Student #: _____ Student Name: _____

Physics 12 Homework Class 5: Momentum & Impulse

_____ 1. Two ice skaters, a large man and a small woman, are initially at rest and holding each other's hands. They push away horizontally. Afterwards, which of the following statements is true?

(a) They have equal and opposite kinetic energies.
(b) The have equal and opposite momenta.
(c) The large man applies a greater force to the small woman.
(d) The small woman applies a greater force to the large man.
(e) They recoil with equal and opposite velocities.

_____ 2. Which of the following has the greatest magnitude of momentum?

(a) A $500\,\text{kg}$ car moving at $40\,\text{m/s}$
(b) A $30{,}000\,\text{kg}$ dump truck at rest
(c) A $1000\,\text{kg}$ SUV moving at $25\,\text{m/s}$
(d) A $90{,}000{,}000\,\text{kg}$ aircraft carrier moving at $2\,\text{cm/s}$

_____ 3. The momentum change of an object exactly equals which of the following?

(a) The force acting on the object
(b) The velocity change of the object
(c) The product of force and the time the force acts
(d) The product of force and the change in velocity
(e) The ratio of net force and mass

_____ 4. In a particular crash safety test, engineers study what happens when cars hit solid walls. Which of the following observations best indicates that *less* force is exerted on the car?

(a) The car hits the wall and bounces back.
(b) The car crushes during the collision.
(c) The crash dummy flies through the windshield.
(d) The front seat airbags are deployed.
(e) The wall crumbles upon collision.

_____ 5. A $1000\,\text{kg}$ railroad car is rolling without friction on a horizontal track at a speed of $3.0\,\text{m/s}$. Sand is poured into the open top of the car for a time of $5.0\,\text{s}$. The speed of the car after $5.0\,\text{s}$ is $1.0\,\text{m/s}$. The mass of the sand added to the car at the end of $5.0\,\text{s}$ is

(a) $500\,\text{kg}$
(b) $100\,\text{kg}$
(c) $2000\,\text{kg}$
(d) $3000\,\text{kg}$
(e) $3500\,\text{kg}$

6. In a game of egg-toss, you and a partner are throwing an egg back and forth trying not to break it. Given your vast knowledge of momentum, what hint(s) could you give to your partner to keep the force of impact on the egg as low as possible? Clearly explain your answer.

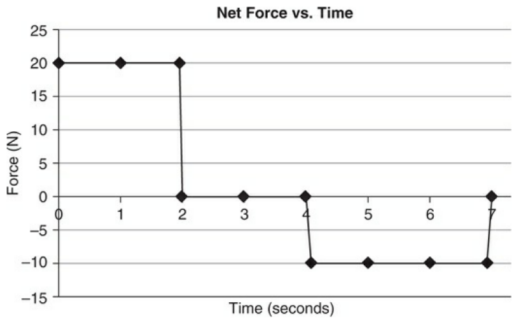
7. Does the situation depicted below defy the law of conservation of momentum? Explain.

8. In a crash test, a car strikes a wall with an average force of 1.23×10^7 N [S] over an interval of 21.0 ms. Calculate the impulse.

9. In a crash test similar to the one described in the last problem, another car, with the same mass and velocity as the first car, experiences an impulse identical to the value you calculated in the last problem. However, the second car is designed to crumple more slowly than the first. As a result, the duration of the crash is 57.1 ms. Determine the average force exerted on the second car.

10. A 1385 kg cannon containing a 58.5 kg cannon ball is on wheels. The cannon fires the cannon ball, giving it a velocity of 49.8 m/s [N]. What is the initial velocity of the cannon the instant after it fires the cannon ball?

11. A $2.0\,\mathrm{kg}$ box is initially moving at $3.0\,\mathrm{m/s}$ and is pushed along a horizontal, frictionless surface with a force that varies with time according to the following graph:



(a) Qualitatively describe what happens to the motion of the box in the following time intervals: 0-$2.0\,\mathrm{s}$, 2.0-$4.0\,\mathrm{s}$, and 4.0-$7.0\,\mathrm{s}$.
(b) Calculate the momentum change of the box during each second of elapsed time.
(c) Plot the velocity versus time graph for this motion.
(d) After $7.0\,\mathrm{s}$ clock reading, the box collides with a wall and bounces backwards at $6.0\,\mathrm{m/s}$. Given that the box is in contact with the wall for $0.20\,\mathrm{s}$, calculate the average force that the wall exerts on the box.

12. Two amusement park bumper cars are heading directly towards each other. The combined mass of car A plus driver is $375\,\mathrm{kg}$ and it is moving with a velocity of $+1.8\,\mathrm{m/s}$. The combined mass of car B plus driver is $422\,\mathrm{kg}$ and it is moving with a velocity of $-1.4\,\mathrm{m/s}$. When they collide, they become stuck together and continue moving along the same straight line. What is their velocity immediately after they collide?

13. A $1875\,\text{kg}$ car is travelling along a country road when the driver sees a deer dart out onto the road. The driver slams on the brakes and manages to stop before hitting the deer. The driver of a second car (mass $2135\,\text{kg}$) is driving too close. When the driver realizes that the car ahead has stopped, he hits the brakes but is unable to stop. The two cars lock together and skid another $4.58\,\text{m}$ along a straight line before coming to a stop. If the coefficient of friction between concrete and rubber is 0.750, what is the speed of the second car when it hits the stopped car?

14. While playing a game of billiards, your $0.17\,\text{kg}$ cue ball, travelling at $1.9\,\text{m/s}$, glances off a stationary $0.16\,\text{kg}$ "eight ball" so that the eight ball moves off at $1.3\,\text{m/s}$ at an angle of 32° clockwise from the cue ball's original path. What is the final velocity (both magnitude and direction) of the cue ball?

15. An $80\,\mathrm{kg}$ astronaut has become detached from the safety line connecting her to the International Space Station. She is $200\,\mathrm{m}$ from the station, and at rest relative to it. She only has 4.0 minutes of air remaining. To get herself back, she tosses a $10\,\mathrm{kg}$ tool kit away from the station at $8.0\,\mathrm{m/s}$. Will she make it back in time?

16. Two blocks are free to slide along the friction-less wooden track shown below. The block of mass $m_1 = 4.98\,\mathrm{kg}$ is released from the position shown, at height $h = 5.00\,\mathrm{m}$ above the flat part of the track. Protruding from its front end is the north pole of a strong magnet, which repels the north pole of an identical magnet embedded in the back end of the block of mass $m_2 = 9.40\,\mathrm{kg}$, initially at rest. The two blocks never touch. Calculate the maximum height to which m_1 rises after the elastic collision.