Physics 112
Worksheet – Extra Momentum, Impulse and Impulse-Momentum Theorem Problems
(November 2016)

1. What is the momentum of a golf ball with a mass of 62 g moving at 73 m/s [W]?
   (-4.5 kgm/s)

2. The momentum of a car is 5.0×10^4 kgm/s. The velocity of the car is 25.9 m/s. What is the mass of the car? (1.9×10^3 kg)

3. A ball was hit by a bat. The impact force is 257 N, and the contact time is 0.23 s. What is the impulse received by the ball? (+59 Ns)

4. A 1.00×10^3 kg car crashed into a garden and stopped. The impulse is 4.6×10^3 Ns and the impact force is 2.1×10^3 N. How long does it take the car to stop? (2.2 s)

5. A 44 kg block with velocity 30 m/s encounters a constant 60 N frictional force that stops the block.
   a) What was the initial momentum of the block? ($+1.3 \times 10^3$ kgm/s)
   b) How long did it take the block to stop? (22 s)

6. Assume a 10.0 kg bowling ball moving at 4.9 m/s [E] bounces off a wall at 1.0 m/s [W].
   a) What is its change in velocity of the bowling ball? (5.9 m/s [W])
   b) What is its change of momentum of the ball? (59 kgm/s [W])
   c) What is the final momentum of the ball? (10 kgm/s [W])
   d) What is the impulse exerted on of the ball? (59 kgm/s [W])
   e) If the interaction with the wall occurs in 0.22 s, calculate the average force that the wall exerts on the ball. (2.7×10^2 N [W])

7. A 2.56 kg rock falls from the top of a 13.0 m high building and strikes the ground below. Calculate the impulse experienced by the rock when it hits the ground. (+40.9 kgm/s)

8. A 1.2×10^3 kg car is brought from 25 m/s to 10 m/s over a time period of 5.0 seconds. Determine the force experienced by the car. (-3.6×10^3 N)

9. a) What is the momentum of a 112 kg quarterback running with a speed of 4.8 m/s?
      ($+5.4 \times 10^2$ kgm/s)
   b) What impulse must a tackler impart to the quarterback to stop him? (-5.4×10^2 kgm/s)
   c) If the tackle is completed in 1.2 s, what average force is exerted by the tackler on the quarterback? (-4.5×10^2 N)

10. A 5.00 kg ball accelerates from rest at a rate of 2.00 m/s^2 for 1.50 seconds. Calculate the ball's momentum after the acceleration. (+15.0 kgm/s)

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9. a) What is the momentum of a 112 kg quarterback running with a speed of 4.8 m/s?
      ($+5.4 \times 10^2$ kgm/s)
   b) What impulse must a tackler impart to the quarterback to stop him? (-5.4×10^2 kgm/s)
   c) If the tackle is completed in 1.2 s, what average force is exerted by the tackler on the quarterback? (-4.5×10^2 N)

10. A 5.00 kg ball accelerates from rest at a rate of 2.00 m/s² for 1.50 seconds. Calculate the ball's momentum after the acceleration. (+15.0 kgm/s)

11. A 2.00 kg rock is dropped from the top of a 30.0 m high building. Calculate the ball's momentum at the time that it strikes the ground. (-48.5 kgm/s)

12. A force of 20.0 N is applied to a 3.00 kg object for 4.00 s. Calculate the impulse experienced by the object. (+80.0 Ns)

13. A 1.00 kg rock is thrown up into the air from ground level at a speed of 8.00 m/s. The ball travels up to a maximum height, then returns to the ground. Calculate the rock's momentum as it strikes the ground. (-8.00 kgm/s)

14. A 1200 kg car traveling at 20.0 m/s speeds up to 30.0 m/s. What is the impulse experienced by the car? (+1.2 x 10^4 kgm/s)

15. A 1500 kg car traveling at 80.0 km/h comes to a screeching halt in a time of 4.00 seconds. Calculate the force of friction experienced by the car. (-8.33 x 10^3 N)

16. A 1275 kg car crashed into a wall. The impulse is 4.0 x 10^3 Ns [E] and the impact time is 0.51 s. What is the impact force on the car? (7.8 x 10^3 N [E])

17. A 1.00 kg ball traveling towards a soccer player at a velocity of 5.00 m/s rebounds off the soccer player's foot at a speed of 8.50 m/s. The time of contact between the ball and the player's foot was 20.0 ms.
    a) What was the ball's final velocity? (-8.50 m/s)
    b) What was the ball's change in momentum? (-13.5 kgm/s)
    c) What force did the foot apply on the ball? (-675 N)

18. A 1.50 kg rock falls from the top of a 10.0 m high building and strikes the ground below. What is the force of the ground acting on the rock if it comes to a stop in 0.350 s? (+60.0 N)

19. The momentum of a car is 3.0 x 10^4 kgm/s south. The mass of the car is 1500 kg. What is the velocity of the car? (-20 m/s)

20. With what velocity must a 0.53 kg softball be moving to equal the momentum of a 0.31 kg baseball moving at 21 m/s? (+12 m/s)

21. Calculate the impulse experienced by
    a) a 65.8 kg halfback encountering a force of 1025 N for 0.350 s. (+359 Ns)
    b) a 0.168 kg tennis ball encountering a force of 126 N that changes its velocity by 61.8 m/s. (+10.4 kgm/s)

22. A force of 8.0 x 10^3 N causes an 80.3 kg fullback to change his velocity by 10 m/s. Determine the impulse experienced by the fullback. (8.0 x 10^2 kgm/s)

23. A 0.80 kg soccer ball experiences an impulse of 25 Ns. Determine the momentum change of the soccer ball. (+25 Ns)

24. A 92 kg tight end moving at 9.0 m/s encounters a 400 Ns impulse. Determine the velocity change of the tight end. (+4.3 m/s)

25. For how long must a tow truck pull with a force of 550 N on a stalled 1200 kg car to give it a forward velocity of 2.0 m/s? (4.4 s)

26. A 0.19 kg hockey puck decreases its speed from 40 m/s to 0 m/s in 0.025 s. Determine the force that it experiences. (-3.0×10^2 N)

27. The club head (m = 0.170 kg) of a golf club collides with a golf ball (m = 0.046 kg) at rest upon a tee. Circle the appropriate choice.

   a) Which object experiences the greatest force?

      club head   golf ball   both the same

   b) Which object experiences the greatest impulse?

      club head   golf ball   both the same

   c) Which object experiences the greatest Δmomentum?

      club head   golf ball   both the same

   d) Which object experiences the greatest acceleration?

      club head   golf ball   both the same

28. What is the change in momentum caused by a 35 N force to the right acting on a mass for 7.6 s? ($+2.7 \times 10^2$ Ns)

29. A force acting on a 6.5 kg body increases its speed uniformly from 2.0 m/s to 8.0 m/s through 5.0 seconds.
   a) What is the initial and final momentum of the body? (+13 kgm/s and +52 kgm/s)
   b) What impulse did the body receive? (+39 kgm/s)
   c) What is the net force acting on it? (+7.8 N)

30. How long must a 50 N force act on a 400 kg mass to increase its speed from 10 m/s to 12 m/s? (16 s)

31. Ball A has a mass of 5.0 kg and Ball B has a mass of 10 kg. Both are dropped from rest from a height of 2.0 meters off the ground.
   a) Compare their velocities right before impact with the ground. (both -6.3 m/s)
   b) Compare their accelerations right before impact with the ground. (both -9.80 m/s^2)
   c) Compare their momenta right before impact with the ground. (-32 kgm/s and -63 kgm/s)