Physics Unit 2: Forces Review

1. Know about force, free-body diagrams, Newton's Laws of Motion, inertia, weight, normal force, apparent weight, static friction, kinetic friction and which is greater, tension, Hooke's Law, equilibrium, fundamental forces
2. What is the net force required to stop a 635-kg moose if it stops with a $-2.35\ m/s^2$ acceleration?
3. What is the acceleration of a 1000-kg car that stops with a braking force of 500 N?
4. A 900-kg elephant is standing on the ground. If there are no other forces, what is the normal force between the elephant and the ground?
5. Francis rides a freefall drop ride at the fair. What is her apparent weight if her mass is 60 kg and the ride is accelerating down at $8.0\ m/s^2$?
6. A 15-kg wagon is pulled across the ground with a constant speed by a rope making an 30° angle with the ground. If the pulling force is 90 N, what is the coefficient of friction between the wagon and the ground?
7. A box is sitting on a table. The coefficient of friction between the table and box is 0.4. If a 70-N horizontal force is required to slide the box across the table, what is the box's mass?
8. A 70-kg sled slides across the level ground and is slowing down due to friction. If the coefficient of friction is 0.2, what is acceleration of the box?
9. A 20-kg child sits on a spring attached to the ground. The spring is compressed 20 cm. If it is in equilibrium, what is the spring constant?
10. An elevator is hung from a cable which is attached to a pulley. If the elevator's mass is 5000 kg and it is rising with a constant velocity, what is the tension in the cable?
11. A 0.1-kg soup can is pulled behind a car by a string. If the string is horizontal and the coefficient of friction is 0.7, what is the tension in the string when the car accelerates at $3\ m/s^2$?
12. A spring with $k = 5000$ N/m is stopping a 2×10^5-kg train. If the spring is compressed 90 cm, what is the acceleration of the train?
13. A 5-kg monkey has a rope tied around her waist. That rope goes up to the ceiling and around a pulley. Then the rope goes back down to the monkey. The monkey pulls on the rope so that she goes up towards the ceiling. If she pulls with 30 N, what is her acceleration?

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Answers

2. $F_{net} = ma$

   $F_{net} = (635\ kg)\left(-2.35\frac{m}{s^2}\right) = \mathbf{-1490\ N}$

3. $F_{net} = ma$

   $500\ N = (1000\ kg)a$

   $\mathbf{0.5}\frac{\mathbf{m}}{\mathbf{s^2}} = a$

4. $F_{net} = ma$

   $F_N - mg = 0$

   $F_N - (900\ kg)\left(9.8\frac{m}{s^2}\right) = 0$

   $F_N = \mathbf{8820\ N}$

5. $F_{net} = ma$

   $F_N - mg = ma$

   $F_N - (60\ kg)\left(9.8\frac{m}{s^2}\right) = (60\ kg)\left(-8.0\frac{m}{s^2}\right)$

   $F_N - 588\ N = -480\ N$

   $F_N = \mathbf{108\ N}$

6. y-direction: $F_{net} = ma$

   $F_N - mg + F_{pull}\sin\theta = 0$

   $F_N - (15\ kg)\left(9.8\frac{m}{s^2}\right) + (90\ N)\sin 30° = 0$

   $F_N = 102\ N$

   x-direction: $F_{net} = ma$

   $F_{pull}\cos\theta - f_k = 0$

   $F_{pull}\cos\theta - \mu_k F_N = 0$

   $(90\ N)\cos 30° - \mu_k(102\ N) = 0$

   $-\mu_k(102\ N) = -77.94\ N$

   $\mu_k = \mathbf{0.76}$

7. y-direction: $F_{net} = ma$

   $F_N - mg = 0$

   $F_N = mg = \left(9.8\frac{m}{s^2}\right)m$

   x-direction: $F_{net} = ma$

   $F_{pull} - f_s = 0$

   $F_{pull} - \mu_s F_N = 0$

   $70\ N - 0.4\left(9.8\frac{m}{s^2}\right)m = 0$

   $\left(-3.92\frac{m}{s^2}\right)m = -70\ N$

   $m = \mathbf{17.9\ kg}$

8. y-direction: $F_{net} = ma$

   $F_N - mg = 0$

   $F_N - (70\ kg)\left(9.8\frac{m}{s^2}\right) = 0$

   $F_N = 686\ N$

   x-direction: $F_{net} = ma$

   $-f_k = ma$

   $-\mu_k F_N = ma$

   $-0.2(686\ N) = (70\ kg)a$

   $\mathbf{-1.96}\frac{\mathbf{m}}{\mathbf{s^2}} = a$

9. $F_{net} = ma$

   $k\Delta x - mg = 0$

   $k(0.2\ m) - (20\ kg)\left(9.8\frac{m}{s^2}\right) = 0$

   $k(0.2\ m) = 196\ N$

   $k = \mathbf{980\ N/m}$

10. $F_{net} = ma$

    $T - mg = 0$

    $T - (5000\ kg)\left(9.8\frac{m}{s^2}\right) = 0$

    $T = \mathbf{49000\ N}$

11. y-direction: $F_{net} = ma$

    $F_N - mg = 0$

    $F_N = (0.1\ kg)\left(9.8\frac{m}{s^2}\right) = 0.98\ N$

    x-direction: $F_{net} = ma$

    $T - f_k = ma$

    $T - \mu_k F_N = ma$

    $T - 0.7(0.98\ N) = (0.1\ kg)\left(3\frac{m}{s^2}\right)$

    $T - 0.686\ N = 0.3\ N$

    $T = \mathbf{0.986\ N}$

12. x-direction: $F_{net} = ma$

    $-k\Delta x = ma$

    $-\left(5000\frac{N}{m}\right)(0.9\ m) = (2\times 10^5\ kg)a$

    $-4500\ N = (2\times 10^5\ kg)a$

    $-\mathbf{0.0225}\frac{\mathbf{m}}{\mathbf{s^2}} = a$

13. $F_{net} = ma$

    $2T - mg = ma$

    $2(30\ N) - (5\ kg)\left(9.8\frac{m}{s^2}\right) = (5\ kg)a$

    $11\ N = (5\ kg)a$

    $\mathbf{2.2}\frac{\mathbf{m}}{\mathbf{s^2}} = a$