Examiners' Report
Principal Examiner Feedback

Summer 2022

Pearson Edexcel GCE
In Physics (8PH0)
Paper 01 Core Physics I

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Introduction

This is the first time that there has been a full cohort of students sitting Pearson Edexcel AS paper 8PH0/01, Core Physics I, since 2019. Section A of the paper consisted of 8 multiple choice questions followed by 8 questions of increasing length or complexity comprising of short open, open-response, calculation and extended writing style questions. Section A examines material from the topics Working as a Physicist, Mechanics and Electric Circuits. Section B is worth 21 marks on this paper and examines material from the whole AS specification. It contains two questions worth 14 and 7 marks including a practical question based on Young modulus. Although this is not a core practical, it uses techniques that should be familiar to students from both their GCSE and their AS courses. The second question in section B was a synoptic question based on a density and resistivity. This paper enabled students of all abilities to apply their knowledge to a variety of styles of examination questions. Many students showed a good progression from GCSE to AS level, with prior knowledge extended and new concepts taught and understood well. The longer calculation questions were generally not answered well by many students who found the multi-step approach challenging. Some questions were not answered as well as would have been expected by many learners. Q17, requiring a graph to be drawn and a gradient calculated should have been a straightforward response, however many students were not confident in their approach which may reflect a lack of practical experience over the last few years. In the open response and the extended writing questions, students that had a sound understanding of the physics involved did not always demonstrate this in their responses due to a lack of precision when applying their knowledge to the context, poor use of subject specific language and missing the point of the question due to being unfamiliar with the command terms. However, learners from across the ability range managed to score some marks within these questions. Timing was an issue for a small number of learners. Q18 was mostly affected by this issue with some blank responses seen.

Q09

This 3 mark question required a knowledge of combining resistances. Most students were able to recall and use the equations for combining resistors correctly as shown by the student response below.

Calculate the total resistance of the resistors in the circuit.

$10 + 20 = 30$

$\frac{1}{30} + \frac{1}{40} = \frac{7}{120}$

$\frac{1}{7/120} = 17.14$

$17.14 + 30 = 47.14\ \Omega$

The following student added the reciprocals of the correct resistors for the parallel part of the circuit but forgot to then find the reciprocal of that answer. This was a common error.

Calculate the total resistance of the resistors in the circuit.

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ $\frac{1}{30} + \frac{1}{40} = \frac{7}{120}$

$R_T = R_1 + R_2 + R_3$

$= 20 + 10 + \frac{7}{120} =$

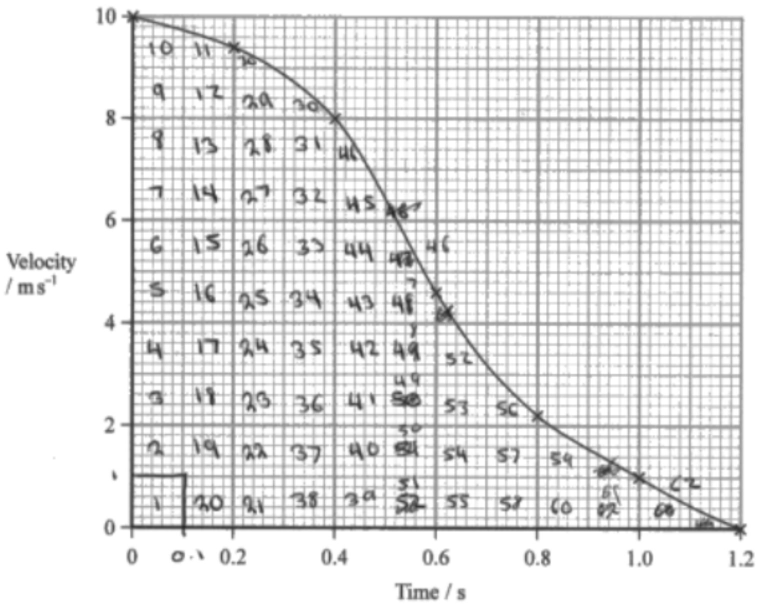
Total resistance = 30 Ω

Some students still left their answers as a fraction and therefore forfeited the final mark.

Q10

This question required students to calculate the distance travelled for motion with a non-linear deceleration by considering the area under a velocity-time graph.
Most candidates were aware that they needed to find the area under the graph, although not all methods yielded results within the range. A few students tried to apply equations of linear motion. Although this produced an answer within the range, this was not credited as these equations can only be used when acceleration is a constant value.

The following student used the method of 'counting squares'. The student was careful to add in partial squares resulting in an accurate estimate of the area and a distance within the given range.



Determine the distance travelled by the sprinter whilst decelerating to rest.

