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Examiners' Report
Principal Examiner Feedback

January 2018

Pearson Edexcel International Advanced Subsidiary Level

Physics (WPH01)

Unit 1: Physics on the Go

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General Introduction

This paper enabled learners of all abilities to apply their knowledge to a variety of styles of examination questions. The questions on this paper were both context and theory based, with most learners appreciating the context and applying their knowledge to the question being asked, even if the context had not been studied directly. However, the preciseness of the wording of many responses seen, even if the context and Physics was understood often let learners down with incomplete steps in explanations and ambiguous references to quantities. Where a question refers to more than one force then any explanation should be specific as to which force is being described. Just using the term F or force is too ambiguous to score the mark.

In this paper, the responses of the learners were generally clearly laid out, so that credit could be given for methods used in calculations and reasoning in written answers even when the final answer or conclusion was not correct. Very rarely did a learner quote an answer without a unit, which in a physics paper would be incomplete. Unusually, an occasional response to a calculation was given to one significant figure, which would not be enough for the examiner to know that the calculation had been done correctly, nor is it good practice unless there are particular reasons for there being a large uncertainty in the answer. A few of the questions in this paper were complex and required the candidate to apply the Physics studied in a context that would not have been specifically included in a physics course, and it is important that learners are able to think through such problems. It requires them to read the questions carefully and ensure that they answer the question set. For instance, in 15b, many learners explained that the capsule continued to accelerate but at a reduced rate, whereas the question says it reduces speed.

One area highlighted by the responses seen is the use of components of forces. This was particularly evident in question 12 and 17 where components were sometimes incorrectly determined or used, and a greater consideration of the direction should have been considered when answering a specific question.

The shorter calculations were successfully answered by many, however, the selection of the correct data into the equations for questions involving multiple steps was not always successful. Similarly, the precise translation of information from the velocity-time graph to the acceleration-time graph was not always evident. While most learners could carry out the straight forward calculation to determine each acceleration, few manage to represent the motion accurately on the new graph, even if the regions were correctly represented.

Section A – Multiple Choice

Many of the multiple choice items were answered very well and, as anticipated. The mean score for questions 1 to 10 across all learners was 5. Strong A grade learners typically scored at least 7. While learners that attained between an A and an E grade scored an average of 6 marks with a great variation in the marks scored with most scoring between 4 to 6 marks in this section of the paper.

	Subject	**Percentage of all learners who answered correctly**	**Common incorrect response**	**Comment**
1	Units	66	A	This was answered well but as a first question answered by some in haste by selecting A, the equivalent unit for the Newton.
2	Properties of materials	74	A	While steel does exhibit both malleable (C) and ductile (A) properties, the rollers are applying a compressive force so only the malleability of steel is being demonstrated in this application.
3	Vectors and scalars	85	A	This was answered well by all learners, however, those that incorrectly selected response A missed the '**not**' in the stem of the question and went for the first correct row of the table.
4	Projectiles	36	A	learners were required to use the equation $v = u + at$ with the initial horizontal component of velocity $u\sin\theta$. As was frequently seen throughout the paper many learners were unable to correctly resolve for a given force or velocity hence the most common incorrect response used $\cos\theta$ and not $\sin\theta$.
5	Laminar flow	52	D	Laminar flow can be considered to consist of adjacent layers of fluid with no mixing between the layers, with each layer at a different velocity. Therefore, the velocity of the fluid at a point should be considered when describing laminar flow.
6	Stress	53	A	A straightforward question requiring the use of $\sigma = F/A$. The most common incorrect response was due to learners using the diameter in place of the radius in the equation πr^2 for the area.
7	ΣF = ma	61	A	The resultant force $T - F$ acts in the same direction as the acceleration as the box is accelerating at a from rest. So, $T - F = ma$. The most common incorrect response re-arranged gives $T - F = -ma$ which would result in an acceleration opposite to the direction of motion and hence a deceleration.

