Some could still be encouraged to summarise their data and show stages clearly in their calculations. There were a number of places where a significant proportion of the candidature did not have a firm grasp of appropriate and specific terminology. Words which were often applied incorrectly on this paper included malleable, hard, soft, plastic, elastic, upthrust, uplift and gravity. Candidates are recommended to learn standard definitions thoroughly to avoid such mistakes.

Answers were usually given to the required extra significant figure in 'show that' questions, and candidates were able to use their calculators correctly and quote answers sensibly in most cases.

Candidates are expected to be able to apply a number of laws which are not summarised as equations on the paper, and it helps if they are able to quote the standard wording directly from memory, even if they don't need to do so directly in a particular examination. On this paper, there was more evidence that candidates remembered Newton's First Law in question 18, although many needed to work on applying all parts of the remembered definition to the context.

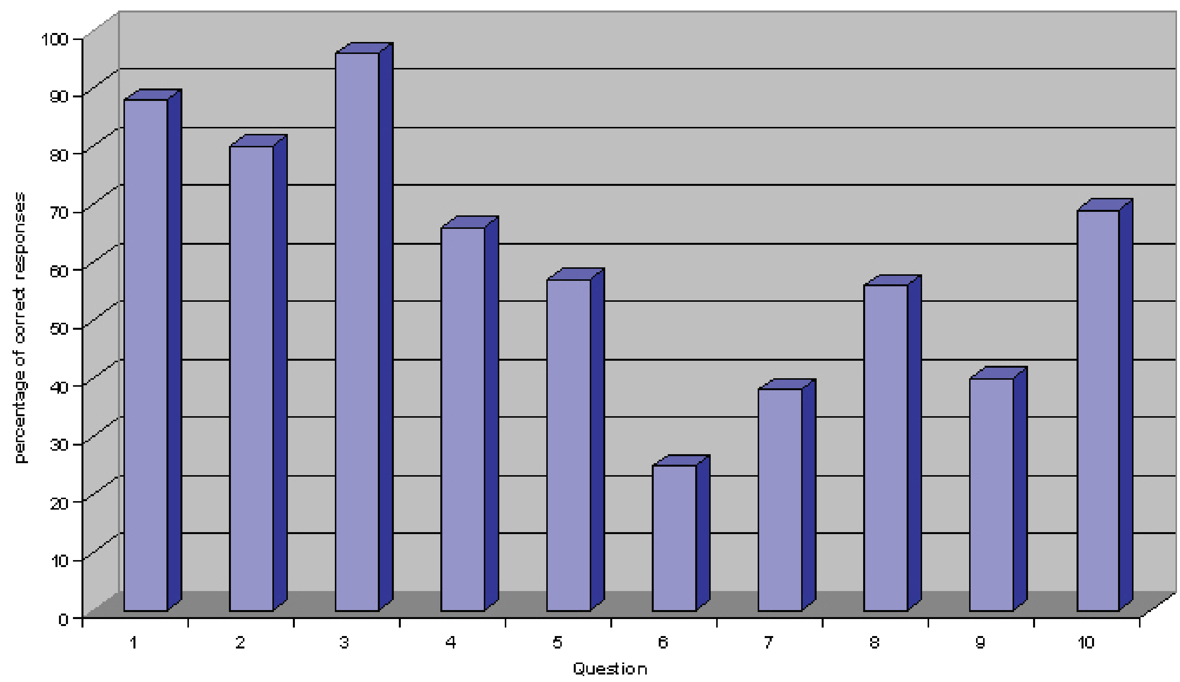
Candidates do not always seem to realise that the questions in Section B are structured, with parts a, b, c etc all linked and parts i, ii, iii etc following directly from each other. This was particularly useful in question 17.

Candidates sometimes give prepared responses to situations similar to, but not the same as, the question as it is written on the paper. This can be a particular issue over time with Multiple Choice questions which may look familiar but ask for something quite different. Candidates should always read each question carefully. Sometimes underlining or highlighting key items of information and the actual thing being asked for can help.

Section A

The vast majority of candidates attempted all of the multiple choice questions.

In increasing order of difficulty, the multiple choice questions were 3, 1, 2, 10, 4, 5, 8, 9, 7, 6.



