Comparison of key skills specifications 2000/2002 with 2004 standardsX015461July 2004Issue 1

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Mark Scheme (Standardisation)

October 2020

Pearson Edexcel GCE In A level Further Mathematics

Paper 9FM0/3C

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**General Marking Guidance**

* All candidates must receive the same treatment.  Examiners must mark the first candidate in exactly the same way as they mark the last.
* Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
* Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
* There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
* All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme.  Examiners should also be prepared to award zero marks if the candidate’s response is not worthy of credit according to the mark scheme.
* Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
* When examiners are in doubt regarding the application of the mark scheme to a candidate’s response, the team leader must be consulted.
* Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

**EDEXCEL GCE MATHEMATICS**

**General Instructions for Marking**

1. The total number of marks for the paper is 75.
2. The Edexcel Mathematics mark schemes use the following types of marks:
* **M** marks: method marks are awarded for ‘knowing a method and attempting to apply it’, unless otherwise indicated.
* **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
* **B** marks are unconditional accuracy marks (independent of M marks)
* Marks should not be subdivided.
1. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes.

* bod – benefit of doubt
* ft – follow through
* the symbol will be used for correct ft
* cao – correct answer only
* cso - correct solution only. There must be no errors in this part of the question to obtain this mark
* isw – ignore subsequent working
* awrt – answers which round to
* SC: special case
* oe – or equivalent (and appropriate)
* dep – dependent
* indep – independent
* dp decimal places
* sf significant figures
* 🞸 The answer is printed on the paper
* The second mark is dependent on gaining the first mark
1. All A marks are ‘correct answer only’ (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **1a** | Impulse-momentum equation | M1 | 3.1a |
|    | A1 | 1.1b |
| Find magnitude of **J**: | M1 | 1.1b |
|   (N s) | A1 | 1.1b |
|  | **(4)** |  |
| **1b** | Correct use of trig | M1 | 3.1a |
|   | A1ft | 1.1b |
|    | A1 | 1.1b |
|  | **(3)** |  |
| **1balt** | Use scalar product of  and  to find the angle | M1 | 3.1a |
|   | A1ft | 1.1b |
|   | A1 | 1.1b |
|  | **(3)** |  |
| **1balt** | Use of cosine rule in triangle of momenta or equivalent | M1 | 3.1a |
|   | A1ft | 1.1b |
|   | A1 | 1.1b |
|  | **(3)** |  |
| **(7 marks)** |
| **Notes:** |
| **(a)M1** | Dimensionally correct. Must be subtracting, but condone subtracting in the wrong order. |
| **A1** | Correct unsimplified equation |
| **M1** | Correct application of Pythagoras to find the magnitude. |
| **A1** | 2.9 or better (2.9154….) |
| **(b)M1** | Correct use of trig to find a relevant angle |
| **A1ft** | Correct unsimplified expression for the required angle. Follow their **J** |
| **A1** |  or better (112.166…..) or accept   |
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| **Question** | **Scheme** | **Marks** | **AOs** |
| **2(a)** | Equation of motion:   | M1 | 3.3 |
| Use of   | M1 | 3.4 |
|   | A1 | 1.1b |
|  deceleration =  | A1 | 1.1b |
|  | **(4)** |  |
| **(b)** | Equation of motion:  | M1 | 3.3 |
|    | A1A1 | 1.1b1.1b |
| Form quadratic and solve for *V*:  | M1 | 1.1b |
|     | A1 | 1.1b |
|  | **(5)** |  |
| **(9 marks)** |
| **Notes:** |
