

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	



General Certificate of Education
Advanced Level Examination
June 2011

Mathematics

MM03

Unit Mechanics 3

Wednesday 22 June 2011 9.00 am to 10.30 am

For this paper you must have:

- the blue AQA booklet of formulae and statistical tables.
- You may use a graphics calculator.

Time allowed

- 1 hour 30 minutes

Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- You must answer the questions in the spaces provided. Do not write outside the box around each page.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.
- The **final** answer to questions requiring the use of calculators should be given to three significant figures, unless stated otherwise.
- Take $g = 9.8 \text{ m s}^{-2}$, unless stated otherwise.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

Advice

- Unless stated otherwise, you may quote formulae, without proof, from the booklet.



JUN11MM0301

Answer **all** questions in the spaces provided.

- 1** A ball of mass 0.2 kg is hit directly by a bat. Just before the impact, the ball is travelling horizontally with speed 18 m s^{-1} . Just after the impact, the ball is travelling horizontally with speed 32 m s^{-1} in the opposite direction.
- (a)** Find the magnitude of the impulse exerted on the ball. *(2 marks)*
- (b)** At time t seconds after the ball first comes into contact with the bat, the force exerted by the bat on the ball is $k(0.9t - 10t^2)$ newtons, where k is a constant and $0 \leq t \leq 0.09$. The bat stays in contact with the ball for 0.09 seconds.
- Find the value of k . *(4 marks)*

QUESTION
PART
REFERENCE



4 The unit vectors **i**, **j** and **k** are directed due east, due north and vertically upwards respectively.

A helicopter, *A*, is travelling in the direction of the vector $-2\mathbf{i} + 3\mathbf{j} + 6\mathbf{k}$ with constant speed 140 km h^{-1} . Another helicopter, *B*, is travelling in the direction of the vector $2\mathbf{i} - \mathbf{j} + 2\mathbf{k}$ with constant speed 60 km h^{-1} .

(a) Find the velocity of *A* relative to *B*. (5 marks)

(b) Initially, the position vectors of *A* and *B* are $(4\mathbf{i} - 2\mathbf{j} + 3\mathbf{k}) \text{ km}$ and $(-3\mathbf{i} + 6\mathbf{j} + 3\mathbf{k}) \text{ km}$ respectively, relative to a fixed origin.

Write down the position vector of *A* relative to *B*, *t* hours after they leave their initial positions. (2 marks)

(c) Find the distance between *A* and *B* when they are closest together. (8 marks)

QUESTION
PART
REFERENCE

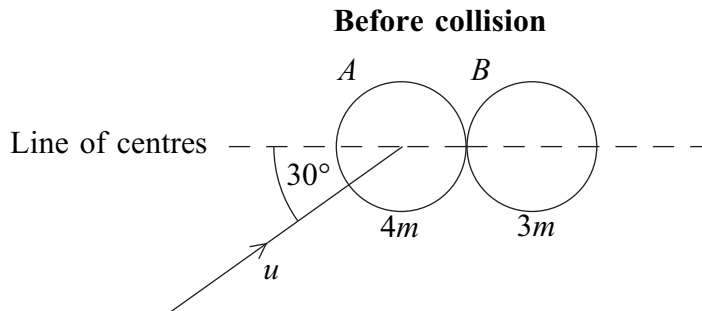
Area with horizontal dotted lines for writing answers.



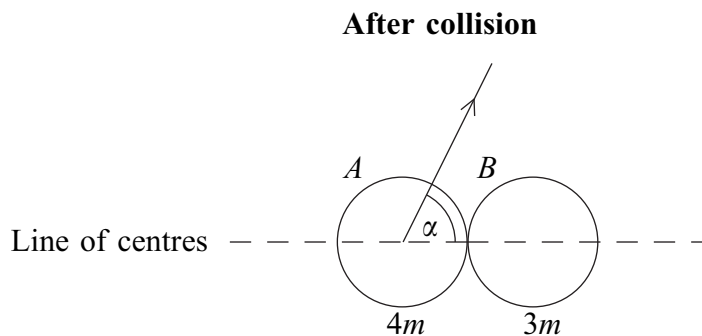
7

Two smooth spheres, A and B , have equal radii and masses $4m$ and $3m$ respectively. The sphere A is moving on a smooth horizontal surface and collides with the sphere B , which is stationary on the same surface.

Just before the collision, A is moving with speed u at an angle of 30° to the line of centres, as shown in the diagram below.



Immediately after the collision, the direction of motion of A makes an angle α with the line of centres, as shown in the diagram below.



The coefficient of restitution between the spheres is $\frac{5}{9}$.

- (a) Find the value of α . (10 marks)
- (b) Find, in terms of m and u , the magnitude of the impulse exerted on B during the collision. (3 marks)

QUESTION
PART
REFERENCE



QUESTION
PART
REFERENCE

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ANSWER IN THE SPACES PROVIDED**

