Examiners' Report/
Principal Examiner Feedback

January 2015

Pearson Edexcel International Advanced Subsidiary Level in Physics (WPH01) Paper 01

January 2015
Publications Code IA040638

Grade Boundaries

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

This is the third time that the Edexcel International A level in Physics has been sat by candidates. The specification examined and assessment structure of the paper is the same as that of the home 6PH01 paper. Section A of the paper contains 10 multiple choice questions while section B contains questions of increasing length and usually of increasing demand.
Unit 1, Physics on the go, examines both the mechanics and materials component of the course providing a transition for candidates between GCSE and A2. Although there is no overlap with the other units, the skills and concepts covered, especially in the mechanics topic are used as a basis for the teaching of circular motion, momentum and simple harmonic motion in units 4 and 5.

This paper enabled candidates of all abilities to apply their knowledge to a variety of styles of examination questions. Many candidates showed a good progression from GCSE to AS level, with prior knowledge extended and new concepts taught and understood well. The quality of open response style questions was good and often it was the higher scoring numerical answers that let down some of the candidates, particularly the more able. At the top end of the ability range candidates did not score as highly as usually seen in the multiple choice section of the paper. The mean score for questions 1 to 10 across all candidates was 6.3 with just a variation of one mark higher for A grade candidates and 1 mark lower for E grade candidates.

The mean mark on the paper as a whole was 38.3; this was 1.5 marks less than the mean on same paper last January. The spread of marks around the mean was slightly greater than last year. However, this was particularly noticeable around the E grade boundary where there was a greater spread of marks compared to that at the A grade boundary. Timing was not an issue at all with this paper with the vast majority of candidates, across all abilities completed all questions on the paper.

Section A – Multiple Choice

	Subject	Percentage of candidates who answered correctly	Most common incorrect response
1	Path of a projectile	65	B and D
2	Use of equations of motion	85	B
3	Resolving forces	64	B
4	Vectors	64	D
5	Acceleration of a projectile	39	A
6	Kinetic energy of a projectile	67	D
7	Properties of materials	82	B
8	Newton's 2nd and 3rd laws	45	D
9	Properties of materials	39	A
10	Force-extension graph	78	B

The multiple choice items were of varying difficulty. The questions found to be more challenging by candidates contained Physics that repeatedly appears to be less well understood across all abilities. Question 5, requiring the candidates to know the magnitude and direction of the acceleration of a projectile, and question 9, identifying the yield point and elastic limit of a material, in particular, are areas that have been identified as less well understood and have been mentioned in these reports in the past. The most common incorrect response is worth considering as it often demonstrates the misconception that many candidates have about a particular topic, especially if it is the incorrect response for the majority of candidates.

Question 1

Although answered correctly by 65 % of candidates it is worth mentioning this question as candidates often are not aware of and cannot explain the reason for the correct trajectory of a projectile. Question 15(a) required the candidates to draw in the path of the netball before reaching the goal and will be discussed later. While question 1 expected the candidates to realise that the package fell with a constant horizontal velocity and an increasing vertical velocity to create the parabolic trajectory.

Question 3

Resolving forces especially parallel and perpendicular to a slope tends to be a skill only the more able candidates can successfully carry out. Just 45 % of candidates at the bottom of the ability range manage to score the mark while 79 % of the top ability candidates answered correctly. Appreciating, as was clearly drawn on the diagram, that the weight is acting from the centre of gravity should help the candidates realise that the parallel and perpendicular components of the weight of the block must all act though the centre of gravity and guide them away from guessing as response B does not really apply to this situation at all.

Question 4

This is an example where candidates were rushing though a question. The most common incorrect response was 'D'. Asked independently of this question most candidates would identify the kinetic energy is not a vector quantity but at speed they just looked at the mention of 'upwards' and did not read on; clearly missing response A and response B's references to north and east as valid directions.

Question 5

The magnitude and direction of the vertical acceleration of a projectile are not always considered when answering questions on projectiles. This is usually due to candidates assuming that the acceleration, *g*, is always positive. Question 5 highlights part of this common oversight and was answered poorly across all abilities with most assuming that at maximum height, where the velocity is 0, that the acceleration is also 0.

Question 8

The stem of this question contained a lot of information, every piece of which was relevant when considering the answer. However, many candidates missing the frictionless floor and assumed that the boy would remain stationary and choosing incorrect response D. This question required the candidates to assume, using Newton's third law, that the magnitude of the force on the boy is that same as that on the girl and then apply F = ma to the girl and then the boy. No calculation was required, rather an approximate estimate of the relative magnitude of the acceleration due to the boy having a larger mass.

Section B

Question 11

(a) The majority of candidates have a secure grasp of conversion and indices with 77% scoring all 3 marks. A small number did not convert either units and found that 100 g /0.80 cm obtained an answer, in their opinion, close enough to the show that vale of 120 N m^{-1}. Use of g = 10 N kg^{-1} was also seen and had a one mark penalty, only entitling the candidates to score 2 out of the 3 marks.

(b) All three marks were rarely awarded with the second marking point for identifying that there would be some permanent deformation, the most commonly awarded. Many candidates confused the elastic limit with the limit of proportionality and Hooke's law even though they often went on to correctly describe that the spring would be permanently deformed. Some candidates were not concise in their language and it was common in incorrect responses to see explanations around the idea that a point would be exceeded but did not specifically refer to the elastic limit, as required. The third marking point was almost never scored as candidates did not really relate what was happening within the spring to the balance as a whole. Responses just referring to the 'reading would not be accurate' were seen and should be discouraged as, in the majority of questions, a reason for the lack of accuracy is required.

