Practice problems with answers forces motion and friction

By the end of the section you will be able to: Use problem solving techniques to solve quantities in more complex force systems Use concepts from kinetics to solve problems using Newton's movement laws Solve more complex equilid problems Solve more complex acceleration problems Use calculation for more advanced dynamic problems Success in problem solving is necessary for understanding and applying physical principles. We developed a pattern of analysis and establishment of solutions to problems involving the Newton Act in Newton's laws of motion; in this chapter, we continue to discuss these strategies and apply a gradual procedure. Here we follow the basics of problem solving presented earlier in this text, but we highlight the specific strategies that are useful in applying Newton's movement laws. When you recognize the physical principles that are involved in the problem and find that they involve the Newton Act of Motion, you can use these steps to find a solution. These techniques also reinforce concepts that are useful in many other fields of physics. Many problem-solving strategies are precise in processed cases, so the following techniques should strengthen the skills you have already begun to develop. Define the physical principles included by specifying the given and quantities to be calculated. Sketch the situation, use the arrows to represent all forces. Determine the system of interests. The result is a free body diagram, which is essential to solve the problem. Use Newton's second law to solve the problem. If necessary, use the appropriate kinema equations in the straight line movement chapter. Check the solution to make sure it's reasonable. Let's use this problem-solving strategy to the challenge of lifting the grand piano into a second-floor apartment. When we find out that this is newton's movement law (if the problem involves force), it is especially important to draw a careful sketch of the situation. Such a sketch is shown in Figure 6.2(a). Then, as in Figure 6.2(b), all forces can be represented by arrows. Whenever sufficient information exists, it is best to indicate these arrows with care and that the length and direction of each match the force represented. Figure 6.2 (a) The Grand Piano rises into the second-floor apartment. (b) Arrows are used to represent all forces: T→T→ is the tension in the rope above the piano, F→TF→T is the force used by the piano on the rope, and w→w→ is the weight of the piano. All other forces, such as the breeze, are negligible. (c) Let's say we got the piano mass and asked us to find the tension in the rope. Then we define the interest system as shown and draw a free body diagram. Now →TF→T is no longer displayed because there is no force that works on the system of interests; F→TF→T works on the outside world. (d) If only the arrow is displayed, the head-to-tail method shall be used. It is obvious that if the piano is stationary, T→=−w→T→=−w→. As with most problems, we now need to find out what needs to be determined and what is known or can be identified from the problem, as stated, that is, to make a list of known and unknown. It is particularly important to define a system of interests, since Newton's second law only includes external forces. Then we can figure out which forces are external, and which are internal, necessary steps to apply Newton's second law. (See Figure 6.2(c).) Newton's Third Act may be used to determine whether forces are used between system components (internal) or between a system and something external (external). As shown in Newton's movement laws, the system of interest depends on the question we need to answer. Only forces are shown in free body diagrams, not at acceleration or speed. In previous cases processed, we have drawn several free body diagrams. Figure 6.2(c) shows the free body diagram for the system of interests. Note that internal forces are not shown in the free body diagram. When we draw a free body diagram, we use Newton's second law. This shall be done in Figure 6.2(d) for a specific position. In general, when external forces are clearly defined in free body diagrams, it should be a simple task to put them in the form of an equation and to solve the unknown, as we do in all previous cases. If the problem is one-dimensional, i.e. if all forces are parallel, the forces may be treated algebraically. If the problem is two-dimensional, it should be broken down into a pair of one-dimensional problems. We do this by projecting force vectors on to a set of axes selected for comfort. As has been seen in previous cases, axe selection can simplify the problem. For example, when a setting is turned on, a single-axis axis set parallel to and one perpendicular to it is the most convenient. It is almost always convenient to do one iss parallel to the direction of movement, if known. In general, just write Newton's second law in components in different directions. Then you have the following equations: ∑Fx=max,∑Fy=may.