| **(a)M1** | Dimensionally correct. Condone sign errors |
| **M1** | Correct use of  . Allow in (b) if not seen in (a). |
| **A1** | Correct unsimplified equation |
| **A1** | 0.10 or better |
| **(b)M1** | Need all terms. Dimensionally correct. Condone sign errors |
| **A1****A1** | Unsimplified equation with at most one errorCorrect unsimplified equation |
| **M1** | Use their dimensionally correct equation to form and solve a 3 term quadratic in *V* |
| **A1** | Correct to 2 sf or 3 sf |
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| **Question** | **Scheme** | **Marks** | **AOs** |
| **3(a)** | Taking left to right as positive, |  |  |
| CLM:  | M1 | 3.1a |
|    | A1 | 1.1b |
| Impact Law: | M1 | 3.4 |
|    | A1 | 1.1b |
| Solve for *v* or *w* | M1 | 2.1 |
|   | A1 | 1.1b |
|    | A1 | 1.1b |
|  hence both particles still travelling in the original direction. \* | A1\* | 2.2a |
|  | **(8)** |  |
| **(b)** | CLM:   | M1 | 3.1a |
| Impact:   | M1 | 3.4 |
|   ,   | M1 | 1.1b |
| Consider  i.e.     | M1 | 2.1 |
| Show that  | M1 | 1.1b |
| Complete correct argument and conclusion \* | A1\* | 2.2a |
|  | **(6)** |  |
| **(14 marks)** |
| **Notes:** |
| **(a)M1** | All terms required. Condone sign errors. |
| **A1** | Correct unsimplified equation |
| **M1** | Law used correctly. Condone sign errors |
| **A1** | Correct unsimplified equation |
| **M1** | Use their correctly formed equations to solve for *v* or *w* |
| **A1** | Either velocity correct  |
| **A1** | Both velocities correct |
| **A1\*** | Use possible values of *e* to justify given result from correct working. |
| **(b)M1** | All terms required. Condone sign errors |
| **M1** | Correct use of impact law. Condone sign errors |
| **M1** | Solve to find velocity of *B* (*x*) |
| **M1** | Form relevant difference for a second collision |
| **M1** | Correct method (e.g. differentiation or completing the square or discriminant ) to determine when inequality is true |
| **A1\*** | Reach correct conclusion from correct work. |
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| **Question** | **Scheme** | **Marks** | **AOs** |
| **4(a)** | Use of  or   | M1 | 2.1 |
|    | A1 | 1.1b |
| Use of scalar product  | M1 | 1.1b |
| Hence impulse perpendicular to so *AB* must be parallel to  \* | A1\* | 2.2a |
|  | **(4)** |  |
| **4(a) alt** | Use of  or  | M1 | 2.1 |
|    | A1 | 1.1b |
| Components of velocities parallel to :    | M1 | 1.1b |
| Hence component of velocity parallel to  is unchanged, so *AB* must be parallel to  \* | A1\* | 2.2a |
|  | **(4)** |  |
| **4(a) alt** | Use conservation of velocity parallel to   | M1 | 2.1 |
|      | A1 | 1.1b |
| Find ratio of *a* and *b* to obtain direction:   | M1 | 1.1b |
| Hence *AB* must be parallel to  \* | A1\* | 2.2a |
|  | **(4)** |  |
| **4(b)** | Use scalar product to find components of velocities perpendicular to the wall | M1 | 3.1b |
|   | A1A1 | 1.1b1.1b |
| Use of impact law | M1 | 3.4 |
|    | A1 | 1.1b |
|  | **(5)** |  |
| **(9 marks)** |
| **Notes:** |
| **(a)M1** | Must be finding the difference between two momenta or two velocities |
| **A1** | Correct unsimplified equation for the impulse or for change in velocity |
| **M1** | Use of scalar product or equivalent. In the alt method allow full marks if  not used. |
| **A1\*** | Reach given conclusion from correct working |
| **(b)M1** | Condone if not using a unit vector |
| **A1****A1** | One correct valueSecond correct values |
| **M1** | Use their values the right way round in the impact law. Condone sign error. |
| **A1** | 0.53 or better (0.52941……) |
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| **Question** | **Scheme** | **Marks** | **AOs** |
| **5(a)** |  |  |  |
