Cambridge International AS & A Level

Mathematics 9709/42

Paper 4 Mechanics **May/June 2025**

Question No (2)

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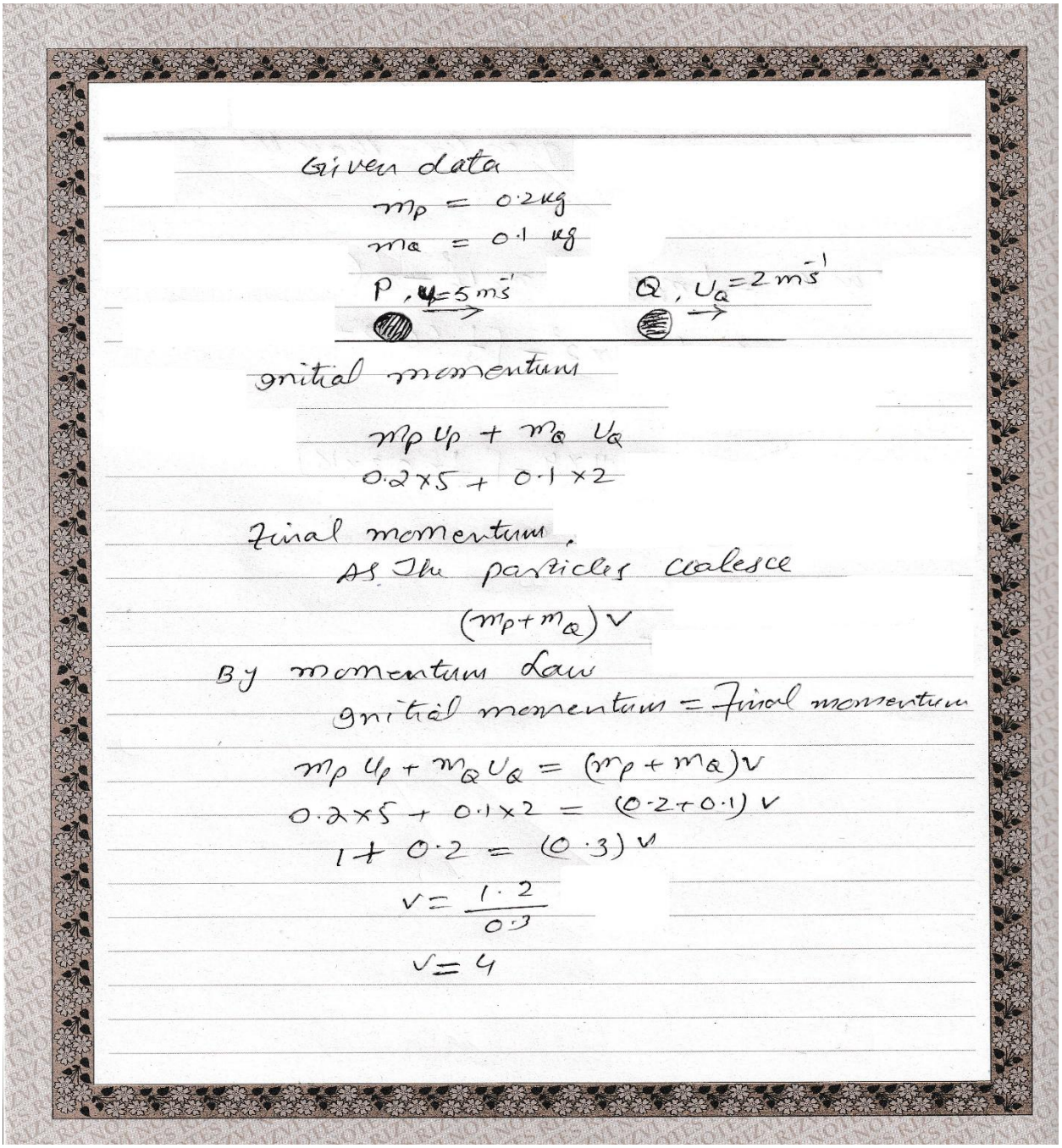
Two particles P and Q, of masses 0.2 kg and 0.1 kg respectively, are free to move in a straight line on a smooth horizontal plane. P is projected towards Q with speed $5\ m\ s^{-1}$. At the same instant, Q is projected away from P with speed $2\ m\ s^{-1}$. When P collides with Q, the particles coalesce.

Find the kinetic energy lost during the collision.

Solution:



Given data

$m_P = 0.2kg$

$m_Q = 0.1\ kg$

P, $u_P = 5ms^{-1}$ → Q, $u_Q = 2ms^{-1}$ →

Initial momentum

$m_P u_P + m_Q u_Q$

$0.2 \times 5 + 0.1 \times 2$

Final momentum,

As the particles coalesce

$(m_P + m_Q)v$

By momentum Law

Initial momentum = Final momentum

$m_P u_P + m_Q u_Q = (m_P + m_Q)v$

$0.2 \times 5 + 0.1 \times 2 = (0.2 + 0.1)v$

$1 + 0.2 = (0.3)v$

$v = \frac{1.2}{0.3}$

$v = 4$

As after collision energy lost, so initial energy is greater than the energy after collision.

$$\text{Loss in K.E} = \frac{1}{2} m_p u_p^2 + \frac{1}{2} m_a u_a^2 - \frac{1}{2}(m_p + m_a) v^2$$

$$= \frac{1}{2} \times 0.2 \times 5^2 + \frac{1}{2}(0.1) \times 2^2 - \left[\frac{1}{2}(0.2 + 0.1) \times 4^2\right]$$

$\therefore v = 4$ from above

$$= \frac{1}{2} \times 0.2 \times 25 + \frac{1}{2} \times (0.1) \times 4 - \left[\frac{1}{2} \times 0.3 \times 16\right]$$

$$= 2.5 + 0.2 - 2.4$$

$$= 2.7 - 2.4$$

Loss in K.E = 0.3 J