Chapter 3
Dynamics: Motion and Force
3.1 Newton's 2nd Law-1D Acceleration-Horizontal Motion Homework # 19

I

01. A net force of 185.0 N is acting on a 25.0 kg object initially at rest.
    a.) What is the acceleration of the object? b.) What is the velocity of the object after 8.25 s?

02. For the brief moment that a baseball bat is in contact with the baseball as a batter hits a pitched ball, the ball "feels" a force of 27,100 N causing it to accelerate at an incredible 193,600 m/s^2. What is the mass of the baseball?

03. How much tension must a rope withstand if it is to accelerate a 1400.0-kg car at 0.850 m/s^2. (Ignore friction)

04. How much force is needed to accelerate a bicycle and its rider (total mass 125-kg) at a rate of 2.15 m/s^2?

05. A net force of 285 N accelerates an object at 5.35 m/s^2. What is the mass of the object?

II

06. What average force is required to stop a 1200.0-kg car in 6.50 s if it is traveling 82.5 km/h?

07. A 0.145-kg baseball traveling 38.5 m/s strikes the catchers mitt causing it to recoil backward 13.5 cm as the ball is brought to rest. What was the average force applied by the glove on the ball?

08. Santa's sleigh, which has a mass of 62.5 kg (without Santa as an occupant), is pulled by eight tiny reindeer with an average force of 8350 N over a 60.0-m stretch of snow before becoming airborne. Assuming the sleigh started from rest, what was the sleigh's takeoff speed? (Ignore friction)

09. A man pushes a 58.5-kg sofa 2.55 m across a carpet with a force of 315 N. If the retarding force (frictional force) is 280N, how long does it take the man to move the sofa? (Assume it started from rest)

10. A 170-g hockey puck leaves a hockey stick with an initial velocity of 11.2 m/s. If the puck travels 64.5 m, what is the retarding force on the puck from the ice?

11. A 73.2-kg man runs 4.50 m/s into a padded wall. If the wall exerts an average force of 18,000 N on the man, how far did the padding compress to stop the man?

ANSWERS: **01.** a.) 7.40 m/s^2 b.) 61.1 m/s **02.** 140 g **03.** 1190 N **04.** 269 N **05.** 53.3 kg **06.** 4231 N **07.** 796 N **08.** 127 m/s **09.** 2.92 s **10.** 0.165 N **11.** 4.12 cm

Chapter 3
Dynamics: Motion and Force
3.2 Newton's 2nd Law-1D Acceleration-Vertical Motion Homework # 20

I

01. A 16.5-kg box is sitting on the floor.
    a.) What minimum force is needed to lift the box?
    b.) If an upward force of 250.0 N is applied to the box, what will be its acceleration?

02. An upward force of 45.0 N is applied to catch a falling girl's bowling ball with a mass of 5.45 kg (12 lb). What is the acceleration of the ball?

II

03. An 800.0-N marine is trying to pull himself to the top of a 10.0-m high rope. If he pulls himself upward with an average force of 825.0 N, how long will it take him to reach the top?

04. A 103.0-kg swat team member descends a 27.5-m cable attached to a helicopter. If he wishes to reach the bottom in 3.50 s, what average force should he apply to the cable?

05. What minimum force is needed to lift a 3.72-kg object off the floor up onto the table 82.5 cm above?

06. A 640-kg elevator is supported by a cable. Find the tension in the cable if the elevator is _____.
    a.) not moving
    b.) moving up at a constant speed of 3.00 m/s
    c.) moving down at a constant speed of 3.00 m/s
    d.) accelerating up at a constant 3.00 m/s^2
    e.) accelerating down at a constant 3.00 m/s^2

07. A 0.100-g spider is descending a web strand by applying a force of 5.65×10^{-4} N. What is the acceleration of the spider? Ignore air resistance.

08. What is the average force exerted by a shotputter on a 7.26-kg shot if it is moved vertically through a distance of 2.75 m and is released with a speed of 12.5 m/s?

09. A 3250-kg elevator is designed to provide a maximum acceleration of 0.0750 *g*. What are the maximum and minimum forces the motor should exert on the supporting cable?

