PHYS 105 · Chapter 9: Linear Momentum and Collisions

Final-Exam Review — questions from PSU past final exams (Terms 182 – 242)

Constant: g = 9.81 m/s^2 · The source of each question is shown in [brackets].

Part 1: Multiple-Choice Questions (17)

Indicate the answer choice that best completes the statement or answers the question.

9.3 Linear Momentum

Q1. *The product of an object's mass and its velocity is called:* **[Final 231]**

A *kinetic energy*
B *momentum*
C *impulse*
D *inertia*

Q2. *Which of the following is a unit of momentum?* **[Final 202]**

A *Ns*
B *kgm/s^2*
C *N/s*
D *kgm^2/s*

Q3. *Which of the following are vector quantities?* **[Final 222]**

A *Momentum and energy*
B *Momentum and impulse*
C *Momentum and velocity*
D *Both B and C*

Q4. *A 70 kg man and a 40 kg boy are running with the same velocity. Who has more momentum?* **[Final 221]**

A *The man*
B *The boy*
C *They have the same momentum*
D *Not enough information*

Q5. *What is the magnitude of the momentum of a 0.140 kg baseball traveling at 45.0 m/s?* **[Final 222]**

A *0.03 kgm/s*
B *284 kgm/s*
C *6.30 kgm/s*
D *0.140 kgm/s*

Q6. *A 1.0 kg ball moving at 2.0 m/s perpendicular to a wall rebounds from the wall at 1.5 m/s. The change in the momentum of the ball is (initial direction positive):* **[Final 242]**

A *–0.5 kgm/s*
B *3.5 kgm/s*
C *–3.5 kgm/s*
D *0.5 kgm/s*

Q7. *A 0.12 kg ball moving at 6 m/s is hit by a bat, which reverses its direction and gives it a speed of 14 m/s. What is the magnitude of the change in its momentum?* **[Final 232 · Final 241]**

A *0.39 kgm/s*
B *1.3 kgm/s*
C *0.42 kgm/s*
D *2.4 kgm/s*

9.4 Collision and Impulse

Q8. *The impulse experienced by a body is equal to its change in:* [Final 232]

A *velocity*
B *kinetic energy*
C *momentum*
D *none of the above*

Q9. *The fastest recorded baseball pitch was 45.0 m/s. What impulse is needed to give a 0.145 kg baseball (initially at rest) this momentum?* [Final 221]

A *6.53 Ns*
B *65.3 kgm/s*
C *0.653 kgm/s*
D *65.3 Ns*

Q10. *A soccer player kicks a 0.450 kg ball moving at 3.20 m/s in the same direction as it is moving, increasing its speed to 12.8 m/s. What is the magnitude of the impulse delivered to the ball?* [Final 231]

A *2.45 kgm/s*
B *4.32 kgm/s*
C *5.61 kgm/s*
D *7.08 kgm/s*

Q11. *A 58 g tennis ball moving horizontally at 30 m/s is hit by a racket and bounces back at 35 m/s. What is the magnitude of the impulse delivered to the ball?* [Final 182]

A *3.77 Ns*
B *0.29 Ns*
C *2.03 Ns*
D *1.74 Ns*

Q12. *When spiking a volleyball, a player changes its velocity from 4.2 m/s to −24 m/s along a certain direction. If the impulse delivered to the ball is −9.3 kgm/s, what is the mass of the volleyball?* [Final 222]

A *0.33 kg*
B *0.47 kg*
C *262 kg*
D *11 kg*

Q13. *A 1.5 kg ball moving at 16 m/s hits a wall and bounces back at 9 m/s. If the ball is in contact with the wall for 0.3 s, what is the magnitude of the average force from the wall on the ball?* [Final 202]

A *35 N*
B *75 N*
C *125 N*
D *37.5 N*

Q14. *A 0.15 kg rubber ball is thrown down onto the floor. Its speed is 6.5 m/s just before impact and 3.5 m/s just after. If the ball is in contact with the floor for 0.025 s, what is the magnitude of the average force applied by the floor?* [Final 232]

A *60 N*
B *3.0 N*
C *133 N*
D *3.5 N*

9.6–9.7 Collisions

Q15. *In which of the following collisions is momentum conserved (isolated system)?* **[Final 211]**

A *Perfectly elastic collisions*
B *Inelastic collisions*
C *Completely inelastic collisions*
D *All types of collisions*

Q16. *In an elastic collision, which of the following is correct?* **[Final 221 · Final 222]**

A *Only momentum is conserved.*
B *Only kinetic energy is conserved.*
C *Momentum and K are both conserved.*
D *Neither momentum nor K is conserved.*

Q17. *A 2 kg ball moving at 6 m/s hits a 4 kg ball at rest in a head-on, perfectly elastic collision. What is the velocity of the 2 kg ball after the collision?* **[Final 182]**

A *2 m/s in the same direction*
B *3 m/s in the same direction*
C *3 m/s opposite to the initial direction*
D *2 m/s opposite to the initial direction*

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Part 2: Problems (11)

Solve the following problems and show your work in detail.