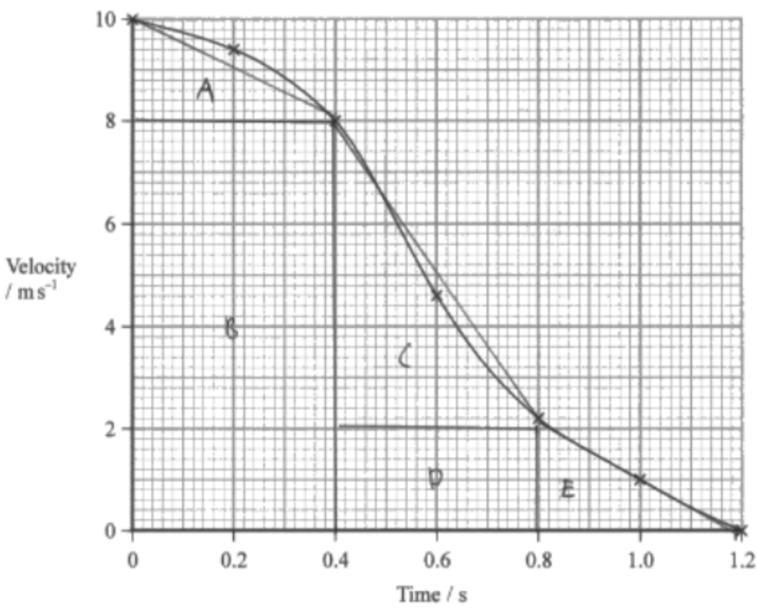
1 square area = 1 × 0.1 = 0.1 m

62 squares underneath graph

Distance = 62 × 0.1 = 6.2 m

Distance = 6.2 m m

This student divided the area up into known shapes. In this case the answer fell within the range, but many students made errors using this method as they had to do many separate calculations.



Determine the distance travelled by the sprinter whilst decelerating to rest.

Area A = $\frac{2 \times 0.4}{2}$ = 0.4 m   Distance = Area T = 6m

Area B = 8 × 0.4 = 3.2m

Area C = $\frac{6 \times 0.4}{2}$ = 1.2m

Area D = 0.4 × 2 = 0.8m

Area E = $\frac{2 \times 0.4}{2}$ = 0.4m

Distance = 6m m

Q11(a)

Students often find problems involving electrical circuits hard to explain. In this question they tended to focus on potential difference as it is mentioned in the question, forgetting that this will be affected by the current changing as well. Use of the principle of a potential divider circuit was a more successful approach for students in this instance as shown by the following response.

Explain what happened to the reading on the voltmeter.

(3)

• $V_{out} = V_{in} \times \frac{R_2}{R_1+R_2}$

• If light intensity was kept constant, the reading on the LDR remains the same

• If the resistance on the variable resistor increases ~~the~~ it ~~reading~~ will have a greater fraction ~~percentage~~ of the total resistance of the circuit

• The reading on the voltmeter will increase as

$V_{out} = V_{in} \times \frac{R_2}{R_1+R_2}$ (where variable resistor = R_2 and LDR = R_1)

Many students tried to apply the idea of $V=IR$ but did not take into account the fact that the current must change too as shown below.

• the ~~volt~~ potential difference would increase

• as the resistance increases so does potential difference as they are proportional to each other.

• as the voltmeter was placed over the variable resistor it would only record for the variable resistor.

Examiners tip:

When approaching a question on a series circuit, consider how the resistance and the current will be changing, as well as the effect on the potential difference.

Q11(b)

Students also approached this question from two angles. They either calculated current and used this to find the resistance of the LDR, or found the resistance directly using the principle of a potential divider circuit.

This student found the current and from there correctly found the resistance of the LDR and hence the light intensity.

$V = IR$

$I = \frac{V}{R} = \frac{2.5}{4500} = 5.55 \times 10^{-4} A$

$R = \frac{V}{I} = \frac{6.5}{5.55 \times 10^{-4}} = 11700\ \Omega$

$= 11.7\ k\Omega$

Light intensity = 190 lux

The following student attempted to use the principle of a potential divider circuit but made the common error of thinking that the voltmeter was across the LDR and not the resistor. R_2 refers to the LDR resistance, and hence the pd on the left hand side of the equation should have been 6.5V.

$2.5 = 9 \times \frac{R_2}{4500 + R_2}$

$11250 + 2.5 R_2 = 9 R_2$

$6.5 R_2 = 11250$

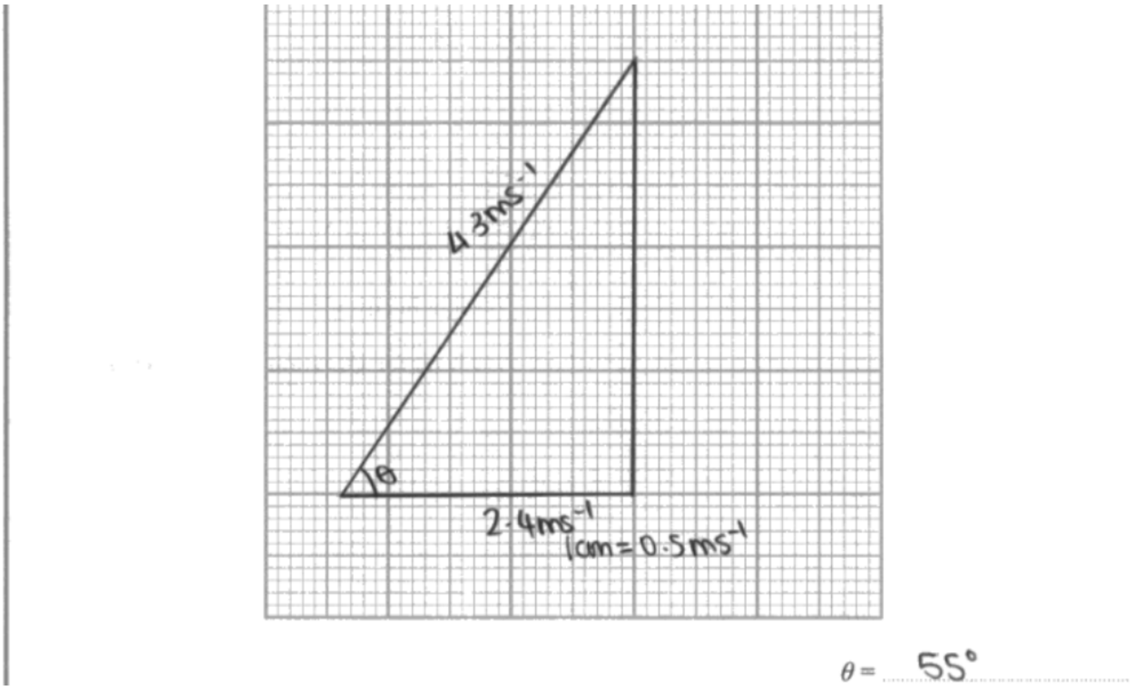
$R_2 = 1730.77\ \Omega = 1.730\ k\Omega$