1, 2 and were answered correctly by a sizeable majority, and 4 and 10 by a good majority. Only 6, 7 and 9 got a minority correct response.

For some questions there was a pattern in the incorrect answers which may reveal something about candidates' thinking.

In question 5, A was the most common incorrect choice, indicating that sine and cosine were mixed up.

In question 6 it was disappointing to see that the favourite incorrect response was D, which involved a constant velocity.

In question 7 the most common incorrect answer was B, suggesting that two springs were not taken into account.

A common incorrect answer for 8 was D, suggesting they were looking at the greatest strain rather than stress. In question 9 it was A, which had the greatest stress, not the greatest Young Modulus.

The most common incorrect answer to question 10 was D, which corresponds to at, suggesting that some candiates used v = u + at.

Section B

Question 11a

Taken over the whole entry, the average candidate got one description correct. Candidates sometimes confused tough with strong, stiff or hard. For example when saying that tough meant a large force is required for plastic deformation they missed the link between the plastic deformation and absorbing energy. Other candidates appeared to have the right idea, but lacked vital details in their answers, writing about brittle materials breaking with no deformation, failing to mention plastic, or getting the correct reference to little or no plastic deformation but neglecting to mention breaking.

tough

is resistant to breaking | ~~see~~ scratching / snapping

brittle

will undergo little plastic or elastic deformation
will crack ~~under~~ / shatter under a large force.

This candidate has some understanding of toughness, but has made no mention of absorbing energy. The answer for brittle needs improvement in two aspects. The deformation mentioned should only be plastic and the two separate statements need to be linked clearly as below:

brittle

Materials which break suddenly with very little plastic deformation.

Question 11b

This required a single word, 'plastic', but two thirds preferred almost any other word from the lexicon of materials, such as malleable, weak, soft or even not hard.

Question 12

Although candidates rarely followed the instruction to label the diagram, they also rarely failed to identify the two regions correctly. They nearly always scored at least three marks, with even poor answers managing to mention eddies in reference to turbulent flow. Where the mark for laminar was not awarded it was usually due to referring to constant velocity in general, rather than at a point, descriptions of particles which did not take into account 'except at the molecular level' in definitions or no reference to layers but just talk of smooth or straight flow.

> **Label the type of fluid flow below and above A and describe each of them.**
>
> **Below A** Laminar flow: straight, steady, streamlined flow.
>
> **Above A** Turbulent flow: mixing of layers, eddy currents and whorls.

Despite this candidate mentioning mixing of layers above A, not mixing below A has not been mentioned. Streamlined is an alternative to laminar, and 'straight, steady' is insufficient detail.

The following answer is straightforward and gets the marks:

> **Label the type of fluid flow below and above A and describe each of them.**
>
> **Below A** Laminar flow – the smoke is flowing in layers that do not mix
>
> **Above A** Turbulent flow – the layers of smoke mix and eddy currents begin to form

Question 13a

The majority of candidates were able to complete this calculation with little difficulty. A number of students just used mass divided by area, getting an answer roughly ten times too small, but quoted it as the correct answer anyway:

Show that the ultimate tensile strength is about 6×10^7 Pa.

(3)

Stress $= \frac{F}{A} = \frac{84}{1.3 \times 10^{-5}} = 6461538.462 \approx 6 \times 10^7$ Pa

This candidate has written F but only used mass.

Candidates occasionally used 10 rather than 9.81 for the magnitude of g and a few didn't give their final answer to the required extra significant figure:

Show that the ultimate tensile strength is about 6×10^7 Pa.

(3)

$\sigma = \frac{\text{Force}}{\text{Area}}$ $F = ma$

$F = 84 \times 9.81$

$F = 824.04$

$\frac{824.04}{1.5 \times 10^{-5}} = 6 \times 10^7$ Pa

Question 13b

This question was related to precision, and also required a basic understanding of the relationships between physical quantities. A relatively small proportion of the entry noted the significance of masses being added 2 kg at a time, although those who did often went on to score the second mark. A large number thought the mass of the platform would be relevant and did not realise that this would have the opposite effect on the answer to that asked about in the question. Others referred to extension or necking in this part or in the rest of the question, and some related the shape of the sample to the effect on stress:

> (b) Explain why this method of testing may produce a larger value than the true ultimate tensile strength.
>
> (2)
>
> because the cross sectional area at point x is so much thinner, ~~[illegible]~~ this means at that point the stress is greater.