Problem 1. *Two balls of mass 2 kg and 8 kg move toward each other and undergo a head-on collision. Their initial velocities are +12 m/s and −5 m/s respectively. After the collision, the smaller ball bounces back with a velocity of −3 m/s.* **[Final 202]**

a) *What is the velocity of the larger ball after the collision?*

b) *How much kinetic energy is lost in this collision?*

Problem 2. *Two balls of masses 7 kg and 3 kg move toward each other along a straight line with speeds 12 m/s and 20 m/s respectively. They collide head-on and stick together.* **[Final 211]**

a) *Calculate the velocity of the combined object after the collision.*

b) *Calculate the kinetic energy lost in the collision.*

Problem 3. *A 4 kg ball sliding on a frictionless surface at 12 m/s to the right collides head-on with a 2 kg ball sliding at 3 m/s to the left. The two balls stick together.* **[Final 221]**

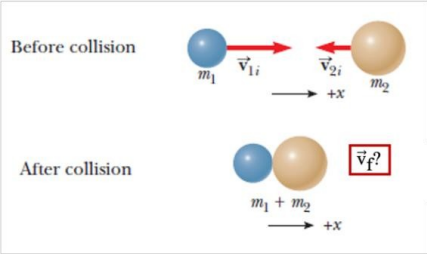
a) *Find the momentum of each ball before the collision.*

b) *Find their velocity after the collision.*

c) *Find the total kinetic energy before and after the collision.*

d) *What is the loss in kinetic energy due to the collision?*

Problem 4. *A ball of mass $m_1 = 2$ kg sliding on a frictionless surface at 12 m/s to the right collides head-on with a ball of mass $m_2 = 4$ kg sliding at 3 m/s to the left. The two balls stick together.* **[Final 242]**



a) *Find the magnitude and direction of their velocity just after the collision.*

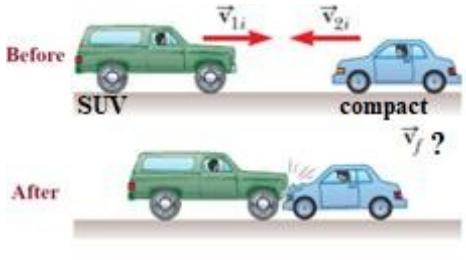
b) *Find the total kinetic energy before the collision.*

c) *Find the total kinetic energy after the collision.*

d) *Find the kinetic energy lost. Is the collision elastic or inelastic? Explain.*

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Problem 5. *An 1800 kg SUV traveling east at 15 m/s collides head-on with a 900 kg compact car traveling west at 15 m/s. The cars stick together.* **[Final 231]**



a) *Find the velocity of the cars after the collision.*

b) *Find the total kinetic energy before and after the collision.*

c) *Find the change in kinetic energy of the system.*

Problem 6. *Two gliders move toward each other on a frictionless air track. Glider A (5.75 kg) moves to the right at 6.00 m/s, and glider B (7.50 kg) moves to the left at 5.00 m/s. The gliders stick together when they collide.* **[Final 232]**

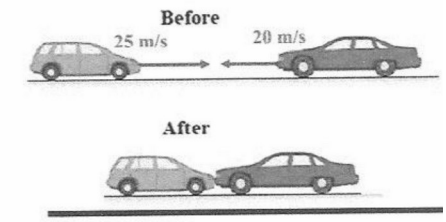
a) *Find the magnitude and direction of their velocity after the collision.*

b) *Calculate the total initial kinetic energy.*

c) *Calculate the total final kinetic energy.*

d) *Calculate the change in kinetic energy.*

Problem 7. *Two cars on a frictionless surface collide and stick together. Before the collision, car 1 (m_1 = 1100 kg) was moving to the right at 25 m/s, and car 2 (m_2 = 1400 kg) was moving to the left at 20 m/s.* **[Final 241]**



a) *Find the magnitude and direction of their velocity just after the collision.*

b) *Find the total kinetic energy before the collision.*

c) *Find the total kinetic energy after the collision.*

d) *Find the kinetic energy lost. Is the collision elastic or inelastic? Explain.*

Problem 8. *A 0.2 kg billiard ball moving to the right has a head-on, perfectly elastic collision with a 1.5 kg bowling ball at rest. After the collision, the bowling ball moves at 0.8 m/s to the right.* **[Final 211]**

a) *Calculate the velocity of the billiard ball before and after the collision.*

b) *Show that kinetic energy is conserved in this collision.*

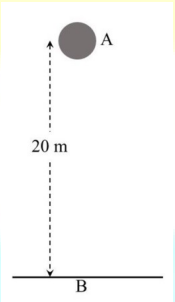
Problem 9. *A 92 kg astronaut and a 1200 kg satellite are at rest relative to the space shuttle. The astronaut pushes on the satellite, giving it a speed of 0.14 m/s directly away from the shuttle.* **[Final 222]**

a) *Use conservation of momentum to find the speed of the astronaut after pushing.*

b) *Calculate the total initial and final kinetic energy.*

c) *Is kinetic energy conserved? Why?*

Problem 10. *A 1.5 kg ball is dropped from rest from point A, 20 m above the ground, and hits the floor at point B. During the fall, the work done by air resistance on the ball is –102 J.* **[Final 211]**



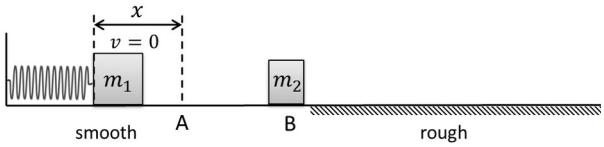
a) *What is the average force of air resistance on the ball from A to B?*

b) *Find the speed of the ball just before it hits the ground.*

c) *The ball bounces upward at 11 m/s. Calculate the impulse delivered by the floor to the ball.*

d) *If the ball is in contact with the floor for 0.25 s, calculate the average force of the floor on the ball.*

Problem 11. *A spring (k = 1200 N/m) is compressed by x = 2 cm by a block m_1 = 3 kg on a smooth horizontal surface and released from rest. After leaving the spring, the block collides head-on with a block m_2 = 1.5 kg at rest. The blocks stick together and slide onto a rough surface (μ_k = 0.25) until they stop.* **[Final 182]**



a) *Find the speed of m_1 when it leaves the spring (point A).*

b) *Find the speed of the two blocks just after the collision (point B).*

c) *Find the distance the blocks travel on the rough surface before they stop.*

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