Unit 4: **Name: ________________**
Dynamics: Newton's Laws of Motion **Date: ________Period_____**

Questions: Use additional sheets to place answers. Don't try to fit on these pages.

1. Why does a child in a wagon seem to fall backward when you give the wagon a sharp pull forward?

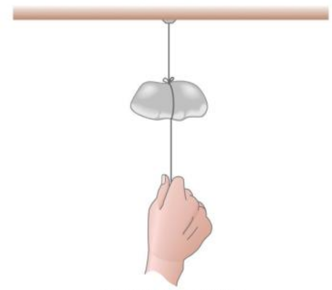
2. If the acceleration of an object is zero, are no forces acting on it? Explain.

3. When a golf ball is dropped to the pavement, it bounces back up. (*a*) Is a force needed to make it bounce back up? (*b*) If so, what exerts the force?

4. Why might your foot hurt if you kick a heavy desk or a wall?

5. A stone hangs by a fine thread from the ceiling, and a section of the same thread dangles from the bottom of the stone (Fig. 4–36). If a person gives a sharp pull on the dangling thread, where is the thread likely to break: below the stone or above it? What if the person gives a slow and steady pull? Explain your answers.

Figure 4-36
Question 9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6. Would a spring scale carried to the Moon give accurate results if the scale had been calibrated (*a*) in pounds, or (*b*) in kilograms?

7. When an object falls freely under the influence of gravity there is a net force mg exerted on it by the Earth. Yet by Newton's third law the object exerts an equal and opposite force on the Earth. Why doesn't the Earth move?

8. According to Newton's third law, each team in a tug of war pulls with equal force on the other team. What, then, determines which team will win?

9. When you stand still on the ground, how large a force does the ground exert on you? Why doesn't this force make you rise up into the air?

10. A heavy crate rests on the bed of a flatbed truck. When the truck accelerates, the crate remains where it is on the truck, so it, too, accelerates. What force causes the crate to accelerate?

11. A block is given a push so that it slides up a ramp. After the block reaches its highest point, it slides back down but the magnitude of its acceleration is less on the descent than on the ascent. Why?

Problems:

Newton's Laws, Gravitational Force, Normal Force

1. (I) What force is needed to accelerate a child on a sled $(\text{total mass} = 60.0\text{ kg})$ at $1.25\,\text{m/s}^2$?

2. (I) How much tension must a rope withstand if it is used to accelerate a 960-kg car horizontally along a frictionless surface at $1.20\,\text{m/s}^2$?

3. (II) What average force is needed to accelerate a 7.00-gram pellet from rest to $125\,\text{m/s}$ over a distance of 0.800 m along the barrel of a rifle?

4. (II) The cable supporting a 2125-kg elevator has a maximum strength of 21,750 N. What maximum upward acceleration can it give the elevator without breaking?

5. (III) A person jumps from the roof of a house 3.9-m high. When he strikes the ground below, he bends his knees so that his torso decelerates over an approximate distance of 0.70 m. If the mass of his torso (excluding legs) is 42 kg, find (*a*) his velocity just before his feet strike the ground, and (*b*) the average force exerted on his torso by his legs during deceleration.

Newton's Laws and Vectors:

6. (I) A box weighing 77.0 N rests on a table. A rope tied to the box runs vertically upward over a pulley and a weight is hung from the other end (Fig. 4–40). Determine the force that the table exerts on the box if the weight hanging on the other side of the pulley weighs (*a*) 30.0 N, (*b*) 60.0 N, and (*c*) 90.0 N.

Figure 4-40
Problem 19

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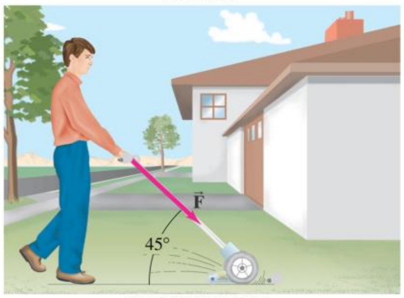
7. (II) A person pushes a 14.0-kg lawn mower at constant speed with a force of $F = 88.0\text{ N}$ directed along the handle, which is at an angle of 45.0º to the horizontal (Fig. 4–45). (*a*) Draw the free-body diagram showing all forces acting on the mower. Calculate (*b*) the horizontal friction force on the mower, then (*c*) the normal force exerted vertically upward on the mower by the ground. (*d*) What force must the person exert on the lawn mower to accelerate it from rest to $1.5\,\text{m/s}$ in 2.5 seconds, assuming the same friction force?

Figure 4-45
Problem 26



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8. (II) A window washer pulls herself upward using the bucket–pulley apparatus shown in Fig. 4–48. (*a*) How hard must she pull downward to raise herself slowly at constant speed? (*b*) If she increases this force by 15%, what will her acceleration be? The mass of the person plus the bucket is 65 kg.