10. What is the acceleration of a 87.5-kg skydiver at a moment when the air resistance exerts a force of 275.0 N?

11. The supporting cable of a 1925-kg elevator has a maximum strength of 23,275 N. What maximum acceleration can it give the elevator without breaking?

III

12. A person jumps from a tower 4.65 m high. As he lands, his knees bend so that his torso decelerates over a distance of approximately 0.675 m. If the mass of his torso is 47.5 kg, what average force did his legs provide on his torso during the deceleration? Hint: Find his velocity just before he hits the ground as a start to the problem.

ANSWERS: **01.** a.) 162 N b.) 5.35 m/s^2 **02.** -1.54 m/s^2 **03.** 8.08 s **04.** 547 N **05.** 36.5 N
06. a.) 6270 N b.) 6270 N c.) 6270 N d.) 8190 N e.) 4350 N **07.** -4.15 m/s^2 **08.** 277 N
09. 34,239 N; 29,461 N **10.** -6.66 m/s^2 **11.** 2.29 m/s^2 **12.** 3675 N

Chapter 3
Dynamics: Motion and Force
3.3 Newton's 2nd Law-2D Acceleration-Force Vectors Homework # 21

I

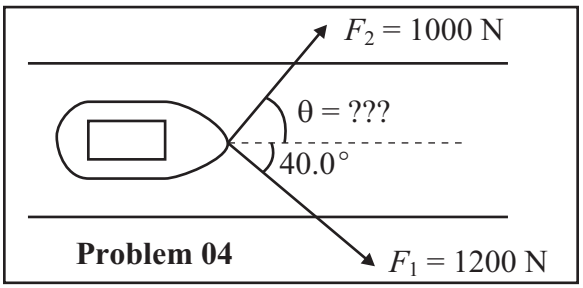
01. A child pulls on the handle of a 12.5-kg wagon with a force of 85.0 N. If the handle is making a 30.0° angle with the ground, what is the acceleration of the wagon (ignore frictional losses)?

II

02. A man pushes a 13.5-kg lawnmower at a constant speed with a force of 75.0 N directed along the handle which is at an angle of 45.0° with the horizontal. Calculate _____.
    a.) the horizontal retarding force on mower
    b.) the normal force exerted vertically upward on the mower by the ground
    c.) the force the man must exert on the handles of the mower to accelerate it from rest to 1.50 m/s in 2.50 s

03. A 67.5-kg sprinter exerts a force of 775 N on the starting block which makes a 20.0° angle to the ground.
    a.) What was the horizontal acceleration of the sprinter?
    b.) If the force was exerted for 0.340 s, with what speed did the sprinter leave the starting block?

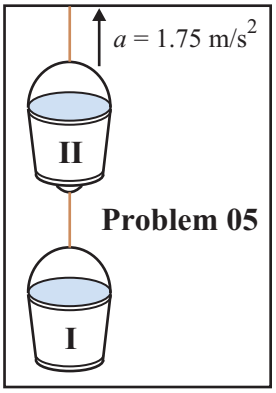
04. Two horses, on opposite sides of a canal, are pulling a boat through the canal via a rope tied from the boat to each horse. One horse is pulling with a force of 1200 N at angle of 40.0° with the direction of the boat's travel. If the other horse pulls with a force of 1000 N, what must be the direction of his pull if the boat moves parallel to the two sides of the canal? See the diagram to the right.



Problem 04

System of Objects

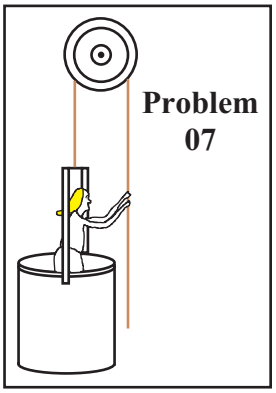
05. One paint bucket weighing 37.5 N (bucket I) is hanging by a massless cord from another paint bucket weighing 31.7 N (bucket II). The two are being pulled upward by a massless cord attached to the top bucket at 1.75 m/s^2 (Shown at right). Calculate the tension in each cord.