Fortunately, this student repeated this in part c where it earned a mark.

Question 13c

While many candidates thought the shape was due to extension of the sample, others who appeared to have an idea of a sensible reason did not express themselves using appropriate terminology from the AS specification. Answers referred to it breaking more quickly or being easier to break, but did not express this in terms of the load or explain why it was quicker or easier. Candidates who took this opportunity to demonstrate a good understanding of the underlying relationships between physical quantities made the required connection between area and force and went on to state that it maximized stress.

> (c) Explain why the wood sample used for this test has the shape shown.
>
> (2)
>
> So that the wood is likely to break quicker as it has a lower cross sectional area. Otherwise higher weight would be needed to break the wood. All stress is focused to that middle point so will break quicker

This response just manages to make the connection between 'quicker' and the number of masses added by implying it breaks with fewer added masses. This student has the idea that stress at that point is significant, but has not simply stated that it will be greatest there, and hasn't quite said that it is most likely to break at that point either.

Question 13d

Responses often focused on factors associated with ensuring a 'fair test' such as ensuring the samples were from the same tree or all had the same cross-sectional area, but did not link reliability with repeatability. While many referred to repeating the test, a large proportion did not say what to do with the repeats, such as finding the mean.

(d) Samples of wood of the same type are not entirely uniform. What should be done to ensure reliable results are obtained when carrying out this test?

(1)

Repeat the experiment several times with different pieces of the type of wood.

This candidate needs find a mean value from the several repeats mentioned.

Question 14

While many students worked through this question in a straightforward fashion, there were a number of stumbling blocks which appeared with some regularity.

Problems with finding the correct distance in part a included only using 3.7 m, finding the area of the circle rather than the circumference, or calculating the time per revolution as 25 seconds and then using 25 m as the distance because this gave the answer of 20 000 J quoted. Please note Appendix 12 of the specification, 'General and mathematical requirements', and the reference to calculations with circles.

(a) Show that the work done by the horse in turning the wheel through one revolution was about 20 000 J.

(3)

Work = force × Distance   144 = 60 mins

= 800 × 3.7   2.4 = 1 min

= 2960   1 = 0.416

This candidate has failed to calculate the circumference of the circle.

There was no problem with remembering power = work done / time, but candidates frequently did not take the 144 turns into account. Others didn't seem to realise that Watt is an SI unit and instead expressed their answer in base units, sometimes going astray. (The reference to SI units was simply to avoid the answer of 1 horsepower, which was still seen occasionally.)

(b) Calculate the average power of the horse in SI units.

(3)

$P = \frac{W}{t}$ $\frac{18598.2}{3600} = 5.16$

$60 \times 60 = 3600s$

Average power = $5.2\ kg\,m^{-1}s^{-7}$

This response shows hours converted to seconds, but only one turn. The resulting answer of 5.2 W was seen quite often. This candidate has tried to express W in base units, but has quoted the powers incorrectly, possibly from memory as no working is shown for deriving the unit. Although this was not required, the candidate could have started by substituting units for an energy quantity involving just base units, such as kinetic energy, and then dividing by seconds.

Question 15a

The majority of candidates across the ability range tackled this calculation satisfactorily, although some forgot to convert cm to m. A number of students used equations of motion for uniform acceleration to find velocity and used this to find kinetic energy. They were not given the marks as, although the answer was the same as found by change in gravitational potential energy, it did not represent the situation correctly and was regarded as an error of Physics.

(a) On one occasion the mass of coins placed in the basket is 0.41 kg. The basket falls through a vertical distance of 7.0 cm.

Calculate the maximum amount of energy available to launch the projectile.

