Surname	
Other Names	
Candidate Signature	

Centre Number						Candidate Number				

Examiner Comments	

Total Marks

FURTHER MATHEMATICS

AS LEVEL FURTHER MECHANICS 1

CM

Bronze Set A (Edexcel Version)

Time allowed: 50 minutes

Instructions to candidates:

• In the boxes above, write your centre number, candidate number, your surname, other names and signature.

• Answer ALL of the questions.

• You must write your answer for each question in the spaces provided.

• You may use a calculator.

Information to candidates:

• Full marks may only be obtained for answers to ALL of the questions.

• The marks for individual questions and parts of the questions are shown in round brackets.

• There are 4 questions in this question paper. The total mark for this paper is 40.

Advice to candidates:

• You should ensure your answers to parts of the question are clearly labelled.

• You should show sufficient working to make your workings clear to the Examiner.

• Answers without working may not gain full credit.

1 1 3 3 1 2 4 1 8 0 0 0 4

1 A stone is projected at 20 m s^{-1} from a cliff, which is 40 m above the ground.

The speed of the stone when it hits the ground is V m s^{-1}.

The stone is modelled as a particle, the acceleration due to gravity is modelled to be 9.8 m s^{-2} and any effects due to air resistance are modelled as negligible.

(a) Use conservation of energy to find V. **(3)**

The model is refined and the effects are air resistance are now not negligible. In the model, it is assumed that the stone experiences a constant resistance to motion of 10 N.

The speed of the stone when it hits the ground is now W m s^{-1}.

Given that the mass of the stone is 7 kg,

(b) use the work-energy principle to find W. **(3)**

(c) Explain the significance of modelling the stone as a particle. **(1)**

(d) Explain how the model for air resistance can be refined to make it more realistic. **(1)**

Question 1 continued

TOTAL 8 MARKS

2 Three particles A, B and C are at rest on a smooth horizontal table. The mass of A is 4 kg, the mass of B is 3 kg and the mass of C is 3 kg. The particle A is given an impulse to the right of magnitude 10 N s^{-1}. The particle A moves towards and collides directly with the particle B. Immediately after the collision, the particle A moves to the right at 2 m s^{-1} and the particle B then moves towards the particle C.

(a) Write down the initial speed of the particle A after receiving the impulse. **(1)**

(b) Find the speed of B after its collision with A. **(3)**

After the collision with A, the particle B collides directly with the particle C. Immediately after that collision, the particle C moves with a speed of 1 m s^{-1}.

(c) Calculate the speed and direction of motion of B after its collision with C. **(4)**

(d) Does the particle B collide with the particle A again? Justify your answer. **(2)**

Question 2 continued

TOTAL 10 MARKS

3 A boy is pulling his brother in a sledge along a straight horizontal path using a rope at a constant speed of 5 m s^{-1}. The mass of the boy's brother is 23 kg. The total resistance to the motion of the sledge is modelled as a constant force of magnitude 20 N.

(a) Find the rate at which the boy is working to pull the sledge. **(3)**

The boy now comes to a hill, which is inclined at θ° to the horizontal, where $\sin\theta = \frac{1}{13}$.

Because of the hill, the boy reduces the speed at which he pulls the sledge to 3 m s^{-1} and he maintains this speed up the hill. The total resistance to the motion of the jogger from non-gravitational forces is still modelled as a constant force of magnitude 20 N. The boy works at a rate of 190 W up the hill.

(b) Find the mass of the sledge. **(5)**

Question 3 continued

TOTAL 8 MARKS

4 Two particles A and B are moving on a smooth horizontal table. The mass of A is m and the mass of B is $3m$. Initially the particle A is moving with speed u when it collides directly with particle B, which is at rest on the table. As a result of the collision, the direction of motion of A is reversed. The coefficient of restitution between the particles A and B is e.

(a) Find expressions for the speed of A and the speed of B immediately after the collision. **(7)**

In the subsequent motion, the particle B strikes a smooth vertical wall and rebounds. The wall is perpendicular to the direction of motion of B. The coefficient of restitution between B and the wall is $\frac{7}{10}$. Given that there is a second collision between A and B,

(b) show that $\frac{1}{3} < e < \frac{17}{23}$. **(4)**

Given that $e = \frac{2}{3}$,

(c) find the total kinetic energy lost in the first collision by A and B. **(3)**

Question 4 continued

Question 4 continued

Question 4 continued

END OF SECTION **TOTAL 14 MARKS**

TOTAL FOR SECTION IS 40 MARKS