∑Fx=max,∑Fy=may. (For example, if the system accelerates horizontally, you can then set ay=0.ay=0.) We need this information to establish that unknown forces are operating on the system. As always, we need to look at the solution. In some cases, it is easy to determine whether the solution is reasonable. For example, it is reasonable to determine that friction causes the object to glide down the incline more slowly than when there is no friction. In practice, intuition develops gradually by solving problems; experience becomes progressively easier to assess whether the answer is reasonable. the way to check the solution is to check the units. If we're saving for a force and we're done with units of millimeters per second, then we've made a mistake. There are many interesting applications of Newton's laws of motion, some of which are more featured in this section. These also serve to illustrate some of the further subtlety of physics and to help build problem-solving skills. First, we examine the problems involving the balance of particles that use Newton's first law, and then consider particle acceleration, which includes Newton's second law. Remember that the fragment in balance is the one for which the external forces are balanced. Static balance involves objects resting, and dynamic balance involves objects in motion without acceleration, but it is important to know that these conditions are relative. For example, an object can rest when viewed from our reference frame, but it seems to be the same object in motion when viewed by someone moving at a constant speed. We are now using knowledge from Newton's laws of movement regarding different types of forces and the use of free body diagrams to solve additional problems in the balance of the particles. Different voltages at different angles Observe the traffic light (mass 15,0 kg) stopped from two wires as shown in Figure 6.3. Find the voltage in each wire, neglect the masses of wires. Figure 6.3 The traffic light is disconnected from two wires. (b) some of the forces involved. (c) Only the forces operating on the system are shown here. A free body diagram for the traffic light is also shown. (d) forces projected to vertical (y) and horizontal (x) axes. The horizontal voltage components must be cancelled and the sum of the vertical voltage components shall be equal to the traffic light weight. (e) The free body diagram shows the vertical and horizontal forces applied at the traffic lights. The Strategy System of Interest is a traffic light and its free body diagram is shown in Figure 6.3(c). The three forces involved are not parallel, so they must be projected into the coordinate system. The most convenient coordinate system shall have one axis vertically and one horizontally, and the vector projections on this system are shown in Figure 6.3(d). There are two unknowns in this problem (T1T1 and T2T2), so two equations are needed to search. These two equations come using the Newton Second Act along the vertical and horizontal axes, with the net external force having zero along each axis because the acceleration is zero. Solution First, observe the horizontal or x-axis: Fnetx=T2x+T1x=0.Fnetx=T2x+T1x=0.As you might expect, this gives us the following relationship: T1cos30°=T2cos45°. T1cos30°=T2cos45°. Therefore, please note that T1T1 and T2T2 are not the same in this case because the angles on both sides are not the same. It is reasonable that T2T2 greater than T1T1 because it is executed more vertically than T1. T1. Now observe the force components along the vertical or y-axis: Fnety=T1y+T2y−w=0.Fnety=T1y+T2y−w=0. This means that the replacement of terms for vertical components gives T1sin30°+T2sin45°=w.T1sin30°+T2sin45°=w. (a) the replacement of the term for T2T2 in the meaning of T1T1 reduces this to one equation with one unknown equation: T1(0.500)+(1.225T1)(0.707)=w=mg,T1(0.500)+(1.1 225T1(0.707)=w=mg, 1,000 yields 1,366T1=(15.0kg)(9.80m/s2).1.366T1=(15.0kg)(9.0 80m/s2). Solving this last equation gives the magnitude of T1T1 finally, we find the magnitude of T2T2 using the ratio between them, T2=1.225T1T2=1.225T1, found above. Thus, we get the significance Both tensions would be greater if both wires were more horizontal, and will be the same if and only if the angles on both sides are the same (as they were in the previous case in the uptight walker in Newton's Laws of Motion. We've given different examples of particles in balance. We are now paying attention to the problems of particle acceleration caused by the net force that is being used. Refer again to the steps listed at the beginning of this section and see how they apply to the following cases. Drag the Force on the boat Two tug boats push onto the boat at different angles (Figure 6.4). The first teg in x direction shall force a force of 2,7×105N2,7×105N and the second to the torm force 3,6×105N3,6×105N in y direction. The mass of the boat is 5×106kg5.0×106kg and its acceleration is 7.5×10−2m/s27×10−2m/s2 in the direction shown. What is the force of pulling water on a boat that resists movement? (Note: The