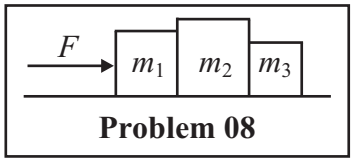
Problem 05

06. A 5350-kg helicopter accelerates upward at 0.625 m/s^2 while lifting a 1350-kg car attached by a cable.
    a.) What is the lift force exerted by the air on the rotors?
    b.) What is the tension in the cable (ignore its mass) that attaches the car to the helicopter?

07. A window washer pulls herself upward using a bucket-pulley apparatus shown in the diagram below and to the right. The mass of the window washer plus the bucket is 92.5 kg.
    a.) How hard must she pull downward to raise herself at a constant speed?
    b.) If she increases this force by 10 percent, what will her acceleration be?


Problem 07

08. Three blocks on a frictionless horizontal surface are in contact with each other, as shown below. A force of F is applied to block 1 (mass m_1) as shown below. Determine _____.
    a.) the acceleration of the system (in terms of F, m_1, m_2, and m_3)
    b.) the net force on each block (in terms of F, m_1, m_2, and m_3)
    c.) the force that each block exerts on any adjacent block or blocks (in terms of F, m_1, m_2, and m_3)
    d.) If m_1 = 8.00 kg, m_2 = 10.0 kg, m_3 = 6.00 kg, and $\boldsymbol{F}$ = 100 N, give numerical answers to a.), b.), and c.).



Problem 08

ANSWERS: **01.** 5.89 m/s^2 **02.** a.) 53.0 N b.) 185 N c.) 86.4 N **03.** a.) 3.93 m/s^2 b.) 1.34 m/s
04. 50.5° **05.** F_{T1} = 44.2 N, F_{T2} = 81.6 N **06.** a.) 69, 848 N b.) 14,074 N **07.** a.) 453 N b.) 0.98 m/s^2
08. d.) a = 4.17 m/s^2, F_{Net1} = 33.3 N, F_{Net2} = 41.7 N, F_{Net3} = 25 N, $F_{12} = F_{21}$ = 66.7 N, $F_{23} = F_{32}$ = 25.0 N

Chapter 3
Dynamics: Motion and Force
3.4 Newton's 2nd Law-2D Acceleration-Friction Homework # 22

Static Friction Causing Objects to Move

II

01. What is the maximum acceleration that a car can attain if the coefficient of static friction between the tires and the level ground is 0.80?

02. A flatbed truck is carrying a 61.7-kg sofa. If the coefficient of static friction between the feet of the sofa and the bed of the truck is 0.55, what is the maximum acceleration (or deceleration) the truck can undergo without the sofa sliding?

03. A magician pulls a table cloth off a table out from under a setting of plates and glasses. If the coefficient of static friction between the table settings and the table cloth is 0.67, what minimum acceleration must the magician give the table cloth as he pulls if the table settings are to remain in place?

Static and Kinetic Friction Opposing Objects' Motion

I

04. If the coefficient of kinetic friction between a 32.5-kg object and the floor is 0.20, what horizontal force is required to move the crate at a constant speed across the floor?

05. A 78.0 kg refrigerator has rubber feet. The coefficient of static friction between a floor and the feet is 1.10, while its coefficient of kinetic friction is 0.90.
    a.) What minimum force is needed to begin moving the refrigerator across the floor?
    b.) Once the refrigerator begins moving, what minimum force is needed to keep it moving across the floor?

II

06. A man pushes a 58.5-kg sofa 2.30 m across a carpet with a horizontal force of 345 N. If the coefficient of kinetic friction between the feet of the sofa and the carpet is 0.55, how long does it take the man to move the sofa? (Assume it started from rest)

07. A man pushes a crate along a floor with a coefficient of friction of 0.48 until it reaches a speed of 6.25 m/s at which time the man stops pushing. How far across the floor will the crate slide after the man stops pushing?