Light intensity = 550 lux

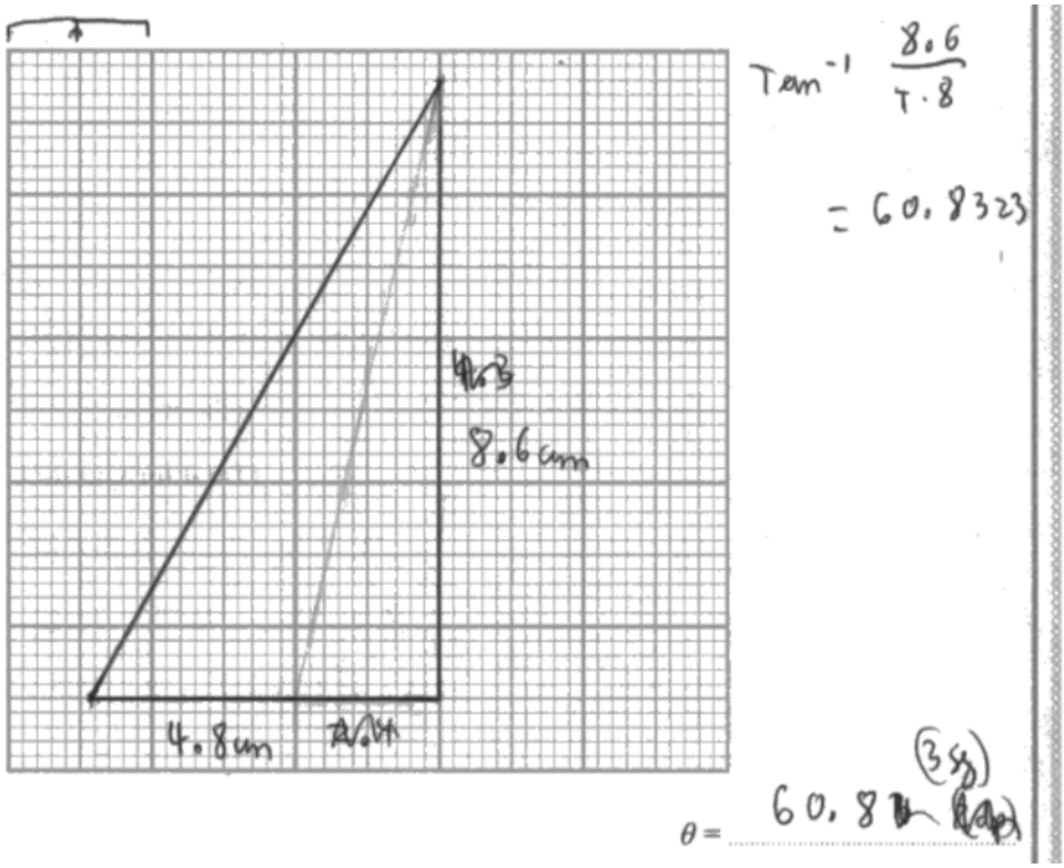
Q12(a)

This question tested students understanding of relative velocities as well as their drawing of vector diagrams. Most students were able to draw vectors to a sensible scale but many got confused as to the direction of the 'velocity of the boat relative to the water'.

This student correctly interpreted the information and was able to draw an accurate diagram to find an answer within the given range. The lack of arrows was forgiven, as the question asked for the direction to be found, not a perfect diagram to be drawn.



The following response was the most common, assuming that the velocity of 4.3 m s^{-1} was in the vertical direction.



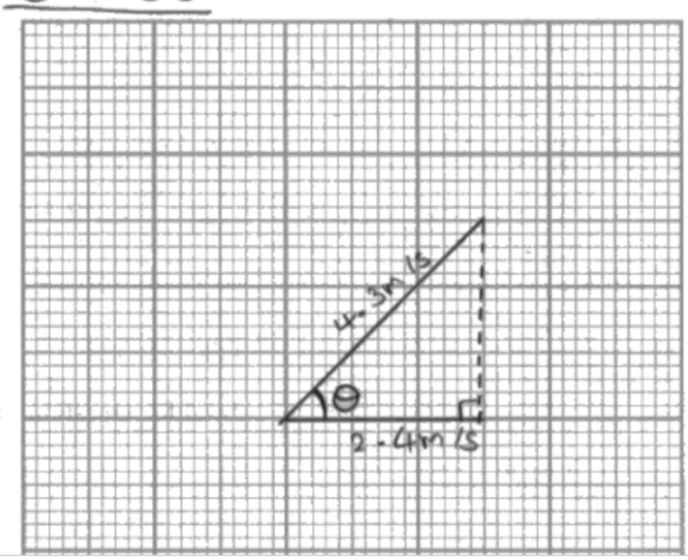
Some candidates calculated the answer using trigonometry and then drew a non-scaled diagram to illustrate it. This was not what the question asked. When a question gives direction as to the method the students should use, then this should be used to answer the question.