Question 12

(a) The candidates were asked to apply the principle of conservation of energy to the context of the bungee rope stretching as it moves downwards and then contracts as it moves upwards. The context, especially as the rope contracts, is a very complex one and goes beyond the specification of this unit. However, the information given in the stem of the question and in the table in part (a) identified exactly which small segments of the bungee jumper's motion had to be considered. Although just over half of all candidates did not score any marks at all, the majority lost out on the first mark by failing to name the elastic potential energy correctly, usually omitting the words 'potential' or 'strain'. The understanding by many candidates of the physical events as the bungee contracted was poor with just 6 % scoring both marks. Most candidates just described the transfer of elastic potential energy to either gravitational potential energy or to kinetic energy as the rope contracted, without considering that the rope can only gain height if moving at the same time. Some candidates did miss out on the marks due to the use of abbreviations. It was expected that all terms had to be written out in full or be defined.

(b) In theory, this appears to be a series of straightforward calculations involving the equations for gravitational and elastic potential energy. However, in practice the context needed to be fully understood so that the candidates could select the correct variables to substitute into the equations. Therefore the 'use of' mark in part (i) was the most commonly awarded with many candidates using the total height of 65 m and not the drop height of 55m. In part (ii) many candidates did not select the correct formula to use from those given at the back of the paper, opting instead to use work done = force × distance. Others calculated the weight of the person or used equations of motion to calculate the acceleration and then used $F = ma$ to find the force. The candidates should be aware that if a question part is broken up into additional sub parts then it is likely that the answer to part (i) will be needed or will guide then towards their response in part (ii).

The response below scored 1 mark for correctly identifying that the extension would be (55 – 23). The incorrect formula of $\triangle W = F \triangle s$ was selected so this could not score any further marks.

(ii) Hence calculate the tension in the rope when the bungee jumper is 10 m above the ground.

initial length of rope = 23 m

(3)

$W = Fd.$

$$F = \frac{W}{\Delta x} = \frac{291 \times 10^4 \text{J}}{(55-23)\text{m}} = 909.4\text{N}$$

$\approx 909\text{N}$

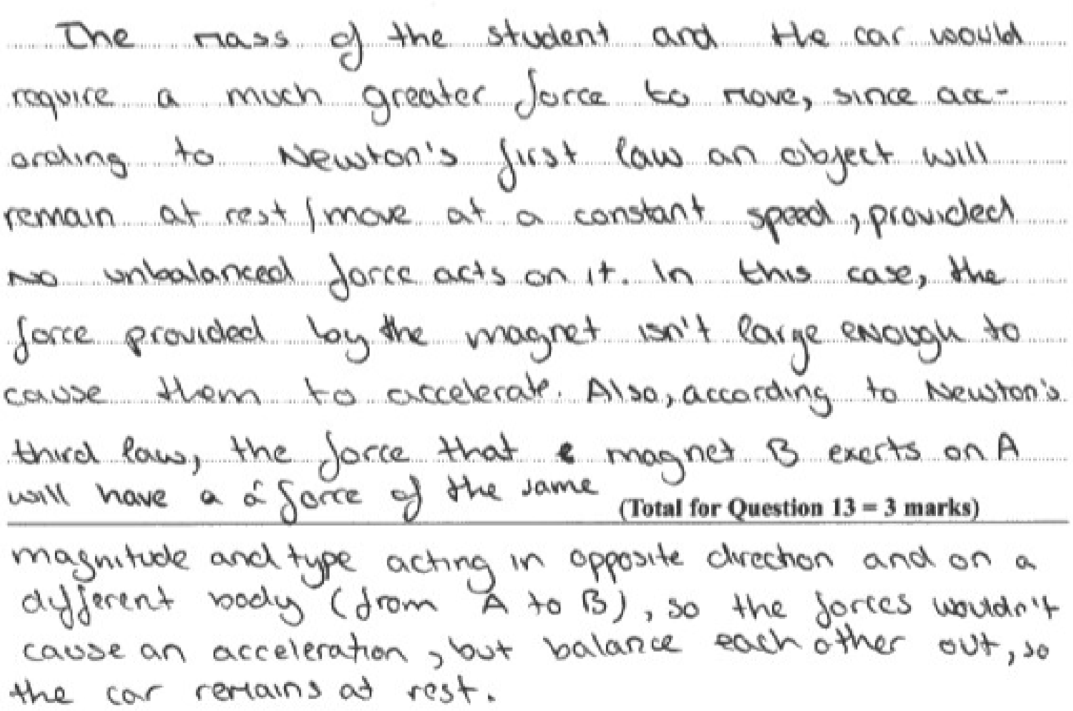
Tension = 909 N

Question 13

This question discriminated well and was answered successfully by many candidates. Unlike previous questions where an explanation specifically in terms of Newton's laws was requested, no prompt was given. The majority of candidates identified that a reference to Newton's third law was required even if it was just described in terms of the magnets without specifically being mentioned. The third marking point for identifying that there would be no resultant force was the most commonly awarded. As mentioned above, many attempted to describe the equal and opposite forces in terms of N3, sometimes missing out on MP1 due to slight brevity of the response. The middle marking point and really the key to this idea not working in that the bodies are connected was fairly subtle and missed by many candidates.

Those who scored zero often based their answers on the idea that the force provided by the magnets was not sufficient to move the car against the force of friction or against the weight of the car and driver.

The response below scored 2 marks for the first and third marking points. Although the candidate started their explanation incorrectly they then went on to identify that the forces on the magnets are equal and opposite due to Newton's 3rd law and that the forces balance. As with the majority of candidates they did not identify that the magnets are connected to each other which is why the forces cancel out.