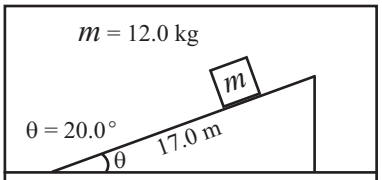
08. A man wants to push a crate-framed box containing a 67.4-kg big screen television across a 32.3-m wide highway that has heavy traffic. He notices that the traffic light stays red, stopping the traffic, for 20.0 s. If the coefficient of kinetic friction between the road and the crate frame is 0.84, what minimum force must he apply to make it safely across the road before the traffic light turns green?

ANSWERS: **01.** 7.84 m/s^2 **02.** 5.39 m/s^2 **03.** 6.57 m/s^2 **04.** 63.7 N **05.** a.) 841 N b.) 688 N **06.** 3.01 s **07.** 4.15 m **08.** 566 N

Chapter 3
Dynamics: Motion and Force
3.5 Newton's 2nd Law-Inclined Planes — Homework # 23

II

01. A 12.0-kg block, initially at rest, begins sliding 17.0 m down a 20.0° incline with negligible friction. See diagram to the right.
    a.) Determine the acceleration of the block as it slides down the plane.
    b.) What will be the block's speed when it reaches the bottom of the incline?



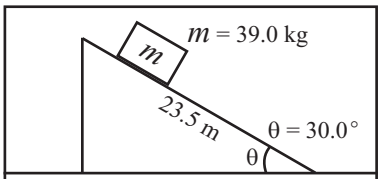
Problem 01

02. Repeat problem 01 if $\mu_k = 0.24$ between the block and the incline.

03. A block is given an initial speed of 12.50 m/s up a 35.0° incline with negligible friction.
    a.) How far up the plane will it go?
    b.) How much time elapses before it returns to the starting point?

04. Repeat problem 03 if $\mu_k = 0.24$ between the block and the incline.

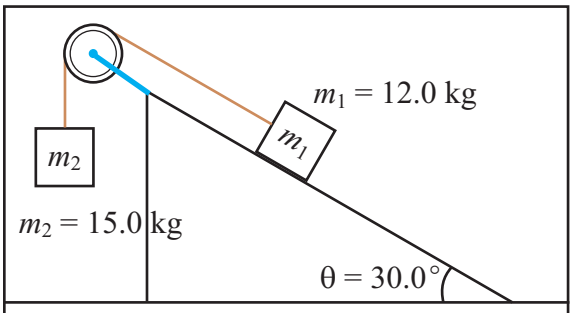
05. A man pushes a 39.0-kg crate, starting at rest, up a 30.0° incline that is 23.5 m long with a force of 335.0 N. The coefficient of sliding friction between the crate and the incline is 0.20. See diagram to the right.
    a.) What is the magnitude of the component of the force of gravity that tends to act parallel to the incline?
    b.) What is the magnitude of the component of the force of gravity that tends to act perpendicular to the incline?
    c.) What is the magnitude of the frictional force acting on the crate?
    d.) What is the net force acting on the crate?
    e.) What is the acceleration of the crate?
    f.) What will be the speed of the crate when it reaches the top of the incline?



Problem 05

III

06. A 12.0-kg block lying on a 30.0° inclined plane is connected to a 15.0-kg block by a massless cord passing over a pulley as shown to the right. The coefficient of kinetic friction between the block and the inclined plane is 0.15.
    a.) Determine the acceleration of the system.
    b.) Determine the tension in the cord joining the two masses.



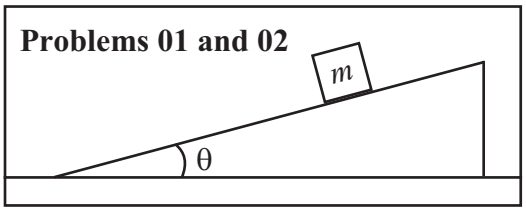
Problem 06

ANSWERS: **01.** a.) -3.35 m/s^2 b.) 10.7 m/s **02.** a.) -1.14 m/s^2 b.) 6.23 m/s **03.** a.) 13.9 m b.) 4.45 s **04.** a.) 10.4 m b.) 4.03 s **05.** a.) 191 N b.) 331 N c.) 66.2 N d.) 77.8 N e.) 1.99 m/s^2 f.) 9.67 m/s **06.** a.) 2.70 m/s^2 b.) 107 N