(3)

$\cos\theta = \frac{2.4}{4.3}$

$\theta = \cos^{-1} 0.5581$

$\theta = 56°$



Q12(b)

Most candidates were able to access this question and score marks. Most instinctively knew that the time would increase but found it harder to explain why. Many discussed force on the boat instead of focusing on the velocity of the boat, and some got confused as to which angle they were referring to. When an angle has been defined on a diagram in a question, it is best to use this angle in explanations and to check with the diagram to make sure it is referenced correctly.

The following candidate was able to do this and score full marks.

Explain how the time taken for the crossing will change.

(3)

- θ will ~~increase~~ decrease
- vertical component of velocity will therefore also decrease ($\sin\theta$)
- therefor time taken to cross increases

Q13(a)

Students found this question hard, despite the emphasis on energy transfers in the question. Many looked at the diagram and tried to answer the question using moments due to the rotation involved. Many also answered in terms of friction and energy transferred as waste energy to the surroundings. This response is of GCSE standard. At this level it is expected that students would refer to the work done by the frictional forces to explain the transfer to the surroundings.
Most of the successful students gained mark points 1 and 2 for consideration of other energy stores that energy was transferred to, as shown by the successful student response below.

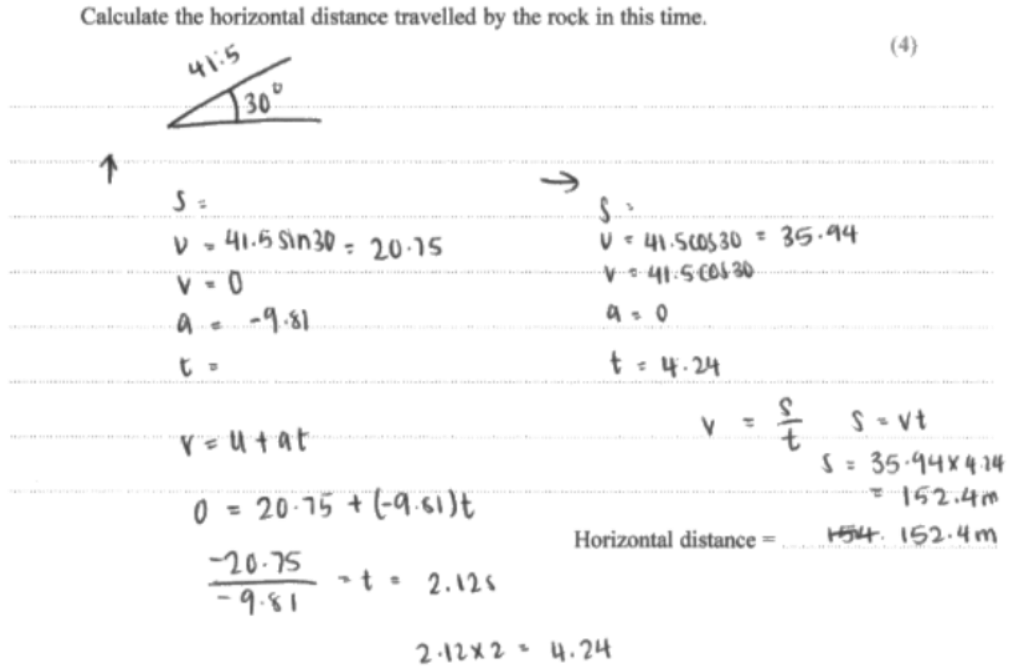
> ~~Some The rock~~ The counterweight will have to lift the beam so some of its gravitational potential energy is converted into gravitation potential energy of the beam. The beam will also move so some of the gravitational potential energy would have been converted into kinetic energy of the beam to move it before the rock is released.

The following response is of a GCSE standard, and therefore does not score.

> • Some of this energy will be dissipated
> • As it travels through the air there will be resistive forces such as air resistance meaning not all energy goes into the rock

Q13(b)
This was a straightforward projectile calculation and most students gained marks. Students were successful using three different approaches. Many chose the method in the mark scheme example, calculating the time to the mid point, then doubling it and using it to find the range. Others used the whole range, either by using s(vertical) = 0, or by using the symmetry of the motion, enabling them to make v(vertical) equal in magnitude but opposite in direction to u(vertical).

The most successful candidates often set their work out to keep horizontal and vertical motion separate, as the following student has done.


Calculate the horizontal distance travelled by the rock in this time.

(4)

41.5, 30°

↑
s =
v = 41.5 sin30 = 20.75
v = 0
a = -9.81
t =

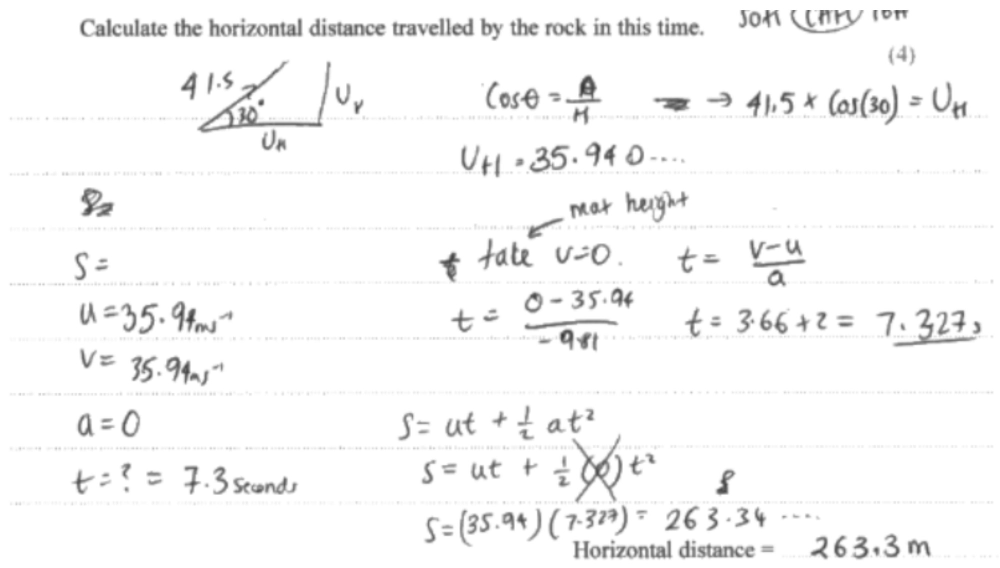
v = u + at
0 = 20.75 + (-9.81)t
-20.75 / -9.81 = t = 2.12s
2.12 × 2 = 4.24