8	Young modulus, stress and strain	67	–	There was no distinct incorrect response but learners should have known that strain is independent of the original length, so a longer wire will have the same percentage increase in length as a shorter wire and hence a greater extension. The cross-sectional area of a wire is inversely proportional to the extension i.e. a thinner wire produces a greater extension.
	Percentage uncertainty	15	A	0.01 mm, to 2 sf , is 2.9 % of 0.35 mm. However, the percentage uncertainty can only be quoted to the same number of sf as the absolute uncertainty of 0.01 mm i.e. 1 sf.
	Gravitationa potential energy	9	D	The most common incorrect response of D compared to the correct response of B indicated that most learners correctly identified that at 0 vertical displacement, i.e. the release position, E_{grav} would be a maximum. What most learners did not realise is that this was a displacement a-time and not a distance-time graph. Therefore, once the mass had reached its minimum position at the bottom of the swing, the displacement would decrease as the mass began to rise, increasing E_{grav}.

Section B

Question 11:

(a) The subtle difference between describing a general property such as hardness and a property of a specific material i.e. hard was missed by some learners. Most knew that it was a property that resulted in the scratching or indenting of a surface. However, learners that described a hard property such as ‘resistant to scratching’ were unable to score the mark and should have implied a scale such as a measure of the ability to be scratched or the resistance to scratching.

(b)(i) This was answered well by most learners identifying that when one material can scratch another, it must be of equivalent or greater hardness. A few responses just stated that the pencil was hard rather than comparing it to the hardness of the paint as the question implied.

(b)(ii) This was not answered as well as expected, with a significant proportion of learners not picking up any marks. This may have been an unfamiliar context to most learners but general common sense about fair testing and controlled variables between individual trials of this method would have been sufficient. Therefore, responses which were not relevant would not be credited. This included reference to the pencil breaking, the paint not being dry, the paint wearing out between tests or the wheels damaging the paint. Good responses describing the discrete nature of the test were seen and demonstrated a good appreciation of the limits of this method.

Question 12:

(a) This question is more complicated than it seems at first sight. The treadmill should be ignored and only the extra power to run up a hill at a slope of 3°. It was common to see the angle incorrectly identified and cos 3, i.e. the horizontal component of the displacement, velocity or force used in place of the vertical. Many calculated the kinetic energy of the athlete, which would have only been correct during the initial acceleration as the speed in the question was constant. It was the increase in GPE that would have required the additional power.

A number of learners who had the final answer incorrect could not score method marks which they might have otherwise gained because the working out was unclear and the interim steps could not be credited. It was often not clear what a calculated quantity represented as few equated the quantity to be determined to the calculation. This was not helped by the continuous equating with additional terms brought into working rather than set out in clear steps each stage of the calculation.

(b) Remarkably few noted that there was no air resistance on the treadmill. Writing that friction was lower would not do as this was not specific enough and many could have been referring to the surface of the track rather than the air resistance. Many referred to corners on the track or a smoother surface.

Question 13:

(a) A reasonable number of learners appreciated that the rate would be equal to the volume divided by the time. A few missed out on this mark by using undefined terms, particularly *V* for volume. Many however, omitted to include a unit conversion, some even just stating that the volume should be converted to m^3 without an explanation as to how. A surprising number that remembered to describe the unit conversion were unable to do so successfully and a conversion of cm^3 to m^3 is a skill that learners should have secured well in advance of commencing this course.

(b)(i) This response required a preciseness of language and detail that many learners omitted to include. Examiners were looking for a statement of the graph to be plotted, a calculation of a gradient and a method of either converting the mass to a volume or of converting the gradient to the rate of flow. While most learners identified a correct graph with many providing a suitable explanation of the conversion, few were precise enough to state how the graph would be used. This was a method-based question and just referring to the gradient being equal to the rate etc was not telling the examiner that the gradient had to be calculated.

(b)(ii) A simple statement of greater accuracy or reliability was easily obtained by many learners for an advantage of the graphical method. Some referred to anomalous points and it was the identification rather than the removal of anomalous points that was required. A graphical method allows anomalous points to be easily identified, hence it being an advantage. Therefore, the language here by learners let some down. Not many learners gave a sensible disadvantage where a relevant reference to the extremely short times between readings would have sufficed.

(c) This question has been asked in previous exam series and required the recall of a decreased viscosity and increased rate of flow at a greater temperature. The majority of learners managed to score both marks for this question. A few described an increasing viscosity but managed to achieve the mark for the increased rate of flow.

