Momentum and collision of identical balls

(a) State Newton's third law. *[1]*

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(b) State the law of conservation of momentum. *[2]*

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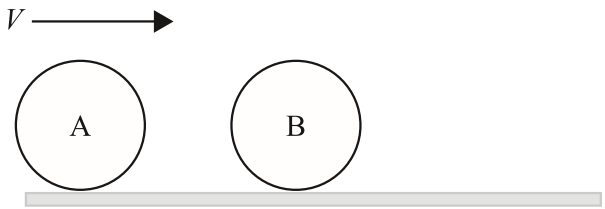
The diagram below shows two identical balls A and B on a horizontal surface. Ball B is at rest and ball A is moving with speed V along a line joining the centres of the balls. The mass of each ball is M.

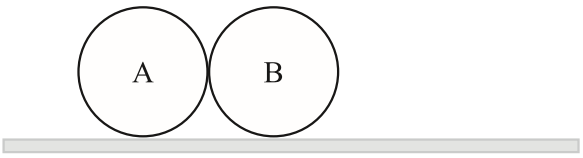
Before collision



During the collision of the balls, the magnitude of the force that ball A exerts on ball B is F_{AB} and the magnitude of the force that ball B exerts on ball A is F_{BA}.

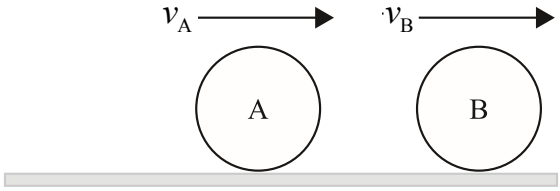
(c) On the diagram below, add labelled arrows to represent the magnitude and direction of the forces F_{AB} and F_{BA}. *[3]*

During the collision



The balls are in contact for a time Δt. After the collision, the speed of ball A is $+v_A$ and the speed of ball B is $+v_B$ in the directions shown.

After the collision



As a result of the collision, there is a change in momentum of ball A and of ball B.

(d) Use Newton's second law of motion to deduce an expression relating the forces acting during the collision to the change in momentum of

(i) ball B. *[2]*

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(ii) ball A. *[2]*

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(e) Apply Newton's third law and your answers to (d), to deduce that the change in momentum of the system (ball A and ball B) as a result of this collision, is zero. *[4]*

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(f) Deduce, that if kinetic energy is conserved in the collision, then after the collison, ball A will come to rest and ball B will move with speed V. *[3]*

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