→
s =
v = 41.5cos30 = 35.94
~~v = 41.5cos30~~
a = 0
t = 4.24

v = s/t   s = vt
s = 35.94 × 4.24
= 152.4m

Horizontal distance = ~~154~~ 152.4m

When students don’t set out their projectile calculations like this, there is more potential for them to confuse the vertical and horizontal velocities as the following candidate has done.


Calculate the horizontal distance travelled by the rock in this time.

(4)

41.5, 30°, U_V, U_H

cosθ = A/H → 41.5 × cos(30) = U_H
U_H = 35.940....

s =
u = 35.94 m s⁻¹
v = 35.94 m s⁻¹
a = 0
t = ? = 7.3 seconds

take v = 0 (max height)   t = (v − u)/a
t = (0 − 35.94)/−9.81   t = 3.66 × 2 = 7.327s

s = ut + ½at²
s = ut + ½(0)t²
s = (35.94)(7.327) = 263.34 ....

Horizontal distance = 263.3 m

Q13(c)

This open ended response question required students to link energy transfer in the trebuchet to their knowledge of 2 dimensional motion. Some chose to consider moments and force for the trebuchet which could also be credited, instead of using energy transfer. Many students focussed either on the trebuchet or on the motion, limiting the number of marks that were accessed. It is a good idea, especially with longer answer questions, to read the question again when the response is complete to ensure that the beginning (the mass increase) is linked right the way through to the end (the increase in range).

The following student's response shows this well.

Explain why the horizontal distance travelled by the rock decreases.

(5)

Less Gravitational potential energy of the counterweight so when the peg is removed less energy is transfered to the kinetic energy of the rock. This means that the vertical component of the rock's velocity is less and so it will fall back to the ground in a shorter time. The horizontal component of the velocity is also less. and the time taken is less so the horizontal distance travelled decreases.

(Total for Question 13 = 11 marks)

Whilst this student discussed the energy transfers but jumped from a higher velocity to a longer range with no consideration of the motion between.

As the mass of the counterweight decreases, the weight of the counterweight also decreases. [illegible] At the same height, the lighter counterweight has a smaller gravitational potential energy. As energy in a closed system is conserved, the decreased gravitational energy of the counterweight decreases the kinetic energy of the rock. Kinetic energy is proportional to the square of the velocity, so as kinetic energy decreases, so does the velocity. A lower velocity means it travels less horizontally.

(Total for Question 13 = 11 marks)

Q14

This question tested the student's ability to link together ideas in a longer explanation. This one was based on the application of Newton's laws to the moment at which a student jumped forward off a moving skateboard. There have been several questions over the past few years that have been similar and it is good to see that the standard of response on this subject is improving. However, it is still common to see students explain the jump in terms of Newton's 3rd law with some detail but fail to mention the effect of those forces on the skateboard and the student using Newton's 2nd law. Many students are also wasting time still explaining the motion of the student on the skateboard prior to the jump, instead of focusing on what the question asked.

The following student explained the motion well using both Newton's 2nd law and Newton's 3rd law.

> Explain how Newton's laws of motion apply to the student and the skateboard as he jumps forward off the moving skateboard.
>
> As the student jumps off the moving skateboard, he exerts a force on the skateboard and due to Newton's 3rd Law, an equal but opposite force is exerted on him from the skateboard. As he jumps off, he accelerates due to Newton's 2nd Law. The force applied on him by the skateboard is proportional to the acceleration of the student as $F = ma$. The force exerted on the skateboard acts in the opposite direction to its movement causing it to decelerate by Newton's 2nd law and come to a stop or even decelerate in the opposite direction so that the skateboard moves backwards before coming to a stop due to friction and drag.

However, this student wasted the first few lines discussing the motion before the jump and did not mention Newton's 2nd Law at all. This student still scored some marks though due to the explanation using Newton's 3rd Law.

Explain how Newton's laws of motion apply to the student and the skateboard as he jumps forward off the moving skateboard.

When the student is ~~going~~ travelling at a constant speed, ~~the~~ the forces ~~act~~ are balanced, with weight and the normal reaction being equal and the forwards and backwards forces being equal. This is an application of Newton's First Law. When the student jumps, ~~that~~ he exerts a force on the skateboard and the skateboard exerts an equal and opposite force on him, which results in him being projected off the skateboard. this is evidence of Newton's Third Law. When in the air, he now ~~simpl~~ just has weight and air resistance acting on him, with no reaction force from the skateboard, so there is a resultant force acting downward and he falls towards the ground.

Q15(a)

This calculation involving energy and efficiency was well answered by many. Most appreciated that the power/energy transfer for the circuit was required, but some tried to calculate kinetic energy gain for the truck, missing the information in the stem of the question that it travelled 'at constant speed'.