The mass of the student and the car would require a much greater force to move, since according to Newton's first law an object will remain at rest / move at a constant speed, provided no unbalanced force acts on it. In this case, the force provided by the magnet isn't large enough to cause them to accelerate. Also, according to Newton's third law, the force that magnet B exerts on A will have a force of the same

(Total for Question 13 = 3 marks)

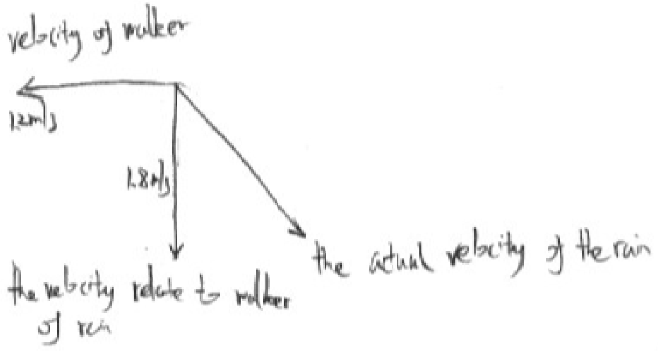
magnitude and type acting in opposite direction and on a different body (from A to B), so the forces wouldn't cause an acceleration, but balance each other out, so the car remains at rest.

Question 14

This question produced a whole spectrum of answers with a mode of 4 marks, mainly due to incorrect directions on the vector diagram. However 3 marks and 5 marks were awarded almost as frequently. Most candidates chose to calculate the value of the resultant velocity and its direction. It was very clear that the vast majority of candidates can use Pythagoras successfully but a smaller number could select the correct angle to calculate, with the angle to the horizontal frequently seen and not the angle to the vertical as requested.

The vector diagrams seen, especially at the lower end of the ability range, did not always score more than the first marking point as the scaling was often not considered or that the resultant force was in the wrong position in addition to the omission of or incomplete directions. Some candidates even drew the direction of the rain as upwards, showing that they had not really thought about the context to which the vector addition was being applied.

The response below scored the 1st marking point only for their diagram and the 4th and 5th marking points for the magnitude and direction of the resultant velocity. No attempt was made to scale the horizontal and vertical velocities and this candidate was not able to construct a correct vector diagram, as their resultant velocity is not consistent with the direction in which the man is walking.



$\sqrt{1.2^2+1.8^2} = 2.16$ m/s

$\tan\alpha = \frac{1.2\text{m/s}}{1.8\text{m/s}} = \frac{2}{3}$

$\therefore \alpha = 33.69°$

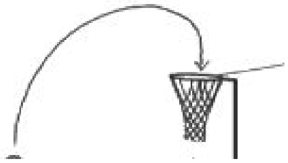
Magnitude of the actual velocity of the rain = 2.16m/s

Angle of the rain to the vertical = 33.69°

(Total for Question 14 = 5 marks)

Question 15

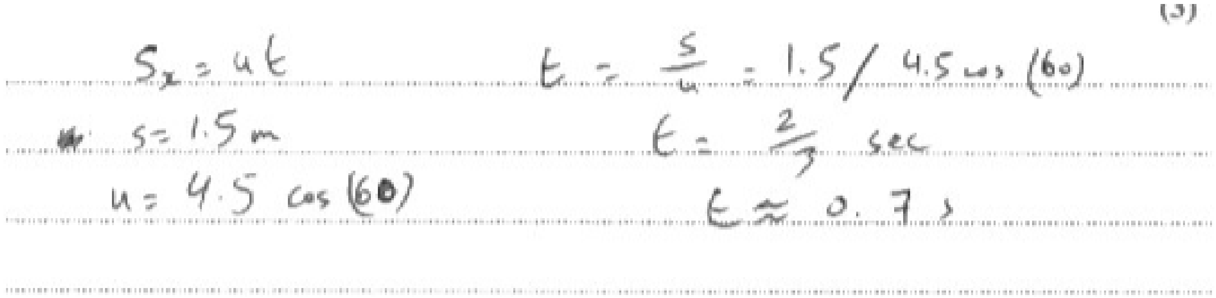
(a) As seen with question 1, the correct trajectory of projectiles is often overlooked by candidates. A small but significant number of responses showed that the candidate did not understand the basics of projectiles and drew highly asymmetrical curves or even straight lines. The examiners were looking for a symmetrical parabolic path above the top of the netball ring. While most candidates attempted a parabolic curve, it often wasn’t symmetrical with the ball just suddenly dropping vertically above the net. This was true for the two incorrect diagrams below which did not did not score the mark.



The image below scored the mark and is an example of a good response.

(b) Most candidates scored both marks in (b)(i) with some failing to score the second mark due to leaving their answer as 2/3 or not rounding and quoting their answer as 0.66. In ‘show that’ questions an answer is expected to one more significant figure than the quoted value. A value of 0.66 has not been rounded correctly to the required minimum number of significant figures and 0.66 reoccurring has not been rounded at all and would not score the 3rd mark.

The response below scores just 2 marks. The final answer has been quoted as 2/3 so cannot score the final answer mark.



