Forces Problem Set

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1 Problems

These problems have been adapted from the sources listed in parentheses. For all problems, you can assume $g = 10$ m/s^2 to simplify arithmetic. Ignore effects of air resistance unless otherwise specified.

1. (Morin, Problems and Solutions in Introductory Physics)
   Connor and Nafi pull on opposite ends of a rope, each exerting a force F. The tension in the rope is
   (A) $\frac{F}{2}$
   (B) F
   (C) $2F$

2. (No source)
   Kevin makes the following claim: "Kinetic friction opposes the direction of motion." Kevin's statement is
   (A) always true
   (B) sometimes true
   (C) never true

3. (Tipler, Physics for Scientists and Engineers)
   A 10 kg block is suspended from the ceiling of an elevator by a cord rated to withstand a tension of 150 N. Shortly after the elevator starts to ascend, the cord breaks. Find the minimum acceleration of the elevator when the cord broke.

4. (Tipler, Physics for Scientists and Engineers)
   Amrita exerts a horizontal force of 100 N to push a 12 kg block up a frictionless incline that makes an angle of 25° with the horizontal. Find the acceleration of the block.

5. (Courtesy of Dr. Dell)
   Bryan drives his truck around a circular track with radius $R = 100$ m at constant speed 25 m/s. A box with a mass of 10 kg hangs from a string in the back of the truck. The coefficient of static friction between the trick's tires and the roadway is 1. Find the angle θ that the string makes with the vertical and the magnitude of the tension in the string.

6. (Morin, Problems and Solutions in Introductory Physics)
   Connor flies his plane at speed v in a horizontal circle of radius R. Find the angle at which the plane should be banked so that he doesn't feel like he is getting flung to the side in his seat. At this angle, find his apparent weight (the normal force from the seat).

7. (Morin, Introduction to Classical Mechanics)
   A particle of mass m is subject to a force $F(t) = kt$. The initial position is x_0, and the initial speed is zero. Find $x(t)$.

8. (Classic)
   A block of mass m rests on a plane inclined at an angle θ. The coefficient of static friction between the block and the plane is μ. Find the largest θ such that the block does not slide down the ramp.

9. ($F = ma$ 2018A)
Two blocks of masses $m_1 = 2.0$ kg and $m_2 = 1.0$ kg are stacked together on top of a frictionless table with m_1 on top of m_2. The coefficient of static friction between the blocks is $\mu_s = 0.20$. Larry applies a horizontal force F to the top block to make it slides across the bottom block. Find the minimum F.

10. (Morin, Introduction to Classical Mechanics)
A book of mass M is positioned against a vertical wall. The coefficient of friction between the book and the wall is μ. Anya keeps the book from falling by pushing on it with a force F applied at an angle θ with respect to the horizontal. Find the minimum F required for a given θ.

11. (No source)
Nafi is rotating around a merry-go-round (MGR) 10 m from the center. If Nafi can achieve a maximum speed of 20 m/s without slipping, find the coefficient of static friction between Nafi and the MGR.

12. (Courtesy of Dr. Dell)
Connor drives his motorbike along a vertical loop with radius R. The coefficient of static friction between the motorbike's wheels and the loop is μ. Find the minimum μ that would allow Connor to maintain a constant speed v during his drive. Assume $v^2 > Rg$.

13. (No source)
A block of mass m is attached to a spring with spring constant k hanging from the ceiling. Find the displacement of the block from the equilibrium position.

14. (Morin, Problems and Solutions in Introductory Physics)
A spring has spring constant k. If Amrita cuts it in half, find the spring constant of each of the resulting shorter springs.

15. (Classic)
A block of mass m is attached to a spring with spring constant k in equilibrium. Anya pulls the block a distance A away from equilibrium and releases it. Assuming there is no friction, the block will then oscillate around the equilibrium position. Find the period of oscillation.

16. (No source)
A 20 kg block is attached to one end of a spring with spring constant 10 N/m. The other end of the spring is attached to a pole with negligible radius. While still attached to the spring, the block undergoes uniform circular motion around the pole with constant speed 6 m/s. Find the distance the spring is stretched.