pull force is a friction force produced by liquid, such as air or water. The pull force opposes the movement of the object. Since the barge is flat bottom, it can be assumed that the pull force is in the direction opposite the movement of the boat.) Figure 6.4 (a) View from above two of the things pushing on to the boat. (b) The free body diagram for the ship shall contain only the forces operating in the plane of water. It omirks two vertical forces – the weight of the boat and the force of the water it supports, cancel and do not appear. Note →appF→app is a common useful force of the vav. The Acceleration direction and ranges strategy and the forces applied are given in Figure 6.4(a). The total force of tug boats on the barge is defined as F→appF→app, so F→app=F→1+F→2.F→app=F→1+F→2. Towing water F→DF→D is in the direction opposite the direction of movement of the boat; this force is working against F→app,F→app as shown in the free body diagram in Figure 6.4(b). The system of interest is here, as the forces at this place are given as well as its Because the forces used are rectangular, the x- and y-axes are in the same direction as F→1F→1 and F→2.F→2. The problem quickly becomes a one→app→app→, as friction is in the direction opposite F→app.F→app. Our strategy is to find the range and direction of the net force used F→appf→app and then use Newton's Second Act to rescue the forces of F→D.F→D. Solution Since FxFx and FyFy are rectangular, we can find the magnitide and the direction of F→appf→app directly. First, the result magnitudo gives pythagorene theorem: Fapp=F12+F22=(2,7×105N)2+(3,6×105N)2=4×105N. Fapp=F12+F22=(2.7×105N)2+(3,6×105N)2=4,5×105N. As θ=tan−1(F2F1)=tan−1(3.6×105N2.7×105N)=53.1°θ=tan−1(F2F1)=tan−1(3,6×105N2.7×105N)=53,1°. We know from Newton's first marriage that this is the same direction as acceleration. We also know that F→DF→D is in the opposite direction F→app,F→app, because it works by slowing acceleration. Therefore, the net external force is in the same direction as F→app,F→app, but its magnitude is slightly smaller than F→app.F→app. The problem is now one-dimensional. From the free body diagram we can see that Fnet=Fapp−FD.Fnet=Fapp−FD. But Newton's second law says that by This can be solved by the magnitudu of the FDFD water-kg water-ing force in terms of known quantity: In return known values gives FD=(4,5×105N)−(5,0×106kg)(7.5×10−2m// s2)=2 7×104N.FD=(4,5×105N)−(5,0×106kg)(7.5×10−2m/s2)=7.5×104N. The direction F→DF→D has already been set to be in the direction opposite F→app,F→app or at an angle of 53°53° south of the west. The significance of the numbers used in this case are reasonable for a moderately large boat. It is certainly difficult to obtain greater acceleration with the tegs, and low speeds are desirable to avoid starting the barge in favor. Drag is relatively small for a well-designed hull at low speeds, according to the answer to this case, where the FDFD is less than 1/600 by the weight of the ship. In Newton's laws of motion, we discussed a normal force, which is a contact force that acts normally on the surface, so that the object has no acceleration perpendicular to the surface. The bathing scale is a perfect example of the normal force that works on the body. It provides a quantitative reading of how much it needs to push up to support the weight of the object. Can you predict what you'd see on the bathing scale if you were standing on it while riding a lift? Will you see a value greater than your weight when the elevator starts? What about when the elevator moves up at steady speed? Guess before reading the next case. What's the bathroom scale reading in the elevator? Picture shows a 75.0 kg man (approximately 165 lb.) standing on a bathing scale in an elevator. Calculate the balance readings: (a) if the lift accelerates upwards at a speed of 1,20m/s2,1,20m/s2 and (b) if the lift moves upwards at a constant speed of 1 m/s. Figure 6.5 (a) Different forces operating when a person is standing on a bathing scale in an elevator. The arrows are roughly correct to accelerate the lift upwards – broken arrows represent forces too large to be drawn on a scale. T→T→ is the voltage in the support cable, w→w→ is the weight of the person, w→sw→s is the weight of the scale, w→ew→e is the weight of the lift, F→sF→s is the force of the rock per person, F→pF→p is the force of the person on the rock, F→tF→t is the force of the rock on the lift floor, a N→N→ is the force of the floor on the rock. (b) The free body diagram shows only external forces that act on a particular system of interest – a person – and is a diagram used to solve the problem. The strategy If the balance in rest is accurate, its reading is equal to F→pF→p, the range of force that a person carries down. Figure 6.5(a) shows a number of forces operating on the lift, the scale and the person. As a result, this one-dimensional problem looks much more mighty than if a person is selected for the interest system and a free body diagram is drawn, as in Figure 6.5(b). Analysis of the free body diagram