(2)

$GPE = mg\Delta H$

$= 0.41 \times 9.81 \times 0.07$

$= 410g \times 9.81 \times 0.07\,m$

$= 281.547$

Energy = 281.547

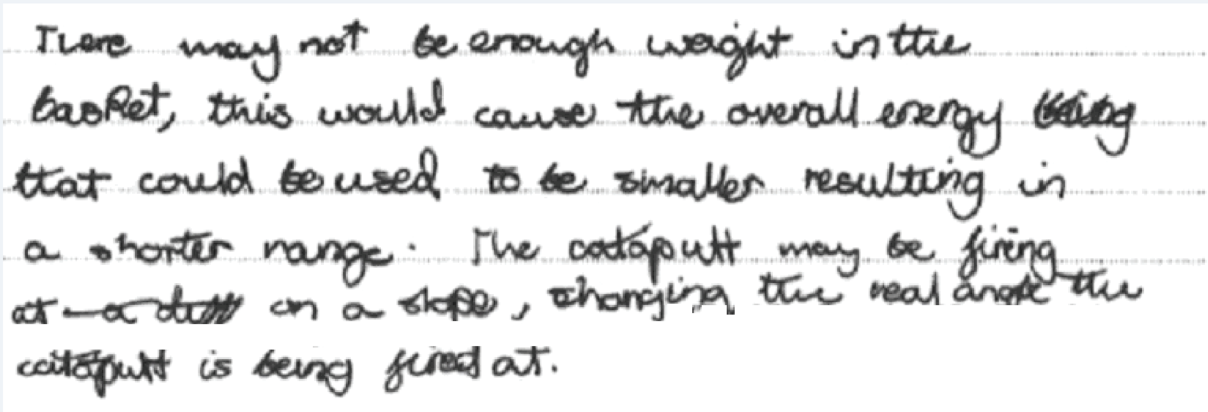
This candidate has avoided the cm to m error, but strangely introduced an error in the units of mass to get an answer of 281, although the units are omitted. A candidate might be expected to recall that the work done lifting an apple through a metre is about 1 Joule and realise that 280 J, or the other common incorrect answer of 28 J, is somewhat large for a model such as this.

Question 15b

Resolving the velocity into components presented few difficulties to candidates, although the components were occasionally reversed or the units were omitted for one or both answers.

Question 15c

Despite the question stating that reasons other than air resistance or friction were required, many candidates relied on these. Others just challenged the angle stated. Most made vague references to energy going elsewhere in the machine, but did not suggest additional relevant mechanisms. Some thought that the projectile mass might be different, affecting the vertical component of velocity and therefore its trajectory. A proportion of candidates gained credit for referring to the projectile having less energy than calculated and therefore a lower initial speed.


There may not be enough weight in the basket, this would cause the overall energy that could be used to be smaller resulting in a shorter range. The catapult may be firing on a slope, changing the real angle the catapult is being fired at.

This candidate challenges the mass and angle data given. The answer does refer to a smaller amount of energy resulting in a smaller range, but needed to add to this to get a mark, for example by saying that the projectile had lower kinetic energy and therefore initial speed, resulting in a smaller range.

Question 16a

While most candidates knew that the area and gradient were required, they were not specific about either the area, the gradient or both. These students tended to get one mark.

(i) the vertical distance travelled by the ball between 0.5 s and 1.0 s

The area under the graph

(ii) the acceleration at Y.

Finding the gradient

These need to refer explicitly to which area must be calculated and where the gradient should be found.

Question 16b

Candidates gave a wide range of responses, with the majority spotting at least one error correctly, although not necessarily expressing themselves well enough to gain both marks for the error. Some did not follow the instruction to explain the error. For example, candidates commonly noted that the final velocity at Z should be less than at X, but did not say that this would be because of energy losses.

Error 1

The velocity increases after the first bounce. As the ~~area~~ distance increases, this would imply the ball bounded higher, which isn't possible.

This student should explain why it isn't possible in terms of energy.

Common errors spotted were a positive initial velocity rather than zero and an apparent increased velocity at X, if the initial velocity was assumed to be correct. A number of candidates thought the graph should have the shape shown in the photograph, mistaking it for a displacement-time graph.

Error 1

One error is that when the ball is released from a height, after it bounces the ball achieves greater height whereas it should be lower.

This candidate has made a correct observation in terms of the lines on the graph, but thinks it represents height, rather than velocity, and has still not linked t to energy when saying it should be lower.