(3)

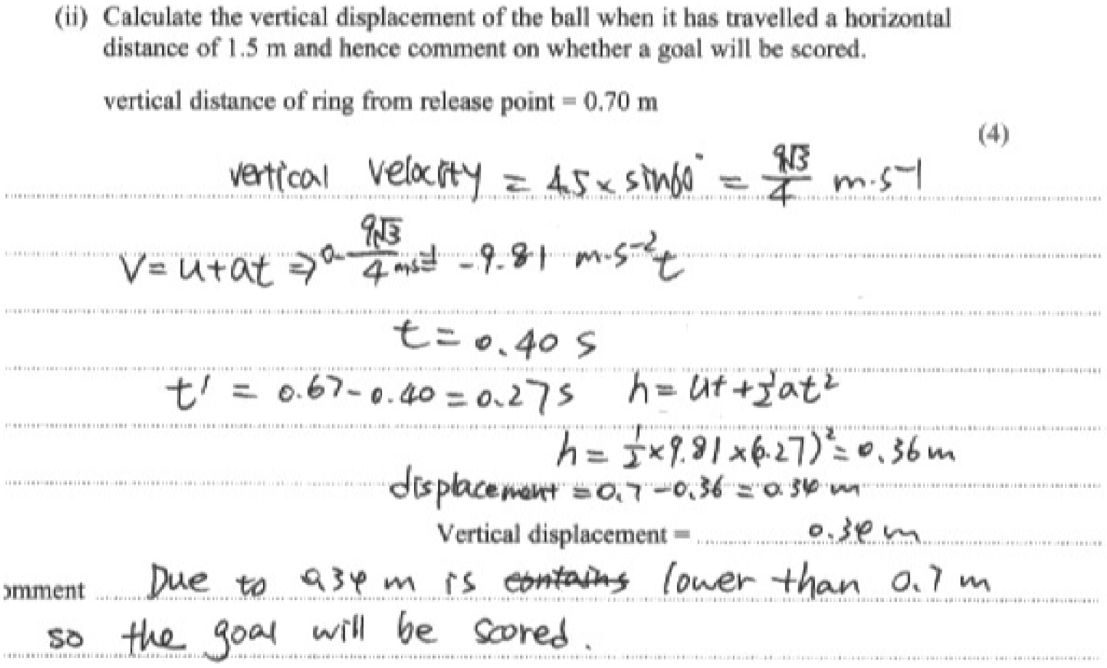
$S_x = ut$ $\quad$ $t = \frac{s}{u} = 1.5 / 4.5 \cos(60)$

$s = 1.5$ m $\quad$ $t = \frac{2}{3}$ sec

$u = 4.5 \cos(60)$ $\quad$ $t \approx 0.7$ s

In part (b)(ii) there was an equal distribution of candidates scoring 1,2,3 or 4 marks. While many candidates could correctly calculate the initial vertical velocity some then went off a very circuitous route, usually incorrectly, to calculate the height. Others substituted in a positive value for ‘*g*’ into the correct equation which excluded them for getting the final answer mark. The fourth mark could be awarded regardless of the candidate’s answer to the height of the ball as long as their response was consistent with their value. Comments however were often limited to a goal would or would not be scored often with no qualification.

The response below scored two marks. The candidate correctly calculated the initial vertical velocity and started off on one of the circuitous routes mentioned above. They calculated the time to reach the maximum height followed by the time from the maximum height to reach the net. (0.27 s) They then calculated the vertical drop from the maximum height in 0.27 s (0.36 m) and subtracted this from the height of the net. They should have calculated the distance to the maximum height and subtracted 0.36 m from his. As this is an alternative method, to award any marks for substitution into an equation, all the relevant equations must be seen and substituted into. Therefore no method marks can be awarded for this indirect route. The candidate did not manage to score the last marking point for commenting on if the goal will be scored. A height of 0.34 m will put the ball under the net rather than in the net at the correct horizontal distance.



(ii) Calculate the vertical displacement of the ball when it has travelled a horizontal distance of 1.5 m and hence comment on whether a goal will be scored.

vertical distance of ring from release point = 0.70 m

(4)

vertical velocity $= 4.5 \times \sin 60^\circ = \frac{9\sqrt{3}}{4}$ m·s⁻¹

$V = u + at \Rightarrow 0 = \frac{9\sqrt{3}}{4} \text{ms}^{-1} - 9.81 \text{ m·s}^{-2} t$

$t = 0.40$ s

$t' = 0.67 - 0.40 = 0.27$ s $h = ut + \frac{1}{2}at^2$

$h = \frac{1}{2} \times 9.81 \times 0.27)^2 = 0.36$ m

displacement $= 0.7 - 0.36 = 0.34$ m

Vertical displacement = 0.34 m

Comment Due to 0.34 m is ~~contains~~ lower than 0.7 m so the goal will be scored.

