Momentum Review Package

Momentum and Impulse

1) A rubber ball of mass 80.0 g hits a wall at 30.0 m/s and rebounds at 20.0 m/s, calculate its $\Delta \rho$.

2) A 60.0 g golf ball at rest is hit for 0.020 s by a 100.0 N force (golf club). What is the ball's change in momentum and new velocity?

3) A 50.0 g tennis ball is screaming towards Serena William's racket at 90. km/h. If the ball ends up leaving her racket going the opposite direction at 120. km/h, determine the ball's change in momentum. Consider the direction Serena hits the ball to be positive.

4) A ball (m = 0.210 kg) is dropped and is moving at 1.8 m/s just before it hits the floor. If the ball rebounds from the floor at 1.8 m/s and was in contact with floor for 0.11 s calculate:
    a) the ball's change in momentum.
    b) the impulse the ball experienced due to the collision with the cushion.
    c) the force the cushion exerted on the ball during the collision.

5) Bobby Hull takes a slap shot and the 220 g puck is on the stick for 0.013 s and it leaves going 40.0 m/s.
    a) Calc puck's $\Delta\rho$
    b) Calc F_{net} on puck

6) A *Return of the Jedi* lunch bucket (0.400 kg) is sliding across the floor at 4.3 m/s. 1.3 s later it is going 2.1 m/s.
    a) Calc $\Delta \rho$
    b) Calc F_{fr}
    c) Calc μ

7) Hank is standing at one end of the rink before practice trying to hit the goal post at the other end. He fires the 275 g puck at 15 m/s towards the post. 1.7 s later the puck is traveling at 13.2 m/s. Determine…
    a) the puck's change in momentum.
    b) the force of friction acting on the puck, slowing it down. (Do not use kinematics!)
    c) the coefficient of friction between the puck and the ice.

8) Wile E. Coyote (m = 22.0 kg) is after the Roadrunner again. This time he is using a large rubber band stretched between two posts to reach a high enough speed to catch the fleet bird. The coyote runs into the rubber band backwards at 3.50 m/s. The rubber band exerts a 400.0 N force on him for 1.30 s, forwards. Determine the velocity of the coyote after the rubber band has released him.

9) A skater (55 kg) is drifting along at 3.0 m/s when his friend pushes him with a 50.0 N force until his speed increases to 7.5 m/s.
    a) What is the skater's change in momentum?
    b) For how long did his friend push for?

10) A passenger railcar (m = 6.00 $x10^4$ kg) has broken away from the rest of the train. The wayward car is heading for a washed out bridge 1100 m ahead at 12.0 m/s. Spiderman arrives just in time to try to stop the train by pulling it backwards with a 4.00 x 10^3 N (he's got spider strength) force.
    a) How much time will it take Spiderman to stop the train?
    b) Will our hero be able to stop the train before bad things happen? (HINT: find a first, then use kinematics)

11) Thor throws his 45 kg hammer at the Incredible Hulk at 75 m/s. The Hulk catches the hammer and manages to stop it over a distance of 0.80 m,
    a) Determine the acceleration of the hammer as the Hulk stops it.
    b) Determine the time it took for the Hulk to stop the hammer.
    c) Using the formula for impulse, determine the force the Hulk exerted on the hammer.
    d) Do you get the same result as c) when you use $F_{net} = ma$?

12) A 0.6 kg green rubber ball is going 20 m/s due east when it collides with a 0.4 kg ball which is at rest. During the collision of 0.04 s, the green ball feels a 100.0 N force.
    a) What is the direction of the force on the green ball?
    b) What is the green ball's $\Delta \rho$ due to collision?
    c) What force must the b-ball have experienced during collision?
    d) What is $\Delta \rho$ on the b-ball?
    e) What was total $\Delta \rho$ for both balls due to collision?

13) Buddy (90.0 kg) is running 12 m/s due north. Pal tackles Buddy and he feels a 400.0 N force for 0.50 s, due south.
    a) Find Buddy's $\Delta \rho$
    b) Find Buddy's V_f after the collision
    c) What $\Delta \rho$ does Pal feel?
    d) What is the total overall $\Delta \rho$ for the two of them?

14) Sami is skating with the 320.0 g puck at 14.0 m/s, when he unleashes a slap shot. The puck screams towards the net at 50.0 m/s.
    a) Calc $\Delta \rho$ of puck
    b) If the puck was on the stick (during the shot) for 0.0100 s, find the force the stick exerted on the puck.
    c) What impulse did the stick experience due to its collision with the puck?