Question 17a

Most candidates were able to work through the three calculations in this section, although part i, with several steps to the calculation, proved more of a challenge. Units were sometimes incorrect or omitted in part ii. In part iii students generally calculated the viscous drag with ease. They then usually only said that it was small rather than justifying it being negligible.

$$F = 6\pi\eta r v$$

$$= 6 \times \pi \times 8.8 \times 1.8 \times 10^{-5} \times 2$$

$$= 5.97 \times 10^{-3}$$

The force acting on it is very small, therefore it is negligible.

This is a typical answer. It notes that the force is small, but does not compare it to the other forces acting, which is required before deciding if it is megligible.

Question 17b

Candidates usually got upthrust and weight correctly, although some did not use the correct term for upthrust, saying lift, uplift, thrust, upwards force, resultant force etc. Drag was omitted sometimes or shown in the wrong direction. Weight was sometimes simply labelled as gravity.

Question 17c

Responses tended to be long and generally gain a mark for including a statement relating to the densities eventually becoming equal. Others gained the mark for noting that the upthrust would decrease. Very few explained how this was linked to the maximum height, instead just making a bald statement. A lot seemed to think that a resultant force of zero caused it to stop rising immediately, showing a poor understanding of Newton's first law.

This candidate recognises that upthrust will decrease and compares it to weight, recalling the first part of question 17, but has not made the final step of referring to resultant force or acceleration, which might have been suggested by the second part.

(c) As the balloon rises the density of the surrounding air decreases. Explain why this density change limits the height to which the balloon will rise.

(2)

because as the density of the surrounding air ↑decreases↓, Upthrust decreases ($U \propto \rho_{surronding\ air}$), and as the density continues to decrease, Upthrust also decreases to a level where it's much smaller than the Weight so this limits the height to which the ballon can rise.

Question 18a

In comparison to the previous series, more candidates showed signs of knowing what Newton's first law is. Even where it was quoted correctly, however, it was rarely used to explain the observations. Candidates often identified that there was no (resultant) horizontal force, but usually just repeated the question by saying this gave no horizontal motion. They did not usually refer to horizontal acceleration. At best, they sometimes said it remained at rest horizontally.

(a) Use Newton's first law to explain why the coin A has no horizontal motion.

(2)

Newtons first law states a body will remain in uniform motion in a straight line as long no external force acts. Since here we have no horizontal forces we have no horizontal motion.

This candidate appears to apply the common misconception that no force means no motion, rather than no acceleration. The candidate may be taking it for granted that the object is initially at rest horizontally so that state of motion continues, but this needs expressing more clearly.

Question 18b

Candidates often appeared to have some understanding of the situation, but did not present their argument clearly using appropriate terminology. While they often mentioned that coin B had horizontal motion, they were not always explicit that only one had horizontal motion. The evidence of the coins striking the floor at the same time was not usually interpreted in any way, such as terms of equal vertical acceleration or velocity.

(b) Explain how this demonstration shows the independence of vertical and horizontal motion.

(2)

one coin Falls vetically the other falls both horisontally And vetically, they Are two different ways of moving, they often coinside

(b) Explain how this demonstration shows the independence of vertical and horizontal motion.

(2)

Both coins will hit the ground at the same time. This is because they are both accelerated downwards at the same rate due to gravity in the vertical direction.

