# Examiners' Report/
# Principal Examiner Feedback

## Summer 2013

## GCE Mechanics M1 (6677)
## Paper 01

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**Mechanics M1 (6677)**

**Introduction**

The vast majority of candidates seemed to find the paper to be of a suitable length, with no evidence of candidates running out of time. Candidates found some aspects of the paper challenging, in particular question 2(b) (forces on a person in a lift), question 6(a) (moments in a particular context), question 7(c) (parallel vectors) and question 8(c) (resultant force on a pulley). However, there were some parts of all questions which were accessible to the majority. The questions on collisions, equilibrium on an inclined plane and use of constant acceleration formulae were generally well understood and full marks for these questions were commonly seen. Although most candidates understood the techniques required to solve the velocity-time graph question, some had difficulty in interpreting the extra information about the motorcyclist. Similarly, in the moments question, candidates who were familiar with the principles involved sometimes found difficulty in applying them to this particular problem. The paper discriminated well at all levels including at the top end, and there were some impressive, fully correct solutions seen to all questions. Generally, candidates who used large and clearly labelled diagrams and who employed clear, systematic and concise methods were the most successful.

In calculations the numerical value of g which should be used is 9.8, as advised on the front of the question paper. Final answers should then be given to 2 (or 3) significant figures – more accurate answers will be penalised, including fractions.

If there is a printed answer to show then candidates need to ensure that they show sufficient detail in their working to warrant being awarded all of the marks available.
In all cases, as stated on the front of the question paper, candidates should show sufficient working to make their methods clear to the Examiner.

If a candidate runs out of space in which to give his/her answer than he/she is advised to use a supplementary sheet – if a centre is reluctant to supply extra paper then it is crucial for the candidate to say whereabouts in the script the extra working is going to be done.

## Report on individual questions

### Question1

This question was generally well answered. In part (a), almost all candidates quoted and used an appropriate formula for impulse in terms of difference of momenta. Since the magnitude of the impulse was asked for, a positive value was required for the final mark. If the impulse on $Q$ rather than $P$ was considered, to be eligible for a method mark it was necessary to find and substitute a value for m. The majority of candidates chose to use a 'conservation of linear momentum' equation in part (b). There were occasional sign, miscopying or arithmetical errors, but these were rare, and full marks were often achieved. Those who chose to use an impulse equation for the other particle generally did so successfully.

### Question 2

Part (a) was mostly well done with the vast majority attempting an equation of motion for the whole system. The most common error was the omission of the minus sign on the acceleration. The second part proved to be a discriminator and revealed a lack of understanding of the basic principles. A significant number treated it as a statics problem, even though they had used an acceleration in part (a), and tried assuming the forces were in equilibrium. Amongst those who did attempt to write down an equation of motion for the woman alone, there was much confusion over which forces were acting on her, with many including the tension in the lift cable.

### Question 3

The vast majority of candidates recognised that this equilibrium question required the resolution of forces in two directions. These were almost invariably (and sensibly) chosen to be parallel and perpendicular to the inclined plane. Candidates who used any other directions tended to miss out at least one force component and so make no valid progress. The question involved two distinct angles (the angle of inclination of the slope and the angle that the rope makes with the plane); in some responses there was evidence of confusion between these. In the perpendicular direction, some equated the normal reaction to the weight component, omitting the component of tension and thereby over-simplifying the problem. Nearly all used $F = \frac{1}{3}R$ appropriately in trying to eliminate $F$ and then $R$ from their two equations and many handled the terms and substitutions systematically, reaching a correct value for the tension. A better use of brackets would have helped some candidates who struggled to simplify the working involved. If g = 9.8 had been substituted, then two or three significant figures were required for the final answer, although an accurate answer in terms of g was also acceptable. Many fully correct solutions were seen.

## Question 4

This is an area of the syllabus in which most candidates feel comfortable and many achieved full marks on this question. There were, however, a number of instances of incorrect formulae being quoted, the most common being $s = \frac{1}{2}(v - u)t$.

In part (a) almost all found $u = 14$, some by first finding $a = 2$, thus securing a couple of bonus marks in part (b), although there were an unfortunate few who having found $a = 2$ in part (a) worked it out again, using a different method, in part (b), got it wrong and then lost their bonus marks by using this wrong answer. The second part was mostly done by setting up and solving a three term quadratic and mostly this went well. A significant minority first found $v = 26$ at the mid-point and then used it to obtain $t = 6$. This proved to be a comparatively risk-free path since it deprived candidates of the opportunity to use an incorrect quadratic formula or to make a sign error in evaluating the discriminant. Common errors included using $v = 34$ at the halfway point and assuming that the average speed, 24 m $s^{-1}$, occurred at the mid-distance point rather than at the mid-time.

