4. A particle P of mass $3m$ and a particle Q of mass $5m$ are moving towards each other along the same straight line on a smooth horizontal surface. The particles collide directly.

Immediately **before** the collision, the speed of P is u and the speed of Q is ku.

Immediately **after** the collision, the speed of P is $2v$ and the speed of Q is v.

The direction of motion of each particle is reversed by the collision.

In the collision, P receives an impulse of magnitude $15mv$.

(a) Show that $u = 3v$.

(3)

(b) Find the value of k.

(3)

The coefficient of restitution between P and Q is e.

(c) Find the value of e.

(3)

The total kinetic energy lost in the collision is λmv^2

(d) Find the value of λ.

(3)

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Question 4 continued

(Total for Question 4 = 12 marks)