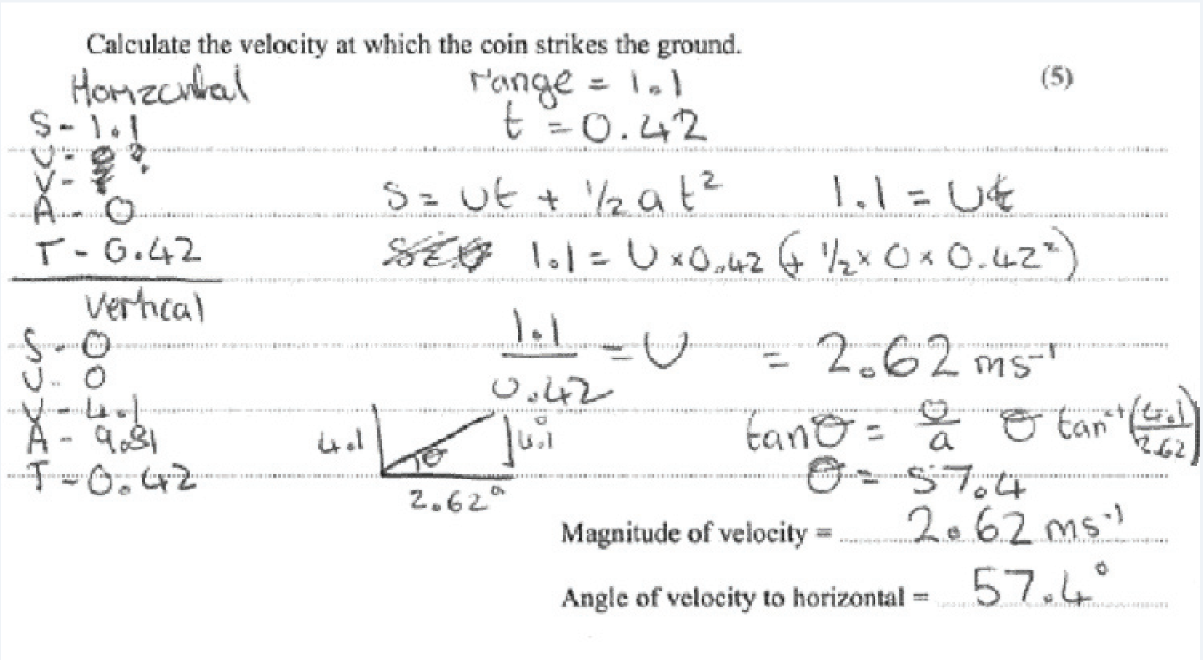
Between them, these answers cover both points, but the first needs to refer to their common vertical motion and the second needs to refer to one having horizontal motion, so it can be seen not to affect the vertical motion.

Question 18c

This presented few difficulties and the majority of candidates gained two marks for this part.

Question 18d

This required a structured calculation of several steps, and many candidates scored no more than the first mark for the horizontal velocity component. The full 5 marks were relatively rarely given. Some candidates didn't realise that the resultant velocity required them to add the horizontal and vertical vectors, and just gave the horizontal velocity component as the final magnitude, as per the following example:


Calculate the velocity at which the coin strikes the ground. (5)

Horizontal
S - 1.1
A - 0
T - 0.42
range = 1.1
t = 0.42
S = ut + ½at²   1.1 = Ut
1.1 = U × 0.42 (+ ½ × 0 × 0.42²)
1.1 / 0.42 = U = 2.62 ms⁻¹
Vertical
S - 0
U - 0
V - 4.1
A - 9.81
T - 0.42
tanθ = o/a   θ tan⁻¹(4.1/2.62)
θ = 57.4

Magnitude of velocity = 2.62 ms⁻¹

Angle of velocity to horizontal = 57.4°

This candidate has pleasingly followed common advice to set out the data given and has worked through the problem methodically, just forgetting to use Pythagoras to find the resultant magnitude.

A number of candidates worked with the vertical and horizontal distance instead, finding the direct distance travelled and dividing by time and finding the angle for the straight line between the starting and finishing positions. Others mixed a vertical speed with a horizontal distance. Candidates did at least usually apply sine, cosine or tangent correctly, even if the quantities were incorrect, and only a few quoted the vertical angle.