Question 14:

(a) This question tested learners on their calculating, drawing and plotting skills in addition to their understanding of velocity-time graphs. Acceleration time-graphs are less familiar to most learners than displacement-time and velocity-time graphs however, this question saw the full range of marks awarded with middle ability or higher learners often managing to incorporate all the aspects required to score full marks. Weaker learners were let down by poor scaling or mis-plotting and some did not represent the regions of constant, non-zero acceleration with horizontal lines. Nearly all learners scored the mark for the use of the formula for calculating the acceleration values (MP5).

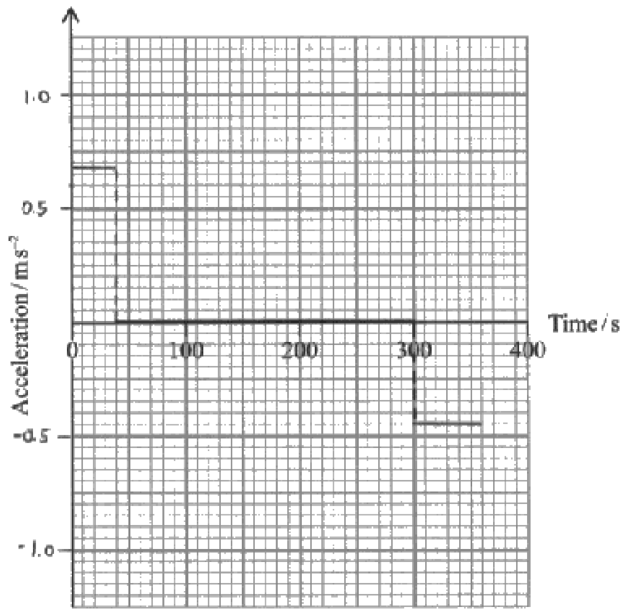
The response below scored all 6 marks. Two numbers above and below 0 were required as a minimum for the scaling mark (MP1). The scale had to be a sensible scale i.e. one from which it would be easy to read additional values. Therefore, scales going in 3 and 7 for each square were not permitted. Although it fitted the two points to be plotted, a scale going up in 22.5 for each cm square was not permitted. The scale also had to cover at least half of the graph paper, in that the acceleration of 0.675 had to be on the top half of the vertical axis.

(6)

a for 0 - 40s : a for 300s - 360s :

a = $\frac{27}{40}$ a = $-\frac{27}{60}$

= 0.675 ms^{-2} = 0.45 ms^{-2}



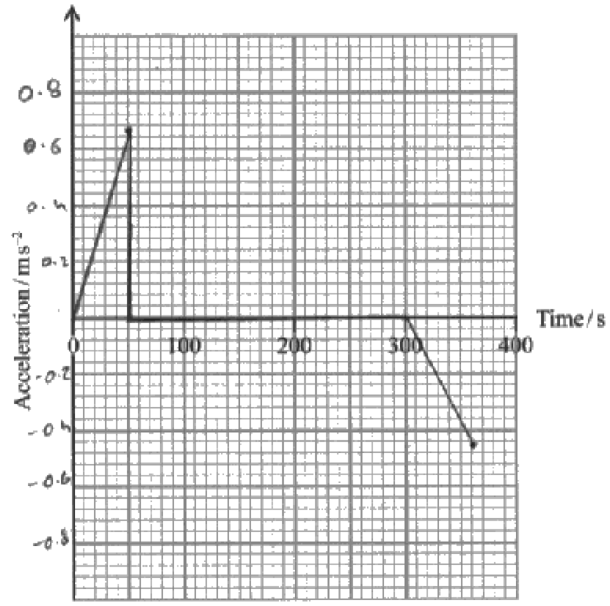
The response below scored 2 marks; MP1 for the scaling and MP5 for use of $a = (v-u)/t$. For MP6, the plotting mark, the candidate had to plot the acceleration at 40 s and 360 s. In this example, the candidate did not have a correct acceleration at 40 s so was unable to score MP6.

Draw a corresponding acceleration-time graph for the motion of the train. Show all working in the space below.

(6)

acceleration in first 40 secs = $\frac{27-0}{40}$ = 0.675 ms^{-2}

decelleration in last 60 secs = $\frac{0-27}{60}$ = −0.45 ms^{-2}



(b)(i) In many, if not most responses seen, the question was answered as though he figure was the path when being viewed from the side rather than above. Therefore, many responses included references to vertical velocities, along with the independence of horizontal and vertical velocities, as would be correct for a projectile. Not many concluded that the path seen was the resultant of two velocities. Most stopped at the description of what learners considered to be the two velocities of the ball.