## Question 5

In part (a) very few candidates failed to score the first B1, but the second was lost in one of two ways either by omitting a figure (usually the 120), or by labelling the $T + 30$ term as $T$. In the second part almost all candidates tried equating the area under the graph to 2145; those who used the whole trapezium were almost invariably successful, but the candidates who split it into two triangles and a rectangle often made errors such as writing the last time interval as $(120 - T)$ or simplifying $(120 - (30 + T))$ to obtain $(90 + T)$. Candidates were able to score full marks in parts (c) and (d) even if part (b) was wrong. The most common error in part (c) was assuming that when the motorcycle passed the car they had not only covered equal distances of 990 m but were also both travelling at 22 m $s^{-1}$. Many subtracted the distance travelled in the first part of the motion, 330 m, from 990 m and divided by 22 to obtain the 30 s part of the car's time, but failed to carry out one or both of the remaining steps (adding the other 30 s and subtracting 10 s). In the final part many scored a method mark for using a wrong time from part (c) correctly, but many scored no marks by persisting with $v = 22$ for the motorcycle.

## Question 6

Many candidates struggled to produce a clear strategy for solving part (a) of this problem. Clear separate diagrams of the two situations (child at one end of the beam and then at the other) would have helped. Those who failed to recognise that the implication of 'on the point of tilting' is that one of the reactions is zero, could make no significant progress and this led to considerable wasted effort in trying to solve a variety of equations in too many unknowns. The most direct method of solution was, for each case, to take moments about the pivot with the non-zero reaction, leading to simultaneous equations in the required distance and mass. Often the unknown distance(s) were not made clear and sometimes the same letter was used to represent the distance to the centre of mass from whatever point a moment was taken about, for example, $50g \times 2 = mgx$ followed by $50g \times 3 = mgx$. If these two equations were added together and the fact that the sum of the two distances was 10 was used, the answer for $m$ fell out. Another valid approach was to find the reaction (same in both situations) by vertical resolution and then use this in appropriate moments equations. However, it was not always obvious which points were being used, where the child was standing, or what unknown distances represented; lack of clarity made some work difficult to decipher with candidates writing down too many equations with a variety of unknowns (and often much crossing out). A number of fully correct solutions were seen, although some candidates penalised themselves by giving weight as their answer rather than mass, and/or giving the distance to the centre of mass from the wrong point. Although some candidates gave up before tackling the second part, this was generally attempted with a much greater degree of success. Those who carried forward incorrect answers from part (a) could achieve 5 out of the 6 available marks and many did so. Most candidates drew a diagram for the new situation and then followed the standard approach of resolving vertically to find the two equal reactions and then taking moments about a point (generally $A$ or $P$). Those who had no values to carry forward from the first part could still achieve the method marks here.

## Question 7

In part (a) the vast majority obtained $\mathbf{i} - 3\mathbf{j}$, and only a few of these forgot to go on and find the speed. In the second part almost all tried to substitute $t = 2$, and almost all of these obtained -3i + 3j; there were, however, many errors in finding the bearing, with 225° being the most common incorrect answer. In part (c) (i) most candidates seemed to realise that something had to be equated to zero; approximately half of them took it to be the **i**-component of $v$, leading correctly to $t = \frac{1}{2}$. Of the remainder, some thought that the **j**-component should be zero, while a substantial number equated both components in turn to zero, obtaining two values for t. It was part (c) (ii) that proved to be a good discriminator. Many just gave up at this point, while some tried equating the **i**-component to –1 and the **j**-component to –3, again obtaining two values for $t$. Of those who knew how to proceed, the $k$-method seemed less error-prone than the 'going straight to the ratio' method, with perhaps less risk of ending up with the ratio the wrong way round. It was surprising to see how many found the value of $k$ first, then substituted it back into one of their equations rather than just eliminating it immediately.

## Question 8

In part (a) the vast majority of candidates attempted to write down separate equations of motion for the two particles. Occasionally '$g$' was omitted from the weight term or, more rarely, included in the 'ma' term and sometimes the masses were given as 2 and 3 rather than $2m$ and $3m$. A more significant error was including a weight term for the particle that is moving horizontally. Almost all solved their equations and found a value for the acceleration and full marks for this part were often achieved. In the second part, the mark for the value of the tension required a correct answer to appropriate accuracy, 2 or 3 significant figures if $g = 9.8$ is used, but the exact answer $\frac{6mg}{5}$ was also acceptable. A fairly common error, apart from over-accuracy, was to omit m, despite it having been included in the original equations.

Part (c) presented greater difficulties for many candidates and it was sometimes omitted. The resultant of the tension forces acting on the pulley was required. Some candidates had different vertical and horizontal forces such as $T + 3mg$, $3mg$ and/or $2mg$, and some thought that the resultant must act vertically downwards. Those who realised that they had to combine the two perpendicular tensions generally used a valid method, Pythagoras or resolving at a 45° angle, to find the magnitude of the resultant but omission of $m$ was again a common error. Over-accuracy is only penalised once per question and, as before, an exact answer in terms of $g$ was credited. Some candidates failed to gain the final independent mark for the direction by not showing it clearly on a diagram; 'at 45° to the horizontal' was not sufficient on its own and SW is not appropriate here.

## Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:
http://www.edexcel.com/iwant to/Pages/grade-boundaries.aspx

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