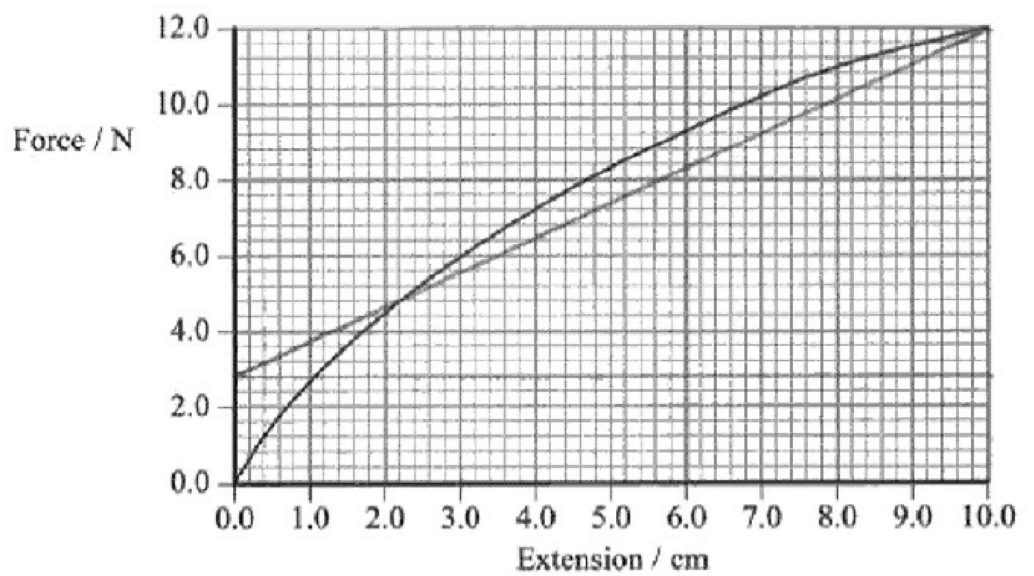
Question 19a

Most candidates spotted the significance of it not being a straight line, and they usually made sufficient reference to Hooke's law to get two marks. Many said straightforwardly, 'No, because extension is not proportional to force'. A surprising number, however, stated exactly the opposite, that it did follow Hooke's law because extension is proportional to force!

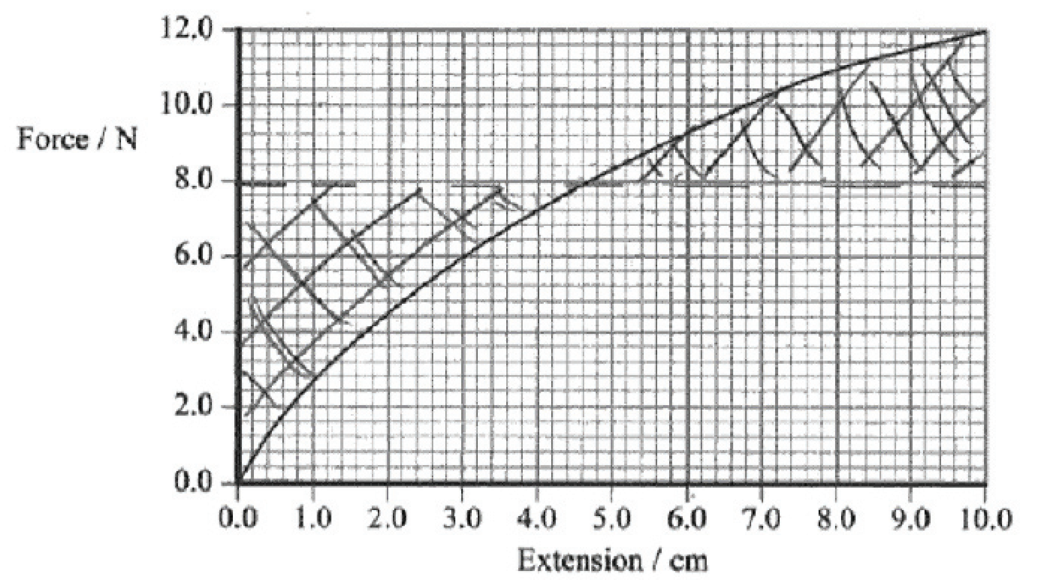
Question 19b

Candidates usually performed a calculation based on a simple triangle to get an answer of 0.6 J, which got two marks. Some counted squares to get a more accurate answer for three marks, and there were some interesting geometrical variations:

