Year 13 Science: Centre of mass and momentum in two dimensions

Name: _____ Date: _____

Try these without your notes first, then check the answer key.

Practice

1. A 4.0 kg mass sits at x = 0 and a 1.0 kg mass at x = 2.5 m. Where is the centre of mass?

2. A 0.0580 kg tennis ball hits a racquet at 20.0 m s^{-1} and returns straight back at 30.0 m s^{-1}. Contact lasts 4.00 ms. Find the average force on the ball.

3. A 0.400 kg ball moving east at 5.00 m s^{-1} hits a 0.600 kg ball moving north at 2.50 m s^{-1}, and they stick together. Find their velocity.

4. A 3.00 kg object at rest explodes into three 1.00 kg pieces. One goes east at 6.00 m s^{-1} and one north at 8.00 m s^{-1}. Find the velocity of the third piece.

Exam-style question: a tackle

In a rugby match, Sione (95.0 kg) runs east at 6.00 m s^{-1}. Nikau (110 kg) runs at 5.00 m s^{-1} in a direction 60.0° north of west. Nikau tackles Sione and they move off together. Ignore friction from the ground during the tackle.

5. Calculate the size of each player's momentum before the tackle.

6. Calculate the velocity of the two players just after the tackle. A vector diagram may help.

7. The tackle lasts 0.300 s. Calculate the size of the average force on Sione.

8. Explain why momentum is conserved in the tackle but kinetic energy is not.

Fix the mistake

9. Correct this statement: "Total momentum = 18 000 + 21 000 = 39 000 kg m s^{-1} for the two cars."

10. Correct this statement: "The ball hits and leaves at 12.0 m s^{-1}, so its momentum did not change and there was no impulse."

11. Correct this statement: "Momentum is conserved, so kinetic energy must be conserved as well."

12. Correct this statement: "The angle of 49.4° is just given as the answer, with no reference direction."