AQA, Edexcel, OCR

A Level

A Level Physics

MECHANICS: Momentum and Collisions

Name:

MME

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Total Marks: /30

1. Total for Question 1: 5

(a) Define momentum. Is it a vector or scalar quantity? [1]

(b) Use Newton's second law to explain the impulse of a force. [2]

(c) Compare and contrast elastic and inelastic collisions. [2]

2. Particle A, which is stationary, radioactively decays to create particle B and an α particle. The α particle weighs only 1.5% of particle B.

Total for Question 2: 13

(a) Show that kinetic energy and momentum can be linked by the equation $E_k = \frac{p^2}{2m}$, where p is momentum, m is mass and v is velocity. [2]

(b) Use the principle of conservation of energy to express the total energy release in terms of the products' momenta and masses. Assume that energy is released only as kinetic energy. [1]

(c) Write an expression for the conservation of linear momentum in this explosion. [1]

(d) By considering the ratio $\frac{E_B}{E_\alpha}$, express E_B in terms of E_α, m_B and m_α. [3]

(e) Using your answer to the previous part, show that $E_B = E_{total}\frac{m_\alpha}{m_B+m_\alpha}$ [3]

(f) In this reaction, 5.00 MeV is released. Particle B has a mass of 4.00×10^{-25} Kg. Calculate the kinetic energies of both particles after the collision. [3]

3. Air hockey is a game played by two players on a low-friction table using a paddle each and a puck. This question will explore the nature of collisions in one and two dimensions during a game.

Simon and Andrena are practising using two pucks of different masses. They hit their pucks towards each other. The resultant collision is head-on and is illustrated in Figure 1.

Total for Question 3: 12

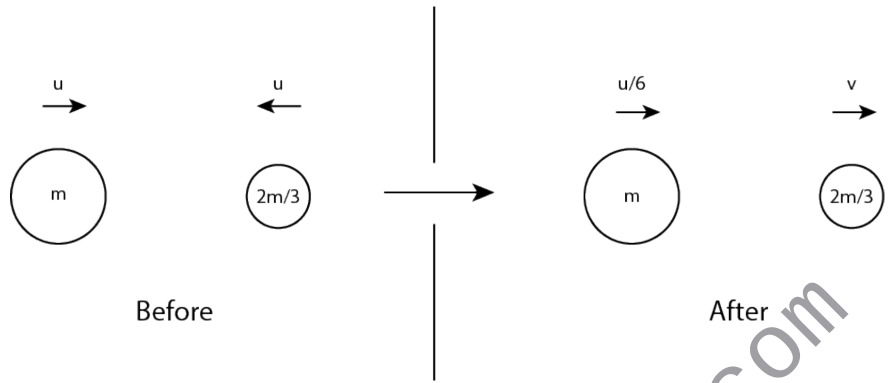

Figure 1: Head-on collision between pucks of different masses. The arrows show the direction of the pucks' motion.

(a) Use the principle of conservation of momentum to express the velocity v in terms of u. [2]

(b) Show that the collision is inelastic and calculate the amount of energy converted to forms other than kinetic. [2]

A little while later two different pucks collide elastically and obliquely, as is shown in Figure 2. This causes the once-stationary puck to move off in the direction of the dashed line.

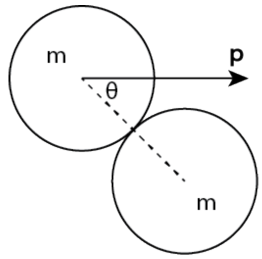

Figure 2: Oblique collision between pucks of equal masses.

(c) What is the total kinetic energy in the system before the collision? [1]

(d) Explain using the principle of conservation of linear momentum why the pucks must move off at 90°to one another. [2]

(e) Draw a diagram showing the momenta of the pucks after the collision. Ensure that you label any vectors with their magnitudes. [2]

(f) Show that kinetic energy is conserved in the collision. [3]