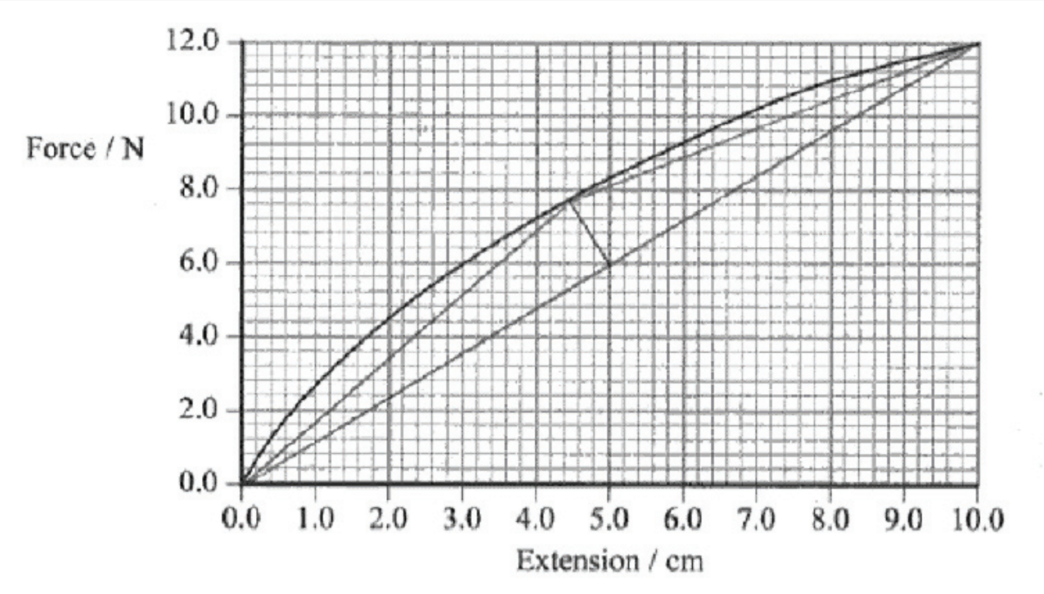
The following graph shows force against extension for the rubber band.



for 0.75 J as the area of the trapezium



for 0.78 J as the area of the rectangle



giving 0.72 J.

Another approach seen was to draw a shape of area 0.8 J and show that the area under the curve was smaller.

Question 19c

Candidates who showed their understanding of the underlying relationships between physical quantities by using conservation of energy found this part straightforward to solve. A few struggled by trying to apply equations of accelerated motion, which did not show a recognition that the acceleration was not constant.

Question 19d

Candidates often did not address the specific points asked for in the question here.

i There were two stages referred to, yet answers often described several. While elastic potential energy was mentioned frequently, even if not that fully, it was very often described as the initial and/or ultimate energy form in this transfer process. Even so, the most common mark was for the transfer to elastic potential energy, with energy transfers to heat not being mentioned often in this part.

(i) Describe the energy transfers taking place when the force on the band is increased and then decreased.

(2)

~~Ea~~ When increased the increase in ~~elastic energy~~ from kinetic to elastic potential energy when decreasing from elastic potential to kinetic energy.

While the initial energy isn't specified in the question, the increase and decrease in elastic potential energy are described in the answer. The student is required to note that some energy when the force is decreased is transferred to internal energy.

ii When the question asked about maximum speed, it was assumed that this would be taken to be the initial speed. A number of candidates, however, went on to describe forces acting to reduce the speed of the aeroplane once in flight.

The most common mark was awarded for managing to suggest that not all of the energy supplied to the band was transferred to the kinetic energy of the 'plane. Some other candidates stated that the energy stored was greater than the energy retrieved. On the whole, the graph was not referred to despite the instruction on the question which should have given a simple mark from a straightforward description.

(ii) The maximum speed of the aeroplane will be less than that calculated in (c). Without further calculation use the graph to explain this.

(3)

There is a lower output of energy than input, so energy is lost, perhaps due to heat caused by the friction of the band as it is pulled back.

This answer gets the middle point about the lower output, but neither refers to how the graph shows this or to its effect on the speed of the aeroplane.

6PH01

Grade	Max. Mark	A	B	C	D	E
Uniform boundary mark	120	96	84	72	60	48
Raw boundary mark	80	53	46	39	32	26

Further copies of this publication are available from
Edexcel Publications, Adamsway, Mansfield, Notts, NG18 4FN

Telephone 01623 467467
Fax 01623 450481
Email publications@linneydirect.com
Order Code US022970 January 2010

For more information on Edexcel qualifications, please visit
www.edexcel.com/quals

Edexcel Limited. Registered in England and Wales no.4496750
Registered Office: One90 High Holborn, London, WC1V 7BH

Llywodraeth Cynulliad Cymru
Welsh Assembly Government

Rewarding Learning