'The train is moving at a constant speed horizontally' was seen quite frequently but, although true, was not describing the velocity with which the ball was thrown and the constant horizontal velocity that the ball had before it was thrown due to the motion of the train.

(b)(ii) This was answered much better than 14(b)(i), probably because trajectories of projectiles has been examined in the past and is a more familiar context to many. Many learners identified that there would be a vertical force or acceleration vertically although fewer commented a constant horizontal velocity, leaving that for the examiner to infer.

(b)(iii) Many learners did not understand what was expected of them to achieve both marks. The path, if air resistance is to be considered, was expected to start at the same point as the given trajectories and then the candidate was required to show the difference that consideration this additional force would have on the trajectories. learners were more successful in their paths for Figure 3 than Figure 2.

This suggests that perhaps some though that the train continued to have an influence on the ball after it had been thrown rather than just thinking that the only force acting on the ball (in a horizontal plane) is air resistance.

Question 15:

(a)(i) This was generally answered well with the vast majority of learners scoring at least one mark here. A unit conversion was required, although often omitted by less able learners and some substituted into the equation $v^2 = u^2 + 2as$ but forgot to square the final velocity.

Some learners attempted to use $v = s/t$ to determine the time and then use the time to determine the acceleration. However, this method required use of the average velocity, which was rarely seen, with most using the final velocity of 11 000m s^{-1}.

(a)(ii) This question was poorly answered by most learners with only the best learners calculating a correct mass of fuel of 60 500 kg. Many were confused with the unit of the energy supplied by the fuel of J $kg^{-1}$and ignored the mass. Therefore, it was very common to see this energy equated to a kinetic energy with an unknown mass rather than the mass of the capsule. Many understood the significance of the 50 %, allowing them to score typically just 1 mark for this question. This was not a difficult question and more time spent considering the significance of the unit J kg^{-1}, before commencing the calculation, would have given many a better idea about what was required.

The following response scored 0 and was typical of many seen. The energy supplied to the capsule (per kg) has been doubled and not halved and this has been equated to a kinetic energy of an object with an unknown mass, rather than the kinetic energy of the capsule.

(ii) It can be assumed that only 50% of the energy supplied by the gunpowder in the cannon would have been transferred to the capsule.

Determine the mass of gunpowder that would have been required to obtain a maximum speed of 11 km s^{-1}.

(4)

mass of capsule = 1500 kg
energy released from gunpowder = 3 MJ kg^{-1}

F = ma

E = ½ mv²

~~E = ½ × 1500~~

E = ½ mv²

3000000 = ½ m 11000²

~~m = 4.9587 × 10⁻²~~

6000 000 = ½ m 11000²

m = 0.099

Mass of gunpowder = 0.099 kg

(b) The capsule is actually accelerating towards the moon; the ejection of gasses would provide a force to the capsule. The question described a reduced speed of the capsule so, the acceleration and hence the resultant force, must have been negative. Only if the direction of the resultant force is against the direction of travel will the acceleration become negative i.e. a deceleration. A reduced resultant force, which many learners described, would only reduce the acceleration which is not he case for the capsule.

The average score for this question across all learners was 1, with many learners that attained an E or higher on the paper scoring 2 or 3. Only the best learners managed to meet the criteria for all 5 marking points. learners said the gases caused a force on the Moon's surface or a force on the Moon's atmosphere. However, such responses often picked up the later marking points concerning the resultant force and acceleration of the capsule, even if they had not correctly described the use of Newton's third law.

A specific comment regarding the direction of the force and acceleration i.e. deceleration was commonly absent from otherwise high scoring answers. Finally, as is frequently seen with this style of question, a fair proportion of learners quoted Newton's laws without applying them to the context, often resulting in a very low score for this question.

The response below scored 5 marks, marking points 4 and 5 overlapped in that the candidate has referred directly to a deceleration and linked this to N2 and states that the resultant force is opposite to the direction of motion.

should include reference to Newton's laws of motion.