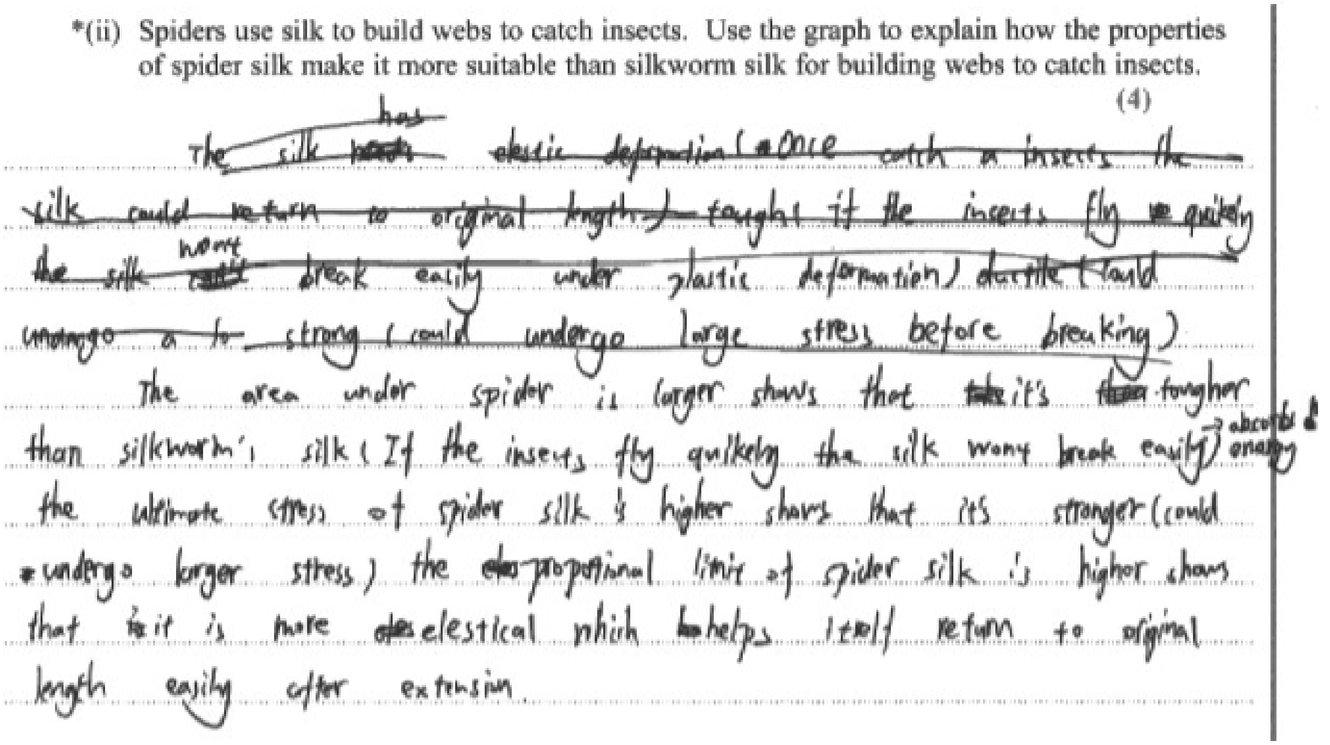
Part (iii) usually scored the mark for increased time with many describing a reduced velocity. As the air resistance is acting continuously on the ball, the velocity is continually decreasing. Most candidates implied that the ball would be travelling at a lower speed all the way, rather than slowing down and did not score the first marking point.

Question 16

(a)(i) The common response was to define strength rather than a high strength. Responses such as ‘the maximum stress before breaking’ were common with just 35 % of candidates scoring the mark. Common misconceptions were relating the tensile strength to the amount of strain or Young modulus.

(a)(ii) Although many answers gained two marks or more, the links between the feature shown on the graph and the explanation was regularly incorrect. The most common example was a higher Young modulus linked to stronger. As can be seen from the mark scheme, the first mark in each pair of marks was awarded for identifying a property from the graph and making a comparison between the two types of silk. The second mark was for applying this to the context and stating the advantage such as stronger, stiffer etc. The large plastic region was often referred to but references to elastic limit were rarely seen.
Many answers also failed to make comparisons between the two types of silk as asked for in the stem of the question. Just to mention here that question 17(b)(i) also required a comparison between the two glides and again candidates lost out on marks because they were not specifically answering the question and comparing the two quantities.

The response below scored all four marks:
Ultimate stress is higher linked to stronger (line 3) [marking points 3 and 4]
Area under graph is larger linked to tougher (line 1) [marking points 5 and 6]

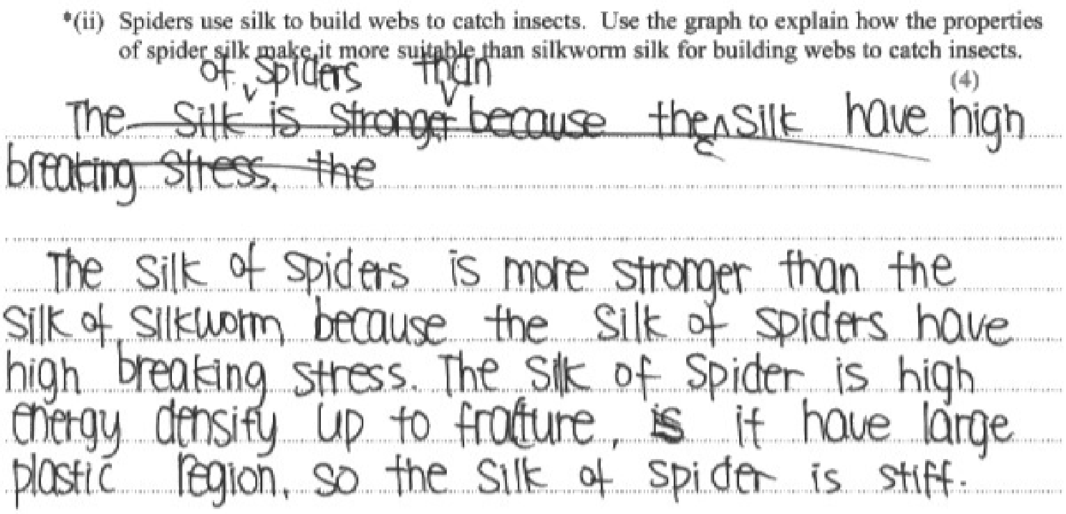


*(ii) Spiders use silk to build webs to catch insects. Use the graph to explain how the properties of spider silk make it more suitable than silkworm silk for building webs to catch insects.
(4)

~~The silk has elastic deformation (once catch a insects the silk could return to original length) taught if the insects fly quikely the silk won't break easily under plastic deformation) ductile (could undergo a to strong (could undergo large stress before breaking)~~

The area under spider is larger shows that ~~tak~~ it's ~~than~~ tougher than silkworm's silk (If the insects fly quikely the silk won't break easily) → absorb energy
the ultimate stress of spider silk is higher shows that its stronger (could undergo larger stress) the ~~ela~~ proportional limit of spider silk is higher shows that ~~to~~ it is more ~~ela~~ elestical which ~~he~~ helps itself return to original length easily after extension.