The following student answered this well.

$E_g = mgh = (0.55)(9.81)(0.2) = 1.1\ J$

$P = VI = 12 \times (8.1 \times 10^{-3}) = 0.097W$

$P = E/t = 1.1/15 = 0.072W$

$\text{Efficiency} = \frac{0.072}{0.097} = 0.74 = 74\%$

However, this student made the common error of finding a power and an energy and using them in the efficiency equation. Efficiency must be calculated using **either** two powers, **or** two energies, not a mixture of the two.

$I = 8.1 \times 10^{-6}$, $V = 12V$

$P = VI \Rightarrow 9.72 \times 10^{-5} W$

$W = Fs$

$= 550 \times 9.8 \times 0.20$

$W = 1078 J$

$$\text{efficiency} = \frac{9.72 \times 10^{-5}}{1078} \Rightarrow 9.01 \times 10^{-8}$$

Efficiency = 9.01×10^{-8}

Q15(b)

Students found this very difficult and it exposed fundamental misunderstandings about parallel circuits. The majority of students considered the current supply from the battery to be a constant and therefore considered that the analogue voltmeter would have current through it and so the motor would receive less current. This misunderstanding probably comes from the fact that current is often described as 'splitting between the branches' of a parallel circuit. Also words like 'current' were often used without reference as to which part of the circuit was being discussed.

The following student, although mistakenly thinking that current through the motor was reduced, does appreciate that the current through the battery has increased which leads to an increase in power input from the battery.

This will decrease the efficiency of the motor circuit as it will cause a larger current to go through the voltmeter and less current to go through the motor. This will therefore decrease the power of the motor whereas the power of the whole circuit will increase due to having a higher current as it has a lower total resistance. Therefore the circuit will be less efficient.

This student however, has not made that link and therefore is accessing less marks.

If the resistance for the voltmer decreases, the current is going to increase. This is because resistance and current are indirectly proportional. This means that the voltmeter is going to draw more current. This will lead to the motor recieving less current. This will cause it to be ~~more~~ less efficient.

Q15(c)

Most candidates were able to successfully use the principle of conservation of linear momentum to answer this question. Some students got confused as to which mass to use.

The following student's response scored well.

Determine the velocity of truck B after the collision.

(3)

Momentum before = Momentum after

$(0.55 \times 5.4) + (0.35 \times 0) = (0.55 \times 2.1) + (0.35 \times v)$

$2.97 = 1.155 + 0.35V$

Velocity of truck B = $5.2 ms^{-1}$

(Total for Question 15 = 11 marks)

$0.35V = 1.815$

$v = 5.2 ms^{-1}$

Q16

This question, based on a simple bridge required students to explain the support forces required using the principle of moments. A lack of precise terminology limited the marks available to many students. Many discussed 'moment' without naming the pivot point used, and didn't refer to moments as 'clockwise' or 'anticlockwise'. Some took the weight as the pivot point and tried to answer the question as if the bridge were a seesaw. This approach was not successful. Moments should always be taken about points which are potential pivots. A surprising number of students did not realise that the question involved a discussion on moments at all.

The following response scored highly, due to the precise terminology used. When discussing moments, the pivot point was defined, and the moments were referred to as clockwise and anticlockwise as appropriate.

For the metre rule to be in equilibrium, the sum of clockwise moments should be equal to the sum of anticlockwise moments about the same pivot. Taking P as the pivot, as x increases, and moment = Fx, the load produces a greater clockwise moment. Hence, as the distance between P and Q remains the same, F_Q increases to increase the anticlockwise moment and balance the increase of the clockwise moment. Taking Q as pivot, as x increases, the distance between the load and Q decreases hence anticlockwise moment decreases. As a result, F_Q decreases to ~~balance the decrease~~ to reduce the clockwise moment.

The following student has not been precise with language and has been far less successful as a result.

Explain how F_P and F_Q changed as x was increased.

The force of P would have to decrease as the distance gets larger so will the turning effect so to create an even turning effect. The value of F_Q will have to increase, so the sum of moments are equal. As x increases, the centre of gravity will increase.

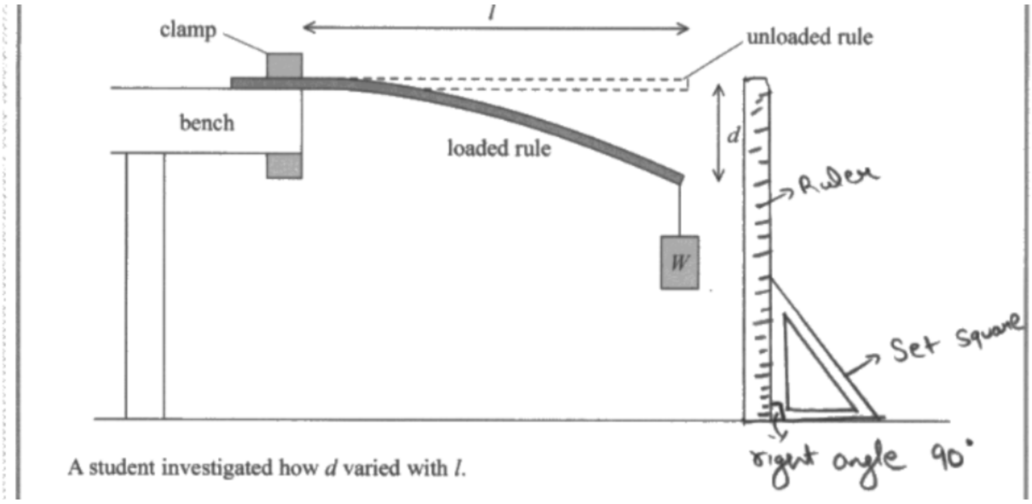
Resultant force of the bridge has to be 0 for it to be in equilibrium.