| Components perpendicular to the line of centres after the collision:  | B1 | 3.4 |
| Kinetic energy: | M1 | 3.1a |
|   | A1 | 1.1b |
| CLM parallel to line of centres: | M1 | 3.1a |
|    | A1 | 1.1b |
| Impact law parallel to line of centres | M1 | 3.1a |
|    | A1 | 1.1b |
| Solve for ,  or *e* | M1 | 1.1b |
|   and | A1 | 1.1b |
|   | A1 | 1.1b |
|  *P* and *Q* have passed through each other: impossible, so solution is unique \* | A1\* | 2.4 |
|  | **(11)** |  |
| **(b)** | Use trig to find angle between velocities | M1 | 3.1a |
|   | A1ft | 1.1b |
|     | A1 | 1.1b |
|  | **(3)** |  |
| **(14 marks)** |
| **Notes:** |
| **(a)B1** | Seen or implied. Correct only |
| **M1** | Equation for KE of *Q*. Dimensionally correct. Condone  on the wrong side. |
| **A1** | Correct unsimplified equation in   |
| **M1** | Equation for CLM. Correct terms required. Condone sign errors. Dimensionally correct. |
| **A1** | Correct unsimplified equation |
| **M1** | Correct use of impact law. Condone sign errors |
| **A1** | Correct unsimplified equation.  |
| **M1** | Solve for   |
| **A1** | Both velocities correct |
| **A1** | Correct only. 0.19 or better (0.19047….) |
| **A1\*** | Or equivalent justification of given result. e.g. a negative value for *e* is not possible |
| **(b) M1** | Use of trig or equivalent to find a relevant angle between two velocities e.g by scalar product or difference between angles. |
| **A1ft** | Correct unsimplified equation in  . Follow their  |
| **A1** | Correct only. (0.785… radians) |
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| **Question** | **Scheme** | **Marks** | **AOs** |
| **6(a)** | Work done against friction  Gain in EPE  Gain in GPE   | B1B1B1 | 3.43.43.4 |
| Work energy equation: | M1 | 2.1 |
|   | A1 | 1.1b |
|  \* | A1\* | 2.2a |
|  | **(6)** |  |
| **(b)** | Tension in the string at *B*:   | B1 | 3.1a |
| Equation of motion: tension + component of weight – friction = *ma* | M1 | 3.3 |
|      | A1A1 | 1.1b1.1b |
|    | A1 | 1.1b |
|  | **(5)** |  |
| **(11 marks)** |
| **Notes:** |
| **(a)B1****B1****B1** | Use model to obtain one correct term Use model to obtain two correct terms Use model to obtain three correct terms  |
| **M1** | Work-energy equation. Need all terms and no extras. Dimensionally correct. Condone sign errors and sin/cos confusion. |
| **A1** | Correct unsimplified equation |
| **A1\*** | Obtain given result from correct working |
| **(b) B1** | Correct unsimplified expression for the tension in the string |
| **M1** | Equation of motion. Need all terms and no extras. Condone sign errors and sin/cos confusion |
| **A1****A1** | Unsimplified equation with at most one errorCorrect unsimplified equation |
| **A1** | Exact answer or accept 12.8 or 13   |
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| **Question** | **Scheme** | **Marks** | **AOs** |
| **7(a)** | Use model to find components of velocity after the impacts:  | B1B1B1B1 | 3.1b3.43.1b3.4 |
|   | M1 | 3.1b |
|   | M1 | 1.1b |
|   \* | A1\* | 2.2a |
|  | **(7)** |  |
| **(b)** |  | B1 | 1.1b |
| change in KE   | M1 | 3.1b |
| % of KE lost   | M1 | 1.1b |
|    | A1 | 1.1b |
|  | **(4)** |  |
| **(11 marks)** |
| **Notes:** |
| **(a)B1****B1****B1****B1** | One mark for each component correct. |
| **M1** | Form expression for   |
| **M1** | Form and solve equation in   |
| **A1\*** | Obtain given answer from correct working  |
| **(b)B1** | Correct use of   |
| **M1** | Dimensionally correct expression for change in KENB note that they may not show component parallel to the wall  |
| **M1** | Dimensionally correct expression for the percentage of KE lost. |
| **A1** | Accept  or better  |
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