**GCE AS Further Mathematics (8FM0) – Paper 25**

**Further Mechanics 1**

**Summer 2019 student-friendly mark scheme**

**Please note that this mark scheme is not the one used by examiners for making scripts. It is intended more as a guide to good practice, indicating where marks are given for correct answers. As such, it doesn’t show follow-through marks (marks that are awarded despite errors being made) or special cases.**

**It should also be noted that for many questions, there may be alternative methods of finding correct solutions that are not shown here – they will be covered in the formal mark scheme.**

**This document is intended for guidance only and may differ significantly from the final mark scheme published in July 2019.**

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| **Guidance on the use of codes within this document** |
| M1 – method mark. This mark is generally given for an appropriate method in the context of the question. This mark is given for showing your working and may be awarded even if working is incorrect.A1 – accuracy mark. This mark is generally given for a correct answer following correct working.B1 – working mark. This mark is usually given when working and the answer cannot easily be separated.Some questions require all working to be shown; in such questions, no marks will be given for an answer with no working (even if it is a correct answer). |

**Question 1 (Total 10 marks)**

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| **Part** | **Working or answer an examiner might expect to see** | **Mark** | **Notes** |
| (a) | *F* – 16 000 = 0 | M1 | This mark is given an for an attempt to produce an equation of motion parallel to the road with *a* = 0 |
| A1 | This mark is given for a fully correct equation of motion |
| *P* = 16 000 × 25 | M1 | This mark is given for the use of *P* = *Fv* |
|  = 400 000 = 400 kW | A1 | This mark is given for a fully correct proof |
| (b) |  | M1 | This mark is given for the use of *P* = *Fv* |
|  – 640*V* = 16000 × 2.1 | M1 | This mark is given for an equation of motion parallel to the road (using the refined model) |
| A1 | This mark is given for a fully correct equation |
| 2*V* 2 + 105*V* – 1250 = 0 | A1 | This mark is given for rearranging to find a three term quadratic equation to be solved |
| (2*V* + 125)(*V* – 10) = 0 | M1 | This mark is given for a method to find a value for *V* |
| *v* = 10 (m s–1) | A1 | This mark is given for finding a correct value for the speed of the lorry |

**Question 2 (Total 13 marks)**

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| **Part** | **Working or answer an examiner might expect to see** | **Mark** | **Notes** |
| (a) | 5*mu* = 3*m*(*vB* – –*u*) | M1 | This mark is given for using the impulse-momentum principle for *B* |
| A1 | This mark is given for a correct equation |
| *vB* =  | A1 | This mark is given for finding the appropriate velocity correctly |
| 4*mu* – 3*mu* = 2*mvA* + 3*m* ×  | M1 | This mark is given for the use of conservation of momentum |
| A1 | This mark is given for a fully correct CLM equation |
| *vA* = – | A1 | This mark is given for finding the correct speed |
|  | M1 | This mark is given for use of NLR |
| *e* =  =  ×  =  | A1 | This mark is given for a method to find the value for the coefficient of restitution, *e* |
| *e* =  | A1 | This mark is given for a correct value for *e* |
| (b) | Loss of KE = Initial KE – Final KE | M1 | This mark is given for a method to find the total loss in kinetic energy |
|  × 2*m*(2*u*)2 +  × 3*mu*2 –  | A1 | This mark is given for an expression for the intital KE |
| A1 | This mark is given for an expression for the final KE |
|  | A1 | This mark is given for a correct expression for the total loss in kinetic energy |

**Question 3 (Total 7 marks)**

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| **Part** | **Working or answer an examiner might expect to see** | **Mark** | **Notes** |
|  | Work done against friction = *mg* × 8 | B1 | This mark is given for an expression for the work done against friction by the particle *P* (resistance to motion × distance moved) |
| Loss of PE = 8*mg* sin *α* | B1 | This mark is given for an expression for the loss of potential energy of the particle *P* |
| Gain in KE = difference of two KE terms | M1 | This mark is given for a method to find an expression for the gain in kinetic energy of the particle *P* |
| = *mv*2 – *m* × 52 | A1 | This mark is given for a fully correct expression for the gain in kinetic energy of the particle *P* |
| Work done against friction = Loss in PE – Gain in KE | M1 | This mark is given for a method to find a work-energy equation for the work done against friction by the particle *P* |
| *mg* × 8 = 8*mg* sin *α* –  | A1 | This mark is given for a correct equation for the work done against friction by the particle *P* in terms of kinetic energy lost and gained  |
| *mg* = *mg* – *mg* = *m**g* = 2 × *g* + 25 = *v*2*v*2 = 87.72*v* = 9.37 (m s–1) | A1 | This mark is given for a correct value for the speed of *P* after it has moved a distance 8 m down the plane |

**Question 4 (Total 10 marks)**

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| **Part** | **Working or answer an examiner might expect to see** | **Mark** | **Notes** |
| (a) | *mu* = –*mvQ* + *kmvP* | M1 | This mark is given for a method to use conservation of momentum, dimensionally correct and with the correct number of terms |
| A1 | This mark is given for a correct expression for *mu* |
| *eu* = *vQ* + *vP* | M1 | Use of Newton’s Law of Restitution |
| A1 | This mark is given for a correct expression for *eu* |
| *vP*= *eu* = *vQ* + *keu* = *kvQ* + *u* + *vQ* *keu – u* = *kvQ* + *vQ**u*(*ke* + 1) = *vQ*(*k +* 1)*vQ* =  | M1 | This mark is given for a method to solve the problem by finding *vQ* |
| A1 | This mark is given for a correct expression for *vQ*in terms of *e* |
| For the second collision, *vQ* > 0 | M1 | This mark is given for the use of the appropriate condition for *vQ* |
|  > 0 (*ke* – 1) > 0 | M1 | This mark is given for a method to find a range of values of *k* for which there is a second collision |
| *k* >  | A1 | This mark is given for a correct range of values of *k* for which there is a second collision |
| (b) | Speed of *Q* =  | B1 | This mark is given for a correct expression for the speed of *Q* after the second collision |