(5)

Gases could be ejected from the upper front end of the capsule ~~for~~ towards the moon. A force would be applied to push the gas out. According to Newton's 3rd law, an equal and opposite force would be applied by the gases onto the capsule. This would cause an unbalanced force ~~of~~ against the capsule's direction of motion, and according to Newton's 1st law, the external force would cause the constant speed to decelerate and become reduced. Also, according to Newton's 2nd law, a resultant force that now exists would cause acceleration in the direction of the force, which would reduce 'its speed.

(Total for Question 15 = 12 marks)

Question 16:

(a) This was answered well by the vast majority of learners, most only dropping a mark because the final answer was not quoted correctly to at least one more significant figure than the show that value. The calculated answer produced a recurring number, 0.048 recurring. Therefore, an answer that rounded to 0.049 m was required. A truncated answer of 0.048 m did not score MP2 however, 0.0489 m and 0.0488, which, to 2 sf, do round to 0.049 m, were acceptable.

(b)(i) This is a basic question on Archimedes principle and most learners referred to the upthrust acting on the mass in the water. However, not all managed to relay the fact that the upthrust had increased or should now be considered. Many explanations stopped there without answering the question as to why the position of the mass was higher. Therefore, interim steps stating the forces acting i.e. weight = tension + upthrust as well as a statement describing both a smaller tension and hence extension were required.

(b)(ii) Approximately one quarter of all learners scored full marks for this question. Most other learners did pick up working marks although a bit more explanation in their working would make it easier to award marks when the definitive answer is incorrect. Most were able to calculate the upthrust of 0.33 N although many were then confused as to what to do next with the upthrust. learners were expected to not only calculate the reduction in upwards force but use this with the tension for the next mark. So, while 0.88 – 0.33 was seen frequently, correct working for many stopped at this point. A few realised that the upthrust was equal the reduction in tension and used this in the Hooke's law equation to determine the reduction in extension i.e. y, directly. Although many using this method, did not appreciate what they had calculated and carried out further calculations. It had to be clear for this direct method that the learner knew what they were doing to score all 4 marks.

The following response scored 2 marks. MP1 for the upthrust and MP3 for the subtraction of what the candidate believed to be the new extension, from the original extension of 0.05 m. The candidate had calculated the correct change in extension of 0.019 m in the penultimate line but did not realise this and went on to carry out a further calculation, so no credit could be given to this more direct method.

(ii) Determine y. You may assume that the extension of the spring when the mass was in air was 0.050 m.

(4)

density of water = $1.0 \times 10^3\,kg\,m^{-3}$
spring constant of spring = $18\,N\,m^{-1}$
volume of mass = $3.4 \times 10^{-5}\,m^3$
weight of mass on spring = 0.88 N

$upthrust = \rho g V$

$= 1.0 \times 10^3\,kg\,m^{-3} \cdot 9.81\,N/kg \cdot 3.4 \times 10^{-5}\,m^3$

$= 0.33354\,N$

$\Delta x = \frac{upthrust}{k} = \frac{0.33354\,N}{18\,N/m} = 0.01853\,m \approx 0.019\,m$

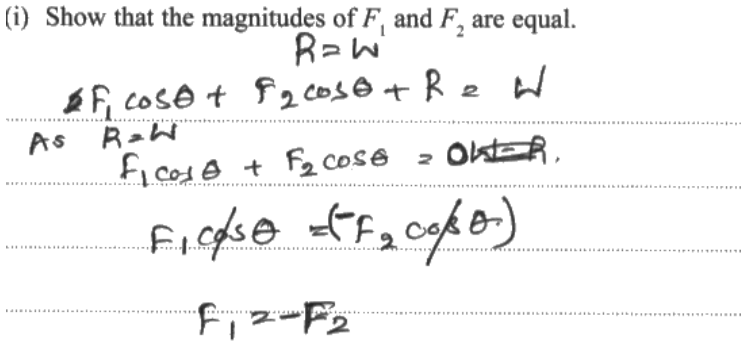
$y = 0.050\,m - 0.019\,m = 0.031\,m$

(c) A considerable number of learners considered that oil has a greater density than water and therefore the upthrust would be greater. Another group were clearly considering that the mass had not reached its equilibrium position and the viscous drag was to be a factor to be considered. Only the best learners mentioned the tension even if they had correctly described a decrease in upthrust.