Moments = Perpendicular force × Distance.

Q17(a)

This question was about practical technique. Many students did not answer correctly which reflects the lack of practical experience this particular cohort of students has had. Many were distracted by the comment that the rule was 'clamped horizontally' in the stem of the question and used the rule as a reference with the set square to align the rule for measuring. This would not work due to the sag of the rule under its own weight. The floor however, can always be considered to be horizontal. Few students took note of the phrase 'You may add to the diagram'. Drawing a diagram was by far the easiest way of answering the question. Some said they would move the vertical rule so it touched the end of the deflected rule. This would not be possible due to the weights sticking out, something which they should appreciate from their own practical work and from the diagram.

This student used a diagram to clearly illustrate the first mark point. It would have been very straightforward to add a second set square to illustrate the second as well.



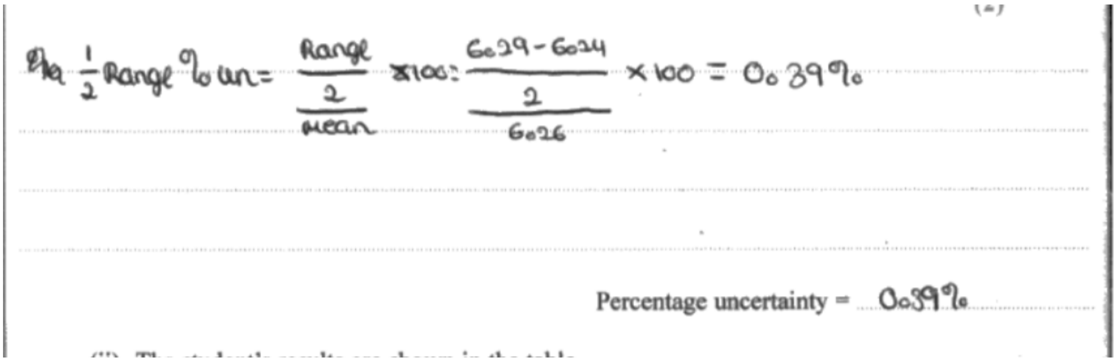
The following student gained both marks with a written answer.

The student should use a clamp stand to hold the metre rule in place, perpendicular to the ground. ~~Ensure~~ check metre rule is perpendicular to ground with a set square. When taking readings for d, use a set square to line up the bottom of the loaded rule with the second metre rule, to reduce parallax.

Q17(b)(i)

Students were asked to calculate the percentage uncertainty of the data given. Most successfully used half the range of the data or the maximum deviation from the mean, but some students discounted data as anomalies or used the whole range of data in their calculation.

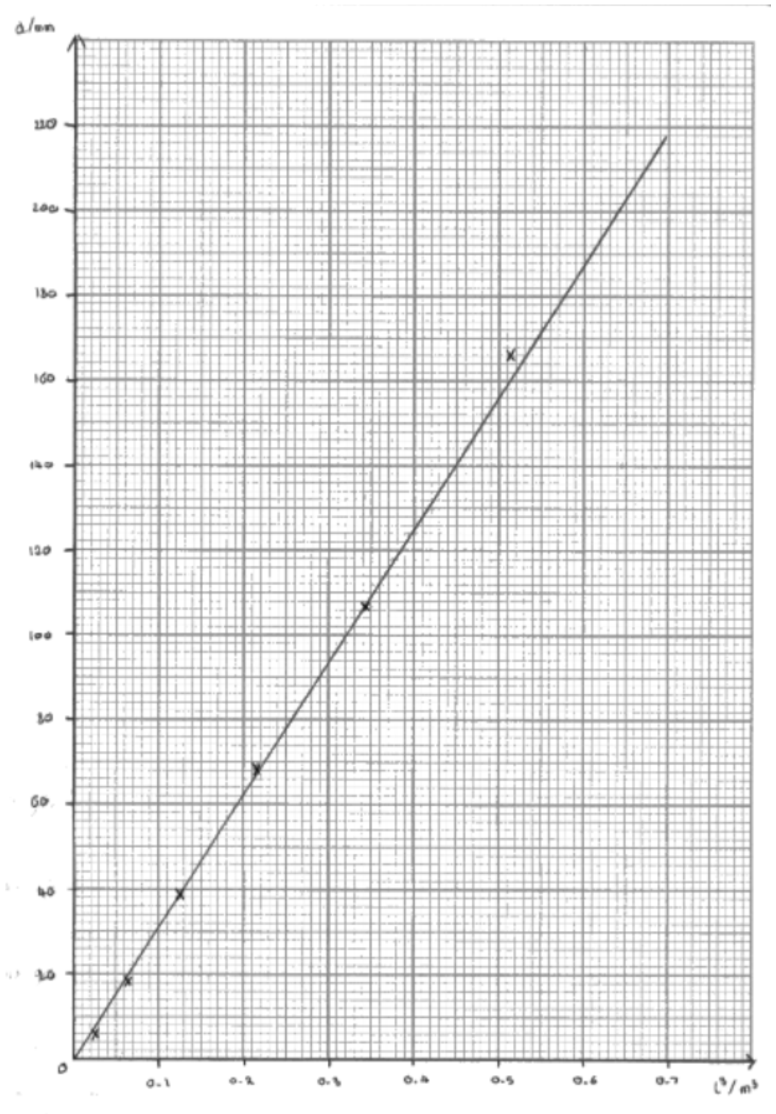
The following student calculated the percentage uncertainty correctly, showing clear working.