While the response below scored just 1 mark for stronger (line 1). The candidate missed out on marking points 3 and 8 as 'high breaking stress' and 'stiff' is not making a comparison between the two types of silk.



*(ii) Spiders use silk to build webs to catch insects. Use the graph to explain how the properties of spider silk make it more suitable than silkworm silk for building webs to catch insects.

(4)

of spiders than

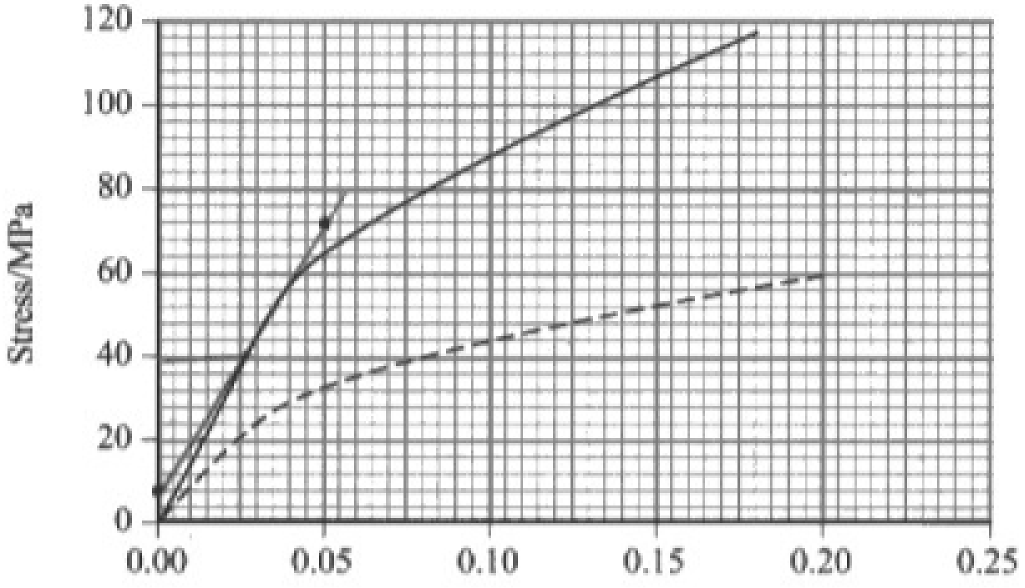
The ~~Silk is Stronger because the Silk have high breaking Stress. the~~

The Silk of Spiders is more stronger than the Silk of Silkworm because the Silk of spiders have high breaking stress. The Silk of Spider is high energy densify up to fracture, ~~is~~ it have large plastic Region, so the Silk of Spider is stiff.

(b)(i) While the vast majority of candidates identified that they were required to find the gradient of the given graph in order to determine a value of the Young modulus of the Spider silk, not as many were able to read accurately from the linear region and correctly apply the scale. The most common mistake was to completely omit the power of 10^6 for the stress with some candidates assuming that the prefix 'M' was 10^3.

(b)(ii) This question was not answered well with just under a quarter of all candidates scoring full marks. Candidates that approached this question in stages rather than in one combined equation were more successful as not all candidates could successfully rearrange a substitution into $E = \frac{F/A}{0.03}$ to obtain a value for A. Therefore candidates that calculated a stress from the Young modulus calculated in part (i) and used the strain of 0.03 could then obtain a value for the stress and consequently a value for the cross sectional area. Some candidates did not seem to know what the significance of the strain of 3% and substituted a value of 1.03 into their equations. Again, as in part (b)(i), although less common, power of 10 errors were seen in particularly 10^{-6} where the prefix μ was missed.

The response below scored (i) 0 and (ii) 2. In part (i) the candidate drew a tangent on the graph at the top of the liner region and calculated its gradient; this is not the correct method for determining the Young modulus so no credit could be given at all. In part (ii) the candidate scored marking points 1 and 3 but not marking point 2 as the strain was substituted as 103/100. There would have been an ecf from part (i) for the incorrect Yong modulus and, in this case the candidate did successfully re-arrange the equation to obtain a value of r corresponding to their incorrect strain. Unfortunately this was not the correct answer so no final answer mark could be awarded.



(b) (i) Use the graph to determine the Young modulus of spider silk for small stresses. (2)

$(0{\cdot}00, 8\times10^{6})$ $(0{\cdot}05, 72\times10^{6})$

$$\frac{72\times10^{6} - 8\times10^{6}}{0{\cdot}05 - 0{\cdot}00} = 1{\cdot}28\times10^{9}\,\text{Pa}$$

Young modulus = $1{\cdot}28\times10^{9}$ Pa

(ii) An insect flies into a spider's web and becomes attached to a single thread. This creates a tension in the thread of 580 μN. The thread extends by approximately 3% of the original length.