Chapter 3
Dynamics: Motion and Force
3.6 Newton's 2nd Law-2D Equilibrium — Homework # 24

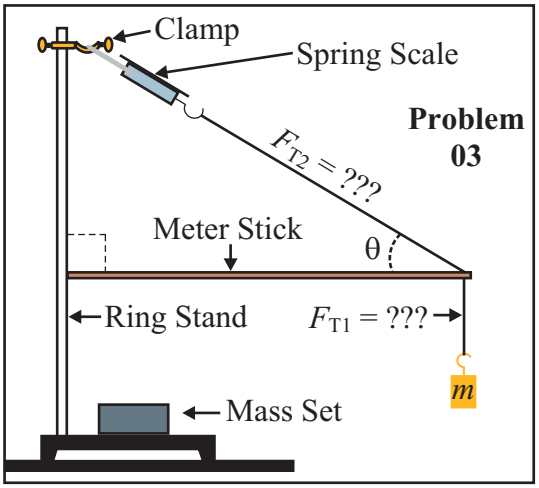
II

01. A box with a mass of m sits on a 15.0° inclined plane as shown to the right. What is the minimum coefficient of static friction between the box and the inclined plane to keep the box from sliding down the incline?



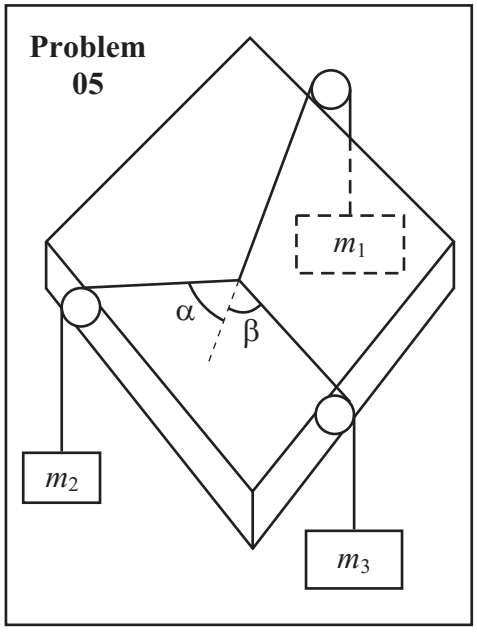
02. A box with a mass of m sits on an inclined plane as shown to the right. If the coefficient of static friction between the box and the inclined plane is 0.42, what is the maximum angle that the incline can be tilted before the box begins to slide?

03. An apparatus is set up, as in your lab, that resembles an old-fashioned street sign hanging from a city building as shown to the right. The meter stick is adjusted such that it makes a 90° angle with the ring stand. The following set of measurements were made: θ = 25.0° and m = 750 g.
a.) Calculate the tension, F_{T1}, in the lower string supporting the mass, m.
b.) Calculate the tension, F_{T2}, in the string connecting the spring scale to the meter stick.



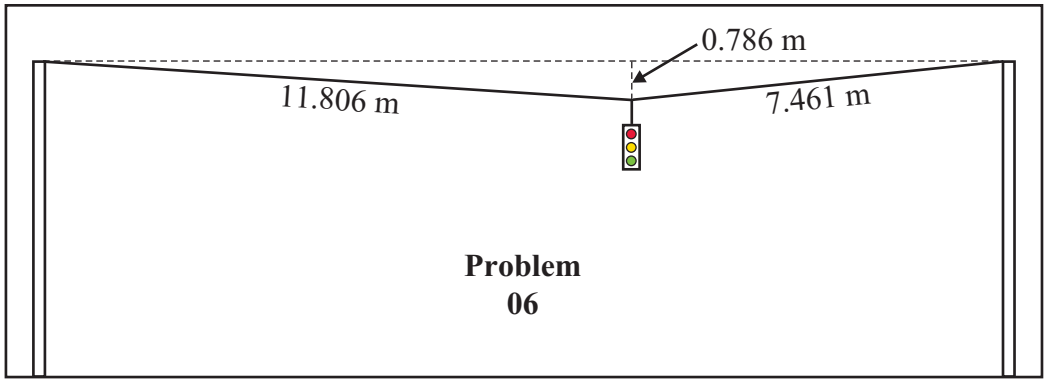
04. A car is traveling up a hill inclined at an average angle of 25.0° at a **CONSTANT** 40.0 km/h. If the friction of the mechanical moving parts of the car can be ignored, what is the minimum coefficient of static friction between the tires of the car and the road?