$\frac{1}{2}$ Range % un = $\frac{\frac{Range}{2}}{mean} \times 100 = \frac{\frac{6.29 - 6.24}{2}}{6.26} \times 100 = 0.39\%$

Percentage uncertainty = 0.39%

Q17(b)(ii)
The students were given data and asked to process that data to plot the specified graph. Most students correctly processed the data although some used a mixture of significant figures. Many students were able to plot the graph accurately but lost marks for labelling the axes incorrectly, for instance by giving units of 'm' for 'l^3', or using brackets round the unit instead of 'unit/quantity'. It was also common to see scales of 4 or 2.5, instead of the preferred scales of 1, 2 and 5. Far fewer students are plotting points as dots now, most plotting with crosses which is preferable as dots have a habit of becoming blobs which, if big enough, are not accurate. Students expect the best fit line to go through the origin and therefore many rotated their line slightly to ensure that it did. A rotated line is easily spotted if data is above the best fit line at one end of the line and below it at the other.

The following student labelled axes and plotted points accurately but rotated the line to force it though the origin.



Q17(b)(ii)

The calculation of a value for the Young modulus of the wood and consequently the students determination of the wood used was a challenge due to the number of unit conversions needed to end up with a correct power of ten for the answer. Some students used a data point from the table to substitute into the equation. This scored some marks but not all as it leads to an answer that is not as accurate as when the gradient is used.

The following student used the gradient of their graph, and correctly converted all the units.

$$d = \frac{4wL^3}{Ebt^3} \qquad E = \frac{4w}{bt^3} \times \frac{L^3}{d}$$

$$= \frac{4 \times 5.6}{0.0302 \times 0.00626^3} \times \frac{0.5 - 0.11}{156 - 20}$$

$$= \frac{22.4}{7.408 \times 10^{-4}} \times \frac{0.39}{136}$$

$$= 8671071 \text{ Pa}$$

$$= 8.6 \text{ GPa}$$

$$\approx 9.7$$

∴ ruler is made of Douglas fir

Q18(a)(i)

This density calculation was carried out well by most. Mistakes came in rearranging the equation incorrectly or in not converting mass to kg. 'Show that' questions require the answer to be given to an extra decimal place when compared to the value given in the question. Most candidates did this well.

This a correct response with clear working.

$$(43 \times 10^{-3}) \div 5300 = 8.1 \times 10^{-6}\ m^3 \approx 8 \times 10^{-6}\ m^3$$

∴ shown.

Q18(a)(ii)

Most students performed this calculation well. Students who didn't, often failed to realise that the volume of a cylinder is cross sectional area x length, which made it impossible to find the length correctly. Students also used the diameter as the radius to find the area.

The following student correctly calculated the answer.

$R = \frac{\rho l}{A}$ ← length, A ← cross sectional area

$A = \pi r^2 = \pi \frac{d^2}{4}$

$A = \pi \frac{(12 \times 10^{-3})^2}{4}$

$= 1.13 \times 10^{-4}\ m^2$

$R = \frac{4.0 \times 10^{-3} \times 0.072}{1.13 \times 10^{-4}}$

$= 2.54\ \Omega$

Volume $= Al$

$l = \frac{\text{Volume}}{A} = \frac{8.11 \times 10^{-6}}{1.13 \times 10^{-4}}$

$= 0.072\ m$

Resistance = $2.54\ \Omega$ or $2.5\ \Omega$

Whereas this student failed to use the volume of a cylinder to find the length, instead assuming that it was a cube and finding the cube root of the volume.

diameter of cylinder = 12 mm → 12×10^{-3} m

resistivity of conducting putty = $4.0 \times 10^{-3}\ \Omega$ m

$R = \frac{\rho l}{A} = \frac{4 \times 10^{-3} \times \sqrt[3]{\frac{43}{5300000}}}{\frac{\pi (12 \times 10^{-3})^2}{4}}$ (3)

$= 0.71\Omega$ (2sf)

Q18(b)

The increase of the length and the reduction of the cross-sectional area both increase the resistance here. Most students spotted at least one of these, scoring the first mark point, but few quoted the equation to prove the relationship for the second mark point.

This student used the equation to prove the relationship.

Make it longer or thinner, as $R \propto$ Length and $R \propto \frac{1}{\text{Area}}$, so increase length or decrease cross sectional area. As $R = \frac{\rho L}{A}$, $R = kL$, so $R \propto L$, and $R = \frac{k}{A}$, so $R \propto \frac{1}{A}$.

Summary

This paper provided students with a wide range of contexts from which their knowledge and understanding of the physics could be tested. A sound knowledge of the subject was evident for many, but the responses seen did not always reflect this as the language lacked precision and its ambiguity prevented some marks from being awarded. Based on their performance on this paper, candidates are offered the following advice:

- Practise questions under timed conditions to ensure that you do not run out of time on the last question.

- Note units that will need converting as you read through a question. Highlighting them is useful at this stage, or even converting them before you start to ensure that you don't forget later.

- Use technical language precisely, especially if there is more than one value for a particular quantity, such as different currents in a circuit or moments taken about different pivots. Make sure it is clear exactly which bit you are discussing.

- For projectile questions, split your answer section in two, with one side for horizontal data and calculations, and the other for vertical. This way you are less likely to muddle up which piece of data to use.

- For longer answer explanations, make sure when you have finished, that you read the question again to check where your explanation should end, and ensure that your answer links from the start right through to the end.

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