Figure 4-48
Problem 29

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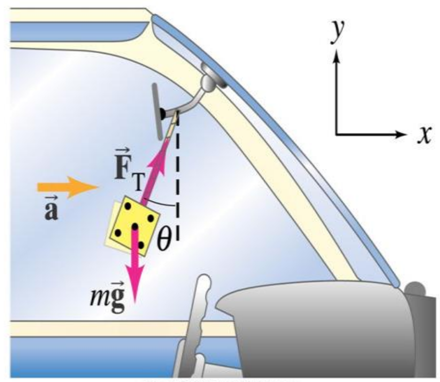
9. (II) A pair of fuzzy dice is hanging by a string from your rearview mirror. While you are accelerating from a stoplight to $28\,\text{m/s}$ in 6.0 s, what angle θ does the string make with the vertical? See Fig. 4–50.

Figure 4-50
Problem 32



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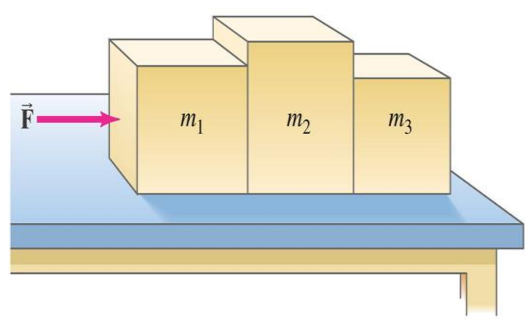
10. (III) Three blocks on a frictionless horizontal surface are in contact with each other, as shown in Fig. 4–51. A force $\vec{\mathbf{F}}$ is applied to block 1 $(\text{mass}\, m_1)$. (*a*) Draw a free-body diagram for each block. Determine (*b*) the acceleration of the system (in terms of m_1, m_2, and m_3), (*c*) the net force on each block, and (*d*) the force of contact that each block exerts on its neighbor. (*e*) If $m_1 = m_2 = m_3 = 12.0\,\text{kg}$ and $F = 96.0\,\text{N}$, give numerical answers to (*b*), (*c*), and (*d*). Do your answers make sense intuitively?

Figure 4-51
Problem 33



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Newton's Laws with Friction; Inclines

11. (I) If the coefficient of kinetic friction between a 35-kg crate and the floor is 0.30, what horizontal force is required to move the crate at a steady speed across the floor? What horizontal force is required if μ_k is zero?

12. (I) What is the maximum acceleration a car can undergo if the coefficient of static friction between the tires and the ground is 0.80?

13. (II) The coefficient of static friction between hard rubber and normal street pavement is about 0.8. On how steep a hill (maximum angle) can you leave a car parked?

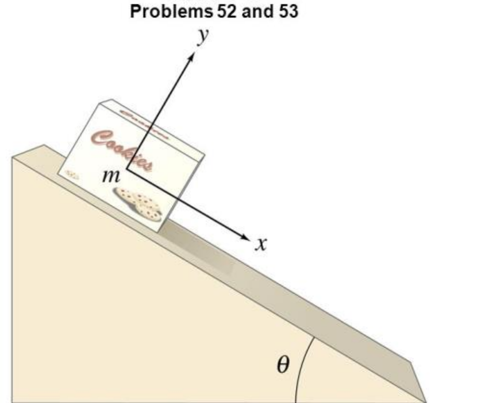
14. (II) A 15.0-kg box is released on a 32º incline and accelerates down the incline at $0.30\,\text{m/s}^2$. Find the friction force impeding its motion. What is the coefficient of kinetic friction?

15. (II) (*a*) A box sits at rest on a rough 30º inclined plane. Draw the free-body diagram, showing all the forces acting on the box. (*b*) How would the diagram change if the box were sliding down the plane? (*c*) How would it change if the box were sliding up the plane after an initial shove?

16. (II) Two crates, of mass 75 kg and 110 kg, are in contact and at rest on a horizontal surface. A 620-N force is exerted on the 75-kg crate. If the coefficient of kinetic friction is 0.15, calculate (*a*) the acceleration of the system, and (*b*) the force that each crate exerts on the other. (*c*) Repeat with the crates reversed.

17. (II) A carton is given an initial speed of $3.0\,\text{m/s}$ up the 22.0º plane shown in Fig. 4–55. (*a*) How far up the plane will it go? (*b*) How much time elapses before it returns to its starting point? Ignore friction.

Figure 4-55
Problems 52 and 53



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18. (II) A roller coaster reaches the top of the steepest hill with a speed of $6.0\,\text{km/h}$. It then descends the hill, which is at an average angle of 45º and is 45.0 m long. What will its speed be when it reaches the bottom? Assume $\mu_k = 0.18$.

19. (III) A coffee cup on the dashboard of a car slides forward on the dash when the driver decelerates from $45\,\text{km/h}$ to rest in 3.5 s or less, but not if he decelerates in a longer time. What is the coefficient of static friction between the cup and the dash?