Collisions

1) A 250 g hockey puck going 40.0 m/s hits a stationary goalie (m = 80.0 kg) right in the middle of the pads and sticks there. At what speed do the goalie and puck move together after the collision? (Assume no friction)

2) A movie crew is performing a stunt during which a stationary car (1200 kg) will be blown into two pieces. If a 450 kg piece flies off at 22 m/s due west after the explosion, what is the velocity of the other piece?

3) A 0.650 kg basketball is flying through space at 6.3 m/s to the right when it collides head on with a 0.190 kg baseball, traveling at 2.8 m/s to the left. After the collision (which took 0.11 s) the basketball has slowed down to 1.3 m/s to the right.
    a) What is the post collision velocity of the baseball?
    b) What impulse did the basketball experience due to the collision?
    c) What force did the basketball experience during the collision?

4) While two 2.5 kg physics carts are rolling along at 2.0 m/s, an explosive device placed between them is detonated by remote control. If the front cart continues along at 4.0 m/s, what is the post "explosion" velocity of the other cart?

5) A proton (mass = 1.67×10^{-27} kg) traveling in a particle accelerator at 1.00×10^{7} m/s collides with a helium nucleus, which is at rest. The proton rebounds back at 6.00×10^{6} m/s and the helium nucleus jumps forward at 4.00×10^{6} m/s.
    a) Determine the mass of the helium nucleus.
    b) What impulse does the proton experience due to the collision?

6) An exploding plastic egg is sitting at rest on a lab table when it explodes into two pieces. One piece goes left at 6.0 m/s, call it m_1, and the other piece goes right at 8.0 m/s, call it m_2. If m_1 has a mass of 120 g, what is the mass of m_2?

7) Two asteroid miners, Thelma (60.0 kg) and Louise (42.0 kg), are attached by a tether, somewhere in space. Thelma sees something of great interest so she pulls on the tether to get the attention of her partner. Due to the small tug Thelma moves towards Louise at 0.40 m/s. What is Louise's velocity?

8) A 75 g marble flying along at 70.0 m/s runs into a 3.1 kg watermelon lying on a large table upon which $\mu = 0.25$. The marble sticks in the watermelon and the pair go sliding across the table.
    a) Determine the velocity of the pair immediately after the collision.
    b) Calculate how far they travel before coming to a stop.

9) A 150 g coffee mug is going 20 m/s W when it collides with a 200 g Gumby doll going 4 m/s W. The doll ends up going 12 m/s W after the collision.
    a) Calc mug's V_f.
    b) Calc doll's $\Delta \rho$?
    c) What is the mug's $\Delta \rho$?

Answers

Momentum and Impulse:

1) - 4.00 kgm/s
2) $\Delta p = 2.0$ kgm/s, $V_f = 33$ m/s
3) 2.9 kgm/s
4) a. 0.76 kgm/s b. 0.76 kgm/s c. 6.9 N
5) a. 8.8 kgm/s b. 6.8×10^2 N
6) a. -0.88 kgm/s b. -0.68 N c. 0.17
7) a. -0.50 kgm/s b. -0.29 N c. 0.11
8) 20.0 m/s
9) a. 2.5×10^2 kg m/s b. 5.0 s
10) a. 180 s b. yes with about 20 m to spare
11) a. -3.5×10^3 m/s^2 b. 2.1×10^{-2} s c. -1.6×10^5 N d. yup
12) a. west b. 4 kgm/s west c. 100 N east d. 4 kgm/s east e. 0 kgm/s
13) a. -2.0×10^2 kgm/s b. 1.0×10^1 m/s c. -2.0×10^2 kgm/s d. 0 kgm/s
14) a. 11.5 kgm/s b. 1150 N c. -11.5 kgm/s

Collisions:

1) 0.12 m/s
2) 13 m/s, due east
3) a. v = 14 m/s right b. $\Delta p = -3.3$ kgm/s c. $F = -3.0 \times 10^1$ N
4) 0 m/s
5) a. 6.68×10^{-27} kg b. -2.67×10^{-20} kgm/s
6) 0.090 kg
7) 0.57 m/s, towards Thelma
8) a. 1.7 m/s b. 0.56 m
9) a 9.3 m/s west b. 1.6 kgm/s west c. - 1.6 kgm/s west or 1.6 kgm/s east