05. Three strings are tied together as shown to the right and placed on a lab table. A different mass is suspended from the free end of each of the three strings after the free ends are draped over pulleys as in your lab (see the diagram to the right). Mass, m_2, is 145 grams and mass, m_3, is 210 grams. Angle α has a value of 65.0° and angle β has a value of 38.7°. What is the value of mass, m_1, if the knot connecting the three strings is at equilibrium (rest)?



III

06. A 13.0-kg traffic light is tied to two supporting cables that are each attached to vertical poles as shown below. If the length of the one supporting cable is 11.806 m and the other is 7.461 m and the light hangs 0.786 m below the level of the supports, what is the tension in each supporting cable?



ANSWERS: **01.** 0.268 **02.** 22.8° **03.** a.) 7.35 N b.) 17.4 N **04.** 0.47 **05.** 225 g **06.** 757 N, 759 N

Chapter 3
Dynamics: Motion and Force

Conceptual Review — Homework # 25

01. Compare the effort (or force) needed to lift a 10-kg object when on the moon compared to being on the earth. Compare the force needed to throw a 2-kg object horizontally with a given speed when on the moon compared to being on the earth.
02. Why does a child in a wagon seem to fall backward when you give the wagon a sharp pull?
03. Whiplash sometimes results from an automobile accident when the victim's car is struck violently from the rear. Explain why the head of the victim seems to be thrown backward in this situation. Is it really?
04. When a golf ball is dropped to the pavement it bounces back up. Is a force needed to make it bounce back up? If so, what exerts the force?
05. A person wearing a cast on an arm or a leg experiences extra fatigue. Explain this on the basis of Newton's first and second laws.
06. If the acceleration of a body is zero, are no forces acting on it? Explain!!!
07. Why do you push harder on the pedals of a bicycle when first starting out then when moving at constant speed?
08. Only one force acts on an object. Can the object have zero acceleration? Can it have zero velocity?
09. When you are running and want to stop quickly, you must decelerate quickly. What is the origin of the force that causes you to stop?
10. In a log-rolling contest, when a contestant "walks" on a log floating in the water, does the log move in the opposite direction? How about if a person were walking along the length of the log in the water, does the log move? Explain!!!
11. Why might your foot hurt when you kick a football?
12. 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 in the air?
13. The force of gravity on a 2-kg rock is twice as great as that on a 1-kg rock. Why then doesn't the heavier rock fall faster?
14. A person exerts an upward force of 40 N to hold onto a bag of groceries. Describe the "reaction" force (Newton's third law) by stating (a) its magnitude, (b) its direction, (c) *on* what body it is exerted, and (d) *by* what body it is exerted.
15. 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?
16. Cross country skiers prefer their skis to have a large coefficient of static friction but a small coefficient of kinetic friction. Explain why.
17. When you brake your car very quickly, why is it safer if the wheels don't lock?
18. When driving on slick roads, why is it advisable to apply the brakes slowly?
19. Why is the stopping distance of a truck much shorter than for a train going the same speed?
20. Can a coefficient of friction exceed 1.0?
21. A block is given a push on a horizontal surface until it reaches a given speed. At this point, the force is removed (ignore fiction) and the block moves at a constant speed until it encounters a ramp. It begins sliding up a ramp with sufficient friction that it can **NOT** be ignored. When the block reaches the highest point it slides back down. Why is its acceleration less on the descent than on the ascent?
22. 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?