Question 17:

(a)(i) This question showed that many learners cannot identify the correct components given a statement of the relation of the angle to the original vector and the horizontal or vertical. learners were required to show that the forces F_1 and F_2, of the crutch on the body were equal. Many learners attempted to answer this in terms of the vertical forces but subsequently found they were unable to cancel any of their equation as the resultant force in the vertical direction also involved the weight and reaction force ($R + F_1\cos\theta + F_2\cos\theta - W = 0$). Others incorrectly resolved for the horizontal, using cosine instead of sine.

This response is a typical response that scored 0. The candidate has resolved correctly, but in a vertical direct. They have cancelled out *W* and *R*, stating that they are equal. The question clearly states that the half the weight is supported by the reaction force and not all the weight, so this method is incorrect.


(i) Show that the magnitudes of F_1 and F_2 are equal.

$R = W$

$F_1\cos\theta + F_2\cos\theta + R = W$

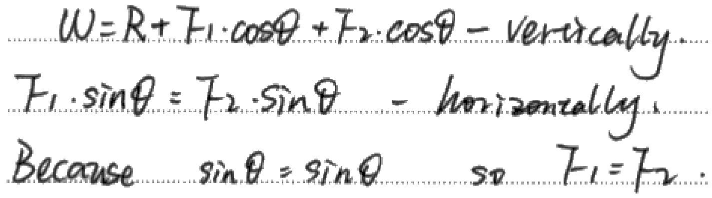
As $R = W$

$F_1\cos\theta + F_2\cos\theta = 0$

$F_1\cos\theta = (-F_2\cos\theta)$

$F_1 = -F_2$

This response scored both marks.


$W = R + F_1\cdot\cos\theta + F_2\cdot\cos\theta$ – vertically.

$F_1\cdot\sin\theta = F_2\cdot\sin\theta$ – horizontally.

Because $\sin\theta = \sin\theta$ so $F_1 = F_2$.

(a)(ii) As with 17(a)(i), once a candidate realised the direction in which they were meant to resolve this question was straightforward. The correct component was commonly seen although the application of the vertical force equilibrium was often incorrect. So, many learners scored 1 mark for $F\cos 10$ but not all were successful in forming an equation for the resultant force involving the unknown force F_1, W and R.

(b) Providing 5 marking points allowed most learners to score at least 1 or 2 marks while not always understanding what was happening. Since this question involved the friction, resolving horizontally should have been the first discussion point. The first mark was rarely awarded as, although many learners stated $F\sin\theta$, few explained what force F represented and appreciated that this was equal to the frictional force. The increase in angle was commonly mentioned but was often not linked to an increase in $\sin\theta$. The horizontal component increasing (MP3) was the most frequently awarded mark and many learners went on to state that this would be greater than the frictional force (MP5). Frequently learners omitted to say that the frictional force would have increased as a result of the horizontal component of the force increasing and the idea that this increased up to a maximum value was not very well known.

(c)(i) An appropriate statement about strain was very common however, fracture was often used rather than breaking when describing the 'fracture of 17 %' section of the statement, preventing many from scoring the second mark.

(c)(ii) With a bit or care the first three marks should have been straightforward as it was clear that the majority of learners could sketch a curve for increasing stress on the alloy. Omissions or inaccuracy in labelling of the curve, probably due to this being the last question on the paper and time being a factor, prevented many for gaining credit for the curve. The most common omission was the 17% strain however, the position of the yield point was usually at the end of the linear region, as described in the question. The subsequent behaviour beyond this point was not typically 'sudden' which would have demonstrated the large increase in strain for little or no increase in stress. Therefore, MP4 was not awarded as often as MP1 and the other marking points.

Summary

This paper provided learners 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 learners. 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 learners could benefit from more teaching time and extra practice on the following concepts and skills:

- Slow down during multiple choice items, take particular note of terms in bold.
- Where you have more than quantity referred to in the stem of a question make sure you are clear in your answer as to which quantity you are referring to. Just stating the force increases is not telling us which force increases, particularly if it is a component of the for that is increasing.
- Practice resolving forces. You must make sure that you use cosine and sine correctly.
- Slow down on longer calculations so that you make sure you are choosing the correct quantity to use in an equation when given more than one value.
- 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 errors due to missed unit pre-fixes.

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