Calculate the radius of a single thread of spider silk. (4)

$$Y = \frac{\sigma}{\varepsilon}$$

$$1{\cdot}28\times10^{9} = \frac{\frac{580\times10^{-6}}{\pi r^{2}}}{\frac{103}{100}}$$

$$1\,318\,400\,000 \times \pi r^{2} = 580\times10^{-6}$$

$$r = \sqrt{\frac{580\times10^{-6}}{1\,318\,400\,000\,\pi}}$$

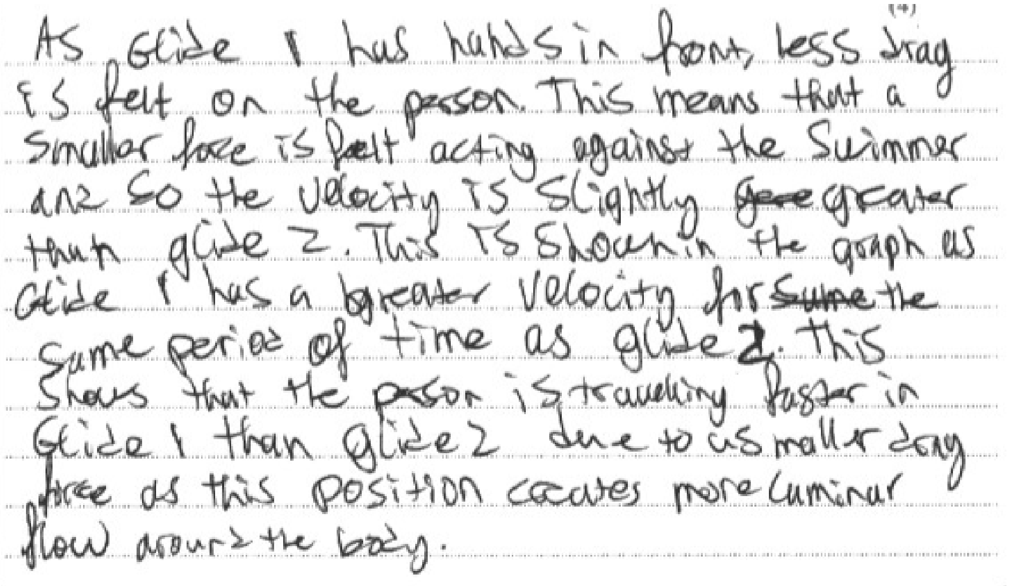
$$= 3{\cdot}74\times10^{-7}\,\text{m}$$

Radius = $3{\cdot}74\times10^{-7}$ m

Question 17

(a) Part (i) was answered very well with just a few candidates preventing themselves from scoring the last mark by not quoting the answer to the correct minimum number of significant figures. Not all candidates knew how to convert the stroke rate to a time in part (ii). While the vast majority of candidates used power = work done/time, various combinations of 55 and 60 were substituted in for the time. The most common mistake was the substitution of 55/60 rather than 60/5 for the time which scored 0 for this item.

(b)(i) The majority of candidates scored at least 1 mark. The most common mark awarded was for the identification from the graph that the swimmers are decelerating. Following on from that some candidates managed to make a successful observation in that the drag acting on glide 2 was greater than the drag for glide 1. Few candidates (about 10%) could successfully explain why there was more drag and less than the top 1 % of candidates commented on and justified the decreasing gradient of the graph. Most candidates tended to select one attribute from the graph and go into detail describing it and occasionally offering an explanation. The most common observation discussed was that the velocity of glide 2 was less than the velocity of glide 1. A very common reference seen was to the surface area and not the cross sectional area when attempting to explain the difference in drag force.
The response below scored 2 marks. Marking point 3 was awarded for identifying that glide 1 has less drag and marking point 4 (line 10) for more laminar flow. As mentioned above, as a typical response, nearly all of the remainder of the explanation discussed the two velocities.



(+)
As Glide 1 has hands in front, less drag
is felt on the person. This means that a
smaller force is felt acting against the swimmer
and so the velocity is slightly ~~gree~~ greater
than glide 2. This is shown in the graph as
Glide 1 has a greater velocity for ~~same~~ the
same period of time as glide 2. This
shows that the person is travelling faster in
Glide 1 than glide 2 due to a smaller drag
force as this position creates more laminar
flow around the body.

(b)(ii) Candidates are getting better at setting out their answers to this type of question. Correct substitutions were common leading to both marks being scored by approximately half of candidates. The most common error was to not clearly state the unit of newtons as kg m s^{-2} which was required to demonstrate the equivalence of the two sides of the equation when substitution. Another common error was to forget that the term for velocity is squared.

(b)(iii) This question produced quite varied responses with just over a third of candidates scoring at least one mark. Some candidates chose factors beyond the control of the swimmer such as temperature, mass, density, viscosity etc. which had a correct Physics basis but were not relevant to the question.

Wearing a swimming hat or tight fitting clothes were probably the two most common correct responses seen although the subsequent explanation was not always precise enough to score the second mark. Usually a second mark was not awarded when attempted due to the mention of the surface area rather than the cross sectional area. Just stating that the method reduced drag was repeating information given in the stem of the question and a reference to ‘viscous’ with drag was also required.

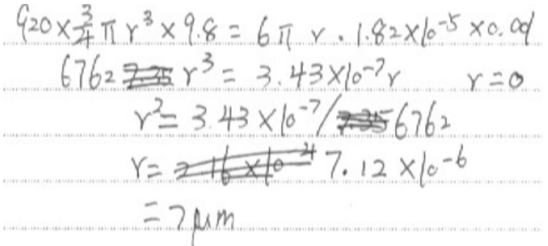
Question 18

(a)(i) Candidates are much better with free-body diagrams and explaining terminal velocity with particles moving down rather than upwards, as was demonstrated in this question. The vast majority of candidates scored at least one mark for part (i), usually for the correct direction and labelling of the weight of the oil drop with some candidates forgetting to draw in the drag force. It was very clear that not all diagrams were drawn with a ruler and the vertical lines, especially for drag were not very precise. Labels in general were usually correct and very few candidates attempted to draw in any additional incorrect forces. Occasionally candidates missed out on the mark because their forces did not start on the dot; close to or next to the dot will not score the mark.

