**Momentum Review Questions**

Momentum and Newton’s Second Law

**1.** Calculate the momentum for the following:

**a)** A 120 kg rugby player running at 4.0 m/s

**b)** The Statue of Liberty (*m* = 2.04 x105 kg) moving forward at 0.2 m/s

**c)** A 60 g tennis ball moving at 140 km/h

**d)** A blue whale (*m* = 130 tonnes) swimming at 20 km/h

**e)** A dragonfly of mass 0.900 g flying at 29 km/h

**2.** A golf ball is hit with an average force of 2200 N. If the impact lasts 1.30 x 10-3 s,

**a)** what is the impulse imparted to the ball?

**b)** what is the ball’s change in momentum?

**3.** A car travelling at 22 m/s changes its velocity to 26 m/s in the same direction. If the car’s mass is 1750 kg,

**a)** what is the change in momentum of the car?

**b)** what is the impulse applied to the car?

**4.** Repeat Problem 3, assuming that the car changed its velocity to 26 m/s in the

opposite direction.

**5.** A pilot experiences an acceleration of 125 m/s2 for 0.20 s when she ejects out of a fighter plane. If her mass is 60 kg,

**a)** what impulse is applied to her?

**b)** what is her change in velocity?

**6.** One of the dangers of space walks is that there are numerous small particles moving at great speeds in space. Calculate the speed a golf ball of mass 45 g must have in order to have the same momentum as a 2 mm piece of paint of mass 4.0 g moving at 8.1 x 103 m/s. Convert your answer to km/h.

**7.** When the astronauts are doing space walks, the shuttle is oriented such that it protects them from the small, high-speed particles. However, there are numerous other larger pieces of space junk out there that could cause great harm to the shuttle itself. What speed would a 2000 kg car need to have in order to have the same momentum as a 2.0 lb object moving at 4.5 miles/s?

(1 kg \_=2.2 lbs, 1 mile = 5280 feet, 1 foot = 12 inches, 1 inch = 2.54 cm)

**8.** What force is exerted on a catcher’s glove if a 142 g baseball is thrown at 160 km/h and takes

**a)** 20 ms to stop?

**b)** 0.20 s to stop?

**9.** A person of mass 80 kg falling at 100 km/h opens a parachute, which slows him down to 33 km/h in 4.0 s. He then lands on the ground and comes to a complete stop. Find the force in each of the following cases:

**a)** The force of the parachute exerted to slow the person down

**b)** The force exerted by the ground if he bends his legs, rolls, and takes 0.500 s to

come to a stop

**c)** If he lands stiff-legged in 0.0150 s

**10.** A bullet of mass 0.0600 kg is fired into a block of wood. If the bullet is moving at

330 m/s as it enters the block and takes 0.15 m to stop, find

**a)** the average force required to stop the bullet.

**b)** the impulse exerted by the wood on the bullet.

**c)** the change in momentum of the bullet.

**11.** A tennis ball travelling at 30 m/s is hit back with a racket at 40 m/s. If the ball has a mass of 60 g and is in contact with the racket for

0.025 s,

**a)** what is the average force on the ball?

**b)** what is the acceleration of the ball?

**12.** A football player of mass 120 kg is moving at 15 km/h. If he is stopped by a tackle lasting 1.10 s, find

**a)** the change in momentum of the football player.

**b)** the impulse imparted to the football player.

**c)** the average force needed to stop the player.

**d)** the distance he moved during the stopping time.

Conservation of Momentum

Problems 13-17 involve two identical pool balls.

**13.** A pool ball of mass 0.165 kg, moving at 8.2 m/s, hits another pool ball, which is at rest. If the first ball continues to move at 3.0 m/s in the forward direction, find the velocity of the second ball.

**14.** Find the velocity of the second ball if the ball in Problem 13 rebounds at 1.2 m/s.

**15.** If the second ball is moving at 2.0 m/s in the same direction as the original ball, find its final velocity after being hit by ball 1 in Problem 13.

**16.** If the second ball attains a velocity of 4.5 m/s from a velocity of 2.2 m/s, what is the initial velocity of the first ball if its final velocity is 0.8 m/s? Both balls move in the same direction after collision.

**17.** Ball 1 is moving at 7.6 m/s to the right. Ball 2 is moving at 4.5 m/s to the left. If ball 2 moves at 2.5 m/s to the right after the collision, find ball 1’s final velocity.

**18.** A lump of clay of mass 40 g moving at 25 cm/s collides with another lump of clay of mass 50 g at rest. What is the final velocity of the two lumps if they are joined together after the collision?

**19.** A 2200 kg car moving at 40 km/h collides head on with an 1800 kg car moving at

20 km/h. Find the velocity of the combined cars after the collision.

**20.** A grenade of mass 300 g at rest blows up into two fragments. If one fragment has a mass of 120 g and is moving at 220 m/s, what is the mass and velocity of the other fragment?

**21.** A 250 g bullet moving at 330 m/s hits and travels through a 1.2 kg block of wood, 0.30 m long. If the bullet’s speed upon leaving the block is 120 m/s, find

**a)** the block’s velocity after the bullet exits.

**b)** the impulse applied to the block.

**c)** the impulse applied to the bullet. (Which of Newton’s laws does this instance

remind you of?)

**d)** the time the bullet spent in the wood.

**e)** the force applied to the bullet.

**f)** the acceleration of the bullet.

**22.** A 10 000 kg loaded truck is moving at 30 km/h. Superman, with mass 100 kg, stands waiting to stop it. When the truck hits him, the only force available to stop the truck is that of friction. Assume that the coefficient of kinetic friction between his suit and the ground is 1.4, and calculate

**a)** the change in momentum of the truck.

**b)** the impulse applied to the truck by Superman.

**c)** the force of friction available.

**d)** the time it takes to bring the truck to rest.

**e)** the distance the truck and Superman travel before they stop.