Unit 6: Newton's Laws Review

$v_f = v_i + at$ $\quad \Delta x = \frac{1}{2}(v_i + v_f)t$ $\quad v_f^2 = v_i^2 + 2a\Delta x$ $\quad \Delta x = v_i t + \frac{1}{2} at^2$

net $F = ma$ $\quad F_g = ma_g$ $\quad F_f = \mu F_N$ $\quad p = mv$ $\quad$ ~~$Ft = mv_f - mv_i$~~

Concepts

1. The block is initially moving at a speed of 5 m/s to the right. If no net force acts on it, what will be its subsequent motion?
   a) The block moves to the right and slows down.
   b) The block moves to the right at the same speed.
   c) The block moves to the right and speeds up.
   d) Its subsequent motion cannot be determined without more information.

2. The block, initially moving to the right at 5 m/s, is acted upon by a net force to the left. How will it continue to move?
   a) The block moves to the right at the same speed.
   b) The block moves to the right and slows down.
   c) The block moves to the right and speeds up.
   d) The block moves to the left and slows down.

3. **A** has a mass of 1 kg, **B** has a mass of 2 kg. Initially, both **A** and **B** are at rest. What is their subsequent motion if the net force acting on **B** is twice the net force acting on **A**.?
   a) **A** and **B** speed up; **B** speeds up twice as fast as **A**.
   b) Both **A** and **B** speed up at the same rate.
   c) Both **A** and **B** remain at rest.

4. A fly ball at a baseball game hits a parked car. As a result the glass breaks....
   a) The ball always exerts more force on the glass than the glass on the ball.
   b) The ball always exerts more force on the glass since the ball is more massive.
   c) The ball and glass always exert equal size forces on one another.

5. If you push against the wall with 10 N of force. Use Newton's 3rd Law to describe the force the wall pushes back.

   wall pushes back w/ 10 N of force.

6. ~~An elevator is traveling from the lobby to the top of the building. As it slows to a stop on the top floor, what happens to your apparent weight?~~

7. You are a passenger in a car that is moving rapidly down a straight road. As the driver makes a sharp left turn, you are pressed against the right side of the car. Explain why this happens.

   your inertia causes you to keep moving in the direction of the path you were first taking ← OBJECTS IN MOTION STAY IN MOTION!

8. If a bug and a truck windshield collide head-on, explain which one experiences a greater impact force.

   SAME FORCE!

Problems

9. What is the tension on a rope that supports a 4.2-kg bucket?

   $F_A = 41.16\,N$
   $F_g = 4.2\,kg \cdot 9.8 = 41.16\,N$

   F_A = Tension = 41.16 N

10. A 65-kg roller skater moves at a constant velocity with a force of 75 N. What is the coefficient of friction between the skater and the floor of the roller rink? All forces balance!

    $F_N = 637\,N$, $F_F = 75\,N$, $F_A = 75\,N$, $F_g = 65\,kg \cdot 9.8 = 637\,N$

    $F_F = \mu F_N$ $\quad 75\,N = \mu \cdot 637\,N$ $\quad \mu = 0.12$

11. An object weighing 35 N is pulled horizontally at constant speed. If the coefficient of friction (μ) is 0.4, what is the frictional force exerted on this object?

    All forces balance!

    $\mu = 0.4$ $\quad F_N = 35\,N$, F_F, F_A, $F_g = 35\,N$ $\quad F_F = \mu F_N$ $\quad F_F = 0.4 \cdot 35\,N$ $\quad F_F = 14\,N$ $\quad (F_A \text{ also} = 14\,N)$

12. During a baseball game, a player hits a homerun, which causes the ball to go from rest to 43 m/s in 0.45 s. The ball has a mass of 0.25 kg. Assuming that the acceleration is constant, find the average net force exerted on the ball by the baseball bat.

$v_i = 0\ m/s$ v_f t net F = ?

$F_g = 0.25 \cdot 9.8 = 2.45$

net F = ma → must use variables given to find

$v_f = v_i + at$

$43 = 0 + a \cdot 0.45$

$a = 95.5\ m/s^2$

net F = 0.25 kg • 95.5 m/s²

net F = 23.88 N

13. A rightward force of 302 N is applied to a 28.6-kg crate to accelerate it across the floor. The coefficient of friction between the crate and the floor is 0.750. Determine the acceleration of the crate.

