| **Question** | **Scheme** | | **Marks** |
| --- | --- | --- | --- |
| **1(a)** |  | | M1 |
| A1 |
|  | | M1 |
| A1 |
|  | | DM1 |
| A1 |
|  |  | | **(6)** |
| **1(b)** |  | | M1 |
| A1 |
|  | | DM1 |
| A1 |
|  | | B1 |
|  |  | | **(5)** |
|  |  | | **(11 marks)** |
| **2** | 4*u*  0  *x*  *v*  3*m*  *m* | |  |
|  | | M1 A1 |
|  | | M1 A1 |
|  | |  |
|  | |  |
|  | | DM1 A1 |
|  | | DM1 |
| **\*\*** | | A1 |
|  |  | | **(8 marks)** |
| **3(a)** | Speed after impact = | | B1 |
| Impulse = change in momentum = | | M1 |
|  | | A1 |
|  |  | | **(3)** |
| **3(b)** | Speed after second collision = | | B1 |
| Total time taken = | | M1 |
| A2 |
| Ratio of times for the three sections is | | M1 |
| A2 |
| ,  o.e. | | DM1 |
| A1 |
|  |  | | **(6)** |
|  |  | | **(9 marks)** |
| **4(a)** | PE lost  J | | M1 |
| A1 |
|  |  | | **(2)** |
| **4(b)** |  | | M1 |
| A2 |
| N | | A1 |
|  | | B1 |
|  | | M1 |
| A1 |
|  |  | | **(7)** |
| **4(c)** |  | | M1 |
| A1 |
|  | | DM1 |
|  | | A1 |
|  |  | | **(4)** |
|  |  | | **(13 marks)** |
| **5(a)** | *u*  *u*  *u*  *v*  *w* | |  |
| Momentum: *u* = *u*’ + *v* | | M1 A1 |
| NEL: *v* - *u*’ = *eu* | | M1 A1 |
| 2*v* = *u*(1 + ), | | M1 A1 |
|  | | A1 |
|  |  | | **(7)** |
| **5(b)** | KE lost =  their speeds | | M1 |
| = | | A2 – 1ee |
| =  **AG** | | A1 |
|  |  | | **(4)** |
| **5(c)** | Speed of C = | | M1 A1  M1 A1 |
|  |  | | **(4)** |
|  |  | | **(15 marks)** |
| **6(a)** | CLM: | | M1  A1 |
| Impact: | | M1  A1 |
| Subst : | | DM1 |
|  | **\*Answer Given\*** | A1 |
|  |  | | **(6)** |
| **6(b)** |  | | B1 |
| CLM:  and Impact: | | M1A1 |
| Subst: | | DM1 |
| , | | A1  A1 |
|  |  | | **(6)** |
| **6(c)** |  | | B1 |
| Speed of separation = | | M1  A1 |
|  |  | | **(3)** |
|  |  | | **(15 marks)** |
| **7(a)** | *u* 0  *A B*  *m* 3*m*  *v w* | |  |
|  | | M1 |
|  | | A1 |
|  | | M1 |
|  | | A1 |
|  | | M1 A1 |
|  | | A1 |
|  |  | | **(7)** |
| **7(b)** | 0  *B C*  3*m* 4*m*  *Y X* | |  |
|  | | M1 |
|  | | A1ft |
|  | | B1ft |
|  | | DM1 |
| Or | |  |
|  | | A1 |
|  | | A1 |
|  |  | | **(6)** |
| **7(c)** |  | | M1 |
|  | |  |
| , 0.293 | | M1 |
| for  so no second collision. | | A1 |
|  |  | | **(3)** |
|  |  | | **(16 marks)** |
| **8(a)** |  | |  |
|  | | M1 A1 |
|  | | M1 A1 |
| , () | | dM1 |
| For *Q* and *R* to collide require , | | M1 |
| , | | A1 |
|  |  | | **(7)** |
| **8(b)** | , | | B1 |
|  | | M1 |
|  | | A1 |
| , | |  |
| Solve for *x* (or  ) | | dM1 |
| , | | A1 |
| *P* and *Q* moving away from each other, so no collision. | | A1 |
|  |  | | **(6)** |
|  |  | | **(13 marks)** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Source paper** | **Question number** | **New spec references** | **Question description** | **New AOs** |
| 1 | M2 2012 | 2 | 3.1, 3.2 | Collisions | 1.1b, 2.2a, 2.5, 3.1b |
| 2 | M2 2011 | 2 | 3.1, 3.2 | Collisions | 1.1b, 1.2, 3.1b |
| 3 | M2 2014 | 5 | 3.1, 3.2 | Collisions | 1.1b, 2.1, 3.1b |
| 4 | M2 2013R | 5 | 3.1, 3.2 | Collisions | 1.1b, 2.1, 3.1b |
| 5 | M2 Jan 2012 | 6 | 3.1, 3.2 | Collisions | 1.1b, 1.2, 2.2a, 3.1b, 3.4 |
| 6 | M2 2013 | 7 | 3.1, 3.2 | Collisions | 1.1b, 2.1, 2.2a, 3.1b, 3.2a, 3.4 |
| 7 | M2 Jan 2013 | 7 | 3.1, 3.2 | Collisions | 1.1b, 1.2, 2.1, 2.2a, 2.5, 3.1b, 3.2a |
| 8 | M2 2015 | 8 | 3.1, 3.2 | Collisions | 1.1b, 2.1, 2.2a, 3.1b, 3.2a, 3.4 |