(a)(ii) Most candidates scored the second mark for identifying that the resultant force would be zero. Responses often mentioned that the drag was increasing but failed to link this with an increase in velocity. The upthrust or both the drag and upthrust increasing was seen quite often. Just to mention here that candidates that stated that the ‘upthrust and drag equal weight’ did not score the second mark as this implies that upthrust equals the weight and drag equals the weight. Candidates should make it clear that it is the sum of the upward forces equal to the weight. An equation in words is sufficient.

(b)(i) This was a simple question that should have scored both marks by candidates that are E grade or above. Surprisingly, less than one third of E grade candidates scored two marks here. Significant figures were a problem with many candidates forgetting to convert from mm into m. A few candidates tried to apply equations of motion involving g or inverted the formula for calculating the velocity from distance and time. Use of significant figures also prevented some candidates from scoring the second mark due to rounding the final answer of 0.00086 to 0.0009, one more significant figure than the ‘show that’ value of 0.001 was required.

(b)(ii) This question discriminated well and really only middle ability candidates or better managed to score at all. Many candidates used the Stokes’ equation however it was not always equated on the left hand side to a force and often candidates just equated it to 920 or 920g. This prevented the candidates from scoring the first two marking points as no ‘use of’ mark for Stokes’ law could be awarded if it is not equated to a force or what the candidates clearly believe to be a force.
Some candidates attempted to use the combined formula for terminal velocity. While some candidates were able to make suitable substitutions and correctly re-arrange the equation for *r*, most could not, often omitting a term or substituting in an inappropriate value for the density of air. Schools should be aware of using large memorised formulae, as here for terminal velocity. It does not show any knowledge of the physics involved, which is important if the final answer is wrong and we need to award method marks.



$920 \times \frac{3}{4} \pi r^3 \times 9.8 = 6\pi r \cdot 1.82 \times 10^{-5} \times 0.001$

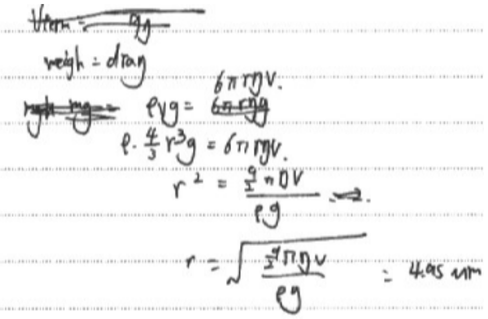
6762 ~~7.35~~ $r^3 = 3.43 \times 10^{-7} r \quad r = 0$

$r^2 = 3.43 \times 10^{-7} /$ ~~7.35~~ 6762

$r =$ ~~2.16 × 10⁻⁴~~ 7.12×10^{-6}

$= 7 \mu m$

2 marks:
MP1 for use of *ρ* = *m/V* and *W* = *mg*
MP2 for use of Drag force = 6πrηv
The volume formula is incorrect so no further marks.



~~Vterm = ρg~~

weigh = drag

~~weight mg =~~ $\rho V g =$ ~~6πrηg~~ $6\pi r\eta v.$

$\rho \cdot \frac{4}{3} r^3 g = 6\pi r\eta v.$

$r^2 = \frac{\frac{9}{2}\eta v}{\rho g}$

$r = \sqrt{\frac{\frac{9}{2}\pi\eta v}{\rho g}} = 4.95$ um

1 mark:
MP1 for seeing *ρVg*
No substitution into Stokes' equation so no further marks.

(b)(iii) Most candidates could identify that the drop was too small to measure and many candidates made a good attempt at describing the practical difficulty of taking a direct measurement. The most frequent response seen was a description of the idea that the drop will change shape if measured. Very few candidates discussed the precision of the measuring equipment being too low for the size of the drop.

(c) A significant number of answers referred to the viscosity of the oil drop and change to the flow rate of the oil rather than the air. Although the direction of the change in viscosity with temperature was not taken into account in this question, many answers stated the change incorrectly. Marking point 2, requiring a link between the temperature or viscosity with the velocity or drag, was awarded less often usually through omission rather than an incorrect statement.

(d) This item was left blank by many candidates and really only the candidates at the top end of the ability range managed to score here, with only 25 % of A grade candidates scoring one mark. Many responses did not score because they made comparisons between the physical nature of the ball bearing and the oil drop e.g. solid-liquid, high density –low density. Other responses referred to the problem of triggering the light gates with something as small as an oil drop. For those with the correct approach, MP2 was mainly awarded for identifying that the terminal velocity would not be reached.
Very few candidates knew that Stokes' Law was the real answer to the question as perhaps candidates do not understand the idea of modelling in Physics, although they have most probably come across it indirectly as part of their studies.

Summary

This paper provided candidates with a wide range of contexts from which their knowledge and understanding of the physics contained within this unit could be tested.

A greater understanding of the context and question being asked would have helped many candidates. A sound knowledge of the subject was evident for many but the responses seen did not reflect this as the specific question was not always answered as intended.

Based on their performance on this paper, some candidates could benefit from more teaching time and extra practice on the following concepts and skills:

- Slow down during the multiple choice items so that key words in the command sentence responses are not missed.
- Remember to check responses if there is time at the end of the paper in case careless mistakes have been made, especially powers of 10 from missing prefixes of units.
- Set out all of your working in calculations for both show that questions and longer, multiple step calculations.
- If a series of events has to be described do not spend all of your time describing one aspect e.g. the resultant force is zero; remember to discuss the series of events leading up to that point as well such as the velocity increases hence the drag increases etc.
- If a graph contains more than one line, remember that your discussion of the graph will need to be a comparison and every statement describing or explaining an aspect of the graph needs to be a comparison and make reference to both of the lines on the graph.

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