$F_N = 280.28\ N$, F_F, $F_A = 302\ N$, $a \rightarrow$, $\mu = 0.750$, $F_g = 28.6\ kg \cdot 9.8 = 280.28\ N$

First find F_F: $F_F = \mu F_N$

$= 0.750 \cdot 280.28\ N$

$F_F = 210.15\ N$

Find net F: $net F = F_A - F_F$

$net F = 302\ N - 210.15\ N$

$net F = 91.85\ N$

Find a: $net F = 91.85\ N = ma$

$91.85\ N = 28.6\ kg \cdot a$

$a = 3.21\ m/s^2$ right

14. What is the momentum of a 0.185-kg softball traveling at 25.5 m/s?

p = ? $p = mv$ $p = 0.185\ kg \cdot 25.5\ m/s$

$p = 4.72\ kg \cdot m/s$

For **questions 15-16**, perform the following steps.

a. Draw the free body diagram and include all the forces
b. Determine the net Force
c. Determine the acceleration of the object (if any)

15. A 5-N force is applied to a 1-kg toy car to move it to the right across the floor at a constant velocity of 1.0 m/s.

All forces balance!

$F_N = 9.8\ N$, $F_F = 5\ N$, $F_A = 5\ N$, $F_g = 1\ kg \cdot 9.8 = 9.8\ N$

net F = 0 N ∴ $a = 0\ m/s^2$

16. A 920-kg car is towed into the body shop with a force of 300 N. The friction between the car tires and the road surface is 115 N.

$F_N = 9016\ N$, $F_F = 115\ N$, $F_A = 300\ N$, $F_g = 920\ kg \cdot 9.8 = 9016\ N$

$net F = F_A - F_F$

$net F = 300\ N - 115\ N$

$net F = 185\ N$

$net F = ma$

$185\ N = 920\ kg \cdot a$

$a = 0.20\ m/s^2$, right

17. ~~A 50.0 kg woman rides in an elevator.~~

~~a) While the elevator is moving up at a *constant* 3 m/s, what is the apparent weight (F_N) of the woman?~~

~~b) While the elevator is accelerating *upward* at 2.5 m/s^2, what is her apparent weight (F_N)?~~

18. Suppose an ice skater glides on the ice rink. The coefficient of friction between the ice and the blade of the skate is 0.15. If the skater has a mass of 55 kg, what force is needed to glide across the rink at a constant velocity? All forces balance

$F_N = 539\ N$, F_F, F_A, $F_g = 55\ kg \cdot 9.8 = 539\ N$

$F_A = ?$, but use F_F to find ($F_A = F_F$)

$F_F = \mu F_N$ $F_F = 0.15 \cdot 539$

$F_A = F_F = 80.85\ N$

19. A roller coaster is accelerates at a rate of 16.4 m/s^2. The mass of the car and riders is 6,000 kg. If the force of friction is 5000 N, what is the value of the **applied force** exerted on the car and riders when the ride begins?

$F_N = 58,800\ N$, $F_F = 5000\ N$, $F_A = ?$, $F_g = 6000\ kg \cdot 9.8 = 58,800\ N$

First find net F: $net F = ma$

$= 6000\ kg \cdot 16.4\ m/s^2$

$net F = 98,400\ N$

$net F = 98,400$

$F_A - F_F = 98,400$

$F_A - 5000 = 98,400$

$F_A = 103,400\ N$

20. During a football workout, two linemen are pushing the coach on the sled. The combined mass of the sled and the coach is 300 kg. The coefficient of friction between the sled and the grass is 0.800. The sled accelerates at a rate of 0.580 m/s^2. Determine the force applied to the sled by the linemen.

$F_N = 2940\ N$, F_A, $a \rightarrow 0.580\ m/s^2$, $\mu = 0.800$, F_F, $F_g = 300\ kg \cdot 9.8 = 2940\ N$

First find F_F: $F_F = \mu F_N$

$= 0.800 \cdot 2940$

$F_F = 2352\ N$

use net F to solve for F_A

$net F = 300\ kg \cdot 0.58$

$net F = 174\ N$

$F_A - F_F = 174$

$F_A - 2352\ N = 174$

$F_A = 2526\ N$

21. ~~A 0.145-kg baseball is pitched at 42 m/s. The batter hits it horizontally to the pitcher at 58 m/s.~~

~~a) Find the change in momentum of the ball.~~

~~b) If the ball and bat were in contact for 0.00046 s, what would be the average force while they touched?~~