using Newton's laws may provide answers to both Figure 6.5(a) and (b) of this case, as well as some other questions that might arise. The only force that works on a person is its weight w→w→ and the force up the scales of F→s.F→s. Under Newton's third law are F→pF→p and F→sF→ the same in magnitudi and opposite direction, so we have to find the FSF's to find what the scale reads. We can do this, as usual, using Newton's Second Act, We see from the Free Body Diagram that F→net=F→s−w→,F→net=F→s−w→, So we have Solving for FsFs giving us an equation sa only sjenom unknown: or, therefore, w=mg,w=mg, there is simply no assumption of acceleration, so this ring should be valid for various accelerations, but not for them in the situation. (Note: The case is examined when the lift accelerates upwards. Fs−w=−ma.) Solution We have a=1,20m/s2,a=1,20m/s2, So Fs=(75.0kg)(9.80m/s2)+(75.0kg)(1.20m/s2)Fs=(75.0kg)(9.80m/s2)+(75.0kg)(1.20m/s2) is 2000 but that the elevator is constantly ampoued? Will the scales still read more than his weight? For each constant speed – up, down or stationary – acceleration is zero because a=ΔvΔta=ΔvΔt and Δv=0.Δv=0. So or Fs=(75,0kg)(9,80m/s2),Fs=(75,0kg)(9,80m/s2), giving meaning The readings of the scale in Figure 6.5(a) are approximately 185 lb. What would the scales read if it was stationary? Because his acceleration would be zero, the Force of the Rock would be the same as the tezin: Fnet=ma=0=Fs−wFnet=ma=0=Fs−w Fs=(75.0m)(9.80m/s2)=735N.Fs=(75.0kg)(9.80m/s2)=735N.Fs=(75.0kg)(9.80m/s2)=735N.Fs=(75.0kg)(9.80m/s2)=735N.Fs=(75.0kg)(9.80m/s2)=735N.Fs=735.0kg(9.80m/s2)=735N.Fs=75.0kg)(9.80m/s2)=735N.Fs=735N.Fs=&&544444000000. Thus, the reading of the scale in the lift is greater than its weight 735-N (165-lb.). This means that the balance puts pressure on the person with a force greater than its weight, as it must accelerate it upwards. Of course, the greater the acceleration of the lift, the greater the reading of the scale, in line with what you feel when accelerating quickly compared to the slow acceleration of the lifts. Figure 6.5(b) shows a balance reading of 735 N, which is equal to the weight of the person. This is the case every time the lift has a constant speed – moving upwards, moving down or stationary. Check Your understanding 6.1 Now calculate the scale reading when the lift accelerates down at a speed of 1.20m/s2.1.20m/s2. The solution to the previous case also applies to the elevator, which accelerates down as mentioned. When the lift accelerates downwards, it is a negative and the reading of the scale is less than the weight of the person. If a constant speed is achieved downwards, the reading of the scale will again be the same as the weight of the person. If the lift is in free fall and accelerates down at g, then the reading of the scale is zero and it appears that the person is weightless. Two attached blocks Figure 6.6 shows the block of mass m1m1 on a frictionless, horizontal surface. He's pulled by a light string that crosses without friction and a manless turtlenew. The other end of the series is connected to the mass block m2.m2. Look for the acceleration of the blocks and the voltage in the series in terms of m1,m2,andg.m1,m2,andg. Figure 6.6 (a) Block 1 is connected to the light string for block 2. (b) Free body block diagrams. Strategy Draw a free body diagram for each mass as shown in Figure 6.6. Then we analyze each one to find the requested unknowns. The forces on block 1 are the gravitational force, the contact force of the surface and the tension in the series. Block 2 is subjected to gravitational force and string tension. Newton's second law applies to each, so we write two vector equations: For block 1: T→+w→+N→=m1a→1T→+w→1+N→=m1a→1 For block 2: T→+w→2=m2a→2. T→+w→2=m2a→2. Notice that T→T→ the same for both blocks. Because the string and pulley have a negligible mass, and because there is no friction in the pulle, the tension is the same throughout the string. Now we can write component equations for each block. All forces are horizontal or vertical, so we can use the same horizontal/vertical coordinate system for both objects Solution equations are tracked from the above vector equations. We see that block 1 has vertical forces balanced, so we ignore them and write an equation that is based on x-components. There are no horizontal forces on block 2, so only the y-equation is written. We get these results: Block 1Block 2∑Fx=max∑Fy=mayTx=m1a1xTy−m2g=m2a2y. Block 1Block 2∑Fx=max∑Fy=mayTx=m1a1xTy−m2g=m2a2y. When block 1 moves to the right, block 2 travels the same distance down; a1x=−a2y.a1x=−a2y. Writing the total acceleration of blocks as a=a1x=−a2y,a=a1x=−a2y, we have and From these two equates can express a and T in terms of mass m1andm2,andg:m1andm2,andg: and T=m1m2m1+m2g. T=m1m2m1+m2g. Importance You notice that the tension in the cord is less than the weight of the block hanging from the end. A common problem error like this is the T=m2g setting. T=m2g. You can see from the free body diagram block 2 that it cannot be correct if the block is accelerating. Check Your understanding 6.2 Calculate the system acceleration and voltage in the string when the masses m1=5,00kgm1=5.00kg and m2=3,00kg.m2=3.00kg. Atwood Machine A classic problem in physics, similar to the one we just solved, is that atwood machine, which consists of a rope running over a pulley, with two objects of different mass attached. It is particularly useful in understanding the link between force and movement. Pictured is 6.7 m1=2,00kgm1=2.00kg and m2=4.00kg.m2=4.00kg. Make sure the sharpe (oeuster) is frictionless. (a) If m2m2 is released, what will its acceleration be? (b) What is the voltage in the series? Figure 6.7 Atwood machine and free body diagrams for each of the two blocks. Strategy Plot a free body chart for each mass separately, as shown in the figure. Then we analyze each diagram to find the requested unknowns. This may include a solution to simultaneous equations. It is also important to take into account the similarity with the previous case. When block 2 accelerates by accelerating the a2a2 downwards, block 1 accelerates upwards by accelerating the a1a1. Thus a=a1=−a2.a=a1=−−a2. Solution We have Form1,∑Fy=T−m1g=m1a. Form2,∑Fy=T−m2g=−m2a. Form1,∑Fy=T−m1g=m1a. Form2,∑Fy=T−m2g=−m2a. (The negative sign before m2am2a indicates that m2m2 is accelerating downwards; both blocks accelerate at the same speed but in opposite directions.) Two equations are solved simultaneously (subtracted) and the result is (m2−m1)g=(m1+m2)a.(m2−m1)g=(m1+m2)a. Rescue for a: a=m2−m1m1+m2g=4kg−2kg4kg+2kg(9.8m/s2)=3.27m/s2.a=m2−m1m1+m2g=4kg−2kg4kg+2kg(9.8m/s2)=3.27m/s2. When observing the first block, we see that T−m1g=m1aT=m1(g+a)=(2kg)(9.8m/s2+3,27m/s2)=26.1N. T−m1g=m1aT=m1(g+a)=(2kg)(9.8m/s2+3.27m/s2)=26.1N. Importance The result of acceleration given in the solution can be interpreted as the relationship between power per system, (m2−m1)g(m2−m1)g, to the total mass of the system, m1+m2m1+m2. The Atwood machine also measures the local power of gravitational fields. Check Your Understanding 6.3 Specify the general formula in terms of m1,m2m1,m2 and g to calculate the voltage in the string for the atwood machine shown above. Physics is the most interesting and powerful when used for general situations involving more than a narrow set of physical principles. Newton's Movement Act can also be incorporated with other concepts that we have discussed before in this text in order to solve the problems of the movement. For example, forces produce acceleration, the theme of kinema and thus the importance of previous chapters. When approaching problems involving different types of forces, acceleration, speed and/or position, indicate the given and quantities to be calculated will allow you to define the principles involved. You can then refer to chapters that address a specific topic and solve the problem by using the strategies described in the text. The following example shows how the problem-solving strategy presented earlier in this chapter, as well as the strategies presented in other chapters, are applied to an integrated concept problem. What forces does a footballer need to reach the top speeds? The footballer starts resting and speeds forward, reaching a speed of 8.00 m/s in 2.50 s. (a) What is his average acceleration? (b) What average force does the ground continue on the runner to achieve this acceleration? The weight of the player is 70.0 kg, and the air resistance is negligible. The Strategy To find answers to this problem, we use the problem-solving strategy that was given earlier in this chapter. Solutions for each part of the case illustrate how to use certain steps to solve problems. In this case, we don't have to take all the steps. We simply identify physical principles, and thus also known and unknown; newton's second law applies; and verify that the answer is reasonable. Solution Give initial and final speeds (zero and 8,00 m/s forward); thus, the change in speed Δv=8,00m/sΔv=8,00m/s. We got past time, so Δt=2,50s.Δt=2.50s. Unknown is the acceleration that can be found from its definition: The replacement of known values gives a=8.00m/s2.50s=3,20m/s2.a=8.00m/s2.50s=3.20m/s2. Here we asked to find the average force that the ground is forcing on a runner to create this acceleration. (Remember that we are dealing with force or forces acting at the target of interest.) That's the force of the reaction to the one that the player executes back against the ground under Newton's third law. If we were to ignore the air resistance, it would be t equal to the net external force per player, as this force causes its acceleration. Since we now know that Acceleration and mass, we can use Newton's second law to find the force. This means that the replacement of known values m and a gives Fnet=(70,0kg)(3,20m/s2)=224N. Fnet=(70,0kg)(3,20m/s2)=224N. This is a reasonable result: Acceleration is in good condition for an athlete. The force is around £50, a reasonable average force. Importance This example shows how problem-solving strategies are applied to situations involving topