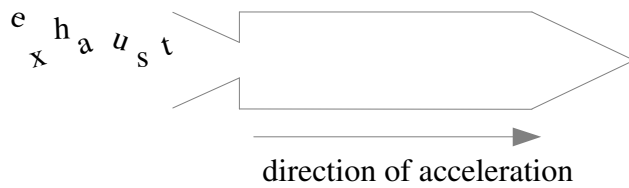Momentum Questions

1. A stick drawing of a firework rocket is propelled by the expulsion of burning "exhaust" letters. The direction of the thrust is shown below:

direction of acceleration

   (a) State the law of conservation of momentum.   /1

   (b) Use this law to explain why the rocket experiences constant acceleration (assuming the mass of the rocket stays constant, the exhaust letters are of equal mass and are expelled at a constant rate).
   /3

The firework (of mass m) is travelling at speed v when it explodes and breaks into two identical fragments, each of mass $\frac{m}{2}$.

The two fragments, fragment A and fragment B, each travel at an angle of 60° to the rocket's initial direction of motion, as shown in the diagram below:

fragment A, $\frac{m}{2}$

rocket, m
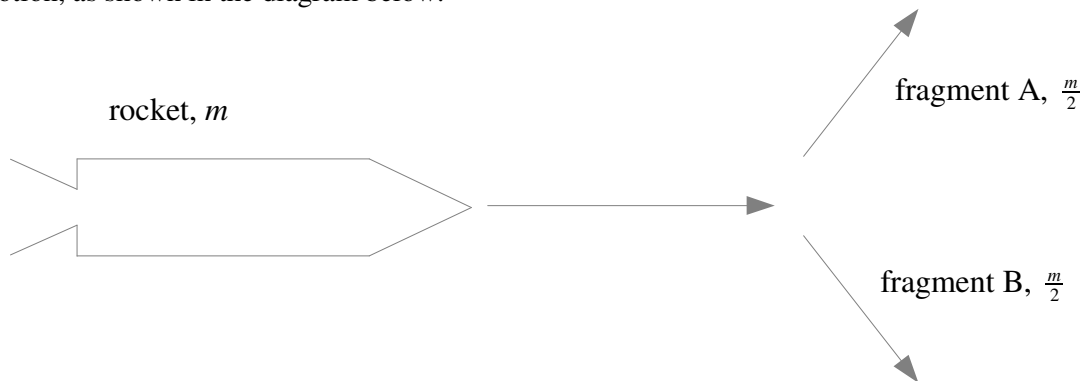
fragment B, $\frac{m}{2}$

   (c) Determine the speed of fragment A in terms of v. Give reasons for your answer.   /3

2.
   a) Derive the equation $\Delta \vec{p}_1 + \Delta \vec{p}_2 = 0$ expressing the conservation of momentum for two interacting particles. /2

   b) Hence state an equation expressing the conservation of momentum for three interacting particles.   /1

3.
   A particle of mass 2.0kg moving at 3.0ms^{-1} collides with a stationary mass of 3.0kg. After the collision the masses move off at right angles to each other, with the 2.0kg mass having a velocity of 2.0ms^{-1} .

   Calculate the speed of the 3.0kg mass after the collision.   /4

4.

  a) Explain in terms of the law of conservation of momentum, how the momentum of light particles (photons) can be used to accelerate a solar sail.   /2

  b) Explain, using vector diagrams, whether absorbed photons or reflected photons would give a craft with a solar sail more acceleration.   /3

5. Ball A, with mass m is moving at speed 2.0 ms^{-1} and collides with ball B of mass 0.25 kg which is stationary. After the collision, the balls are moving away at right angles to each other, as shown below:

A

2.0 ms^{-1}

A   1.3 ms^{-1}

B

0.9 ms^{-1}
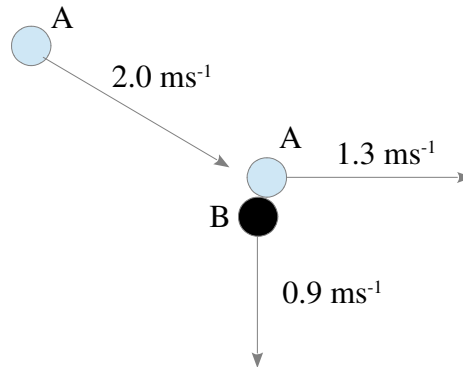
  Determine the mass of ball A.

                                                                                /4

6. A stationary object explodes into three fragments, A, B and C, as shown below.
    Fragment A has a mass of 0.10 kg
    Fragment B has a mass of 0.13 kg and a speed of 0.29 ms^{-1}
    Fragment C has a mass of 0.095 kg and a speed of 0.32 ms^{-1}
    Fragments B and C are moving away at right angles to each other

A

B

C
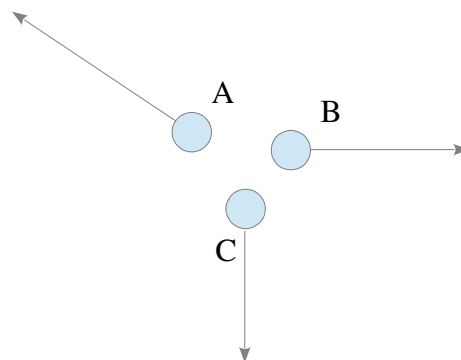
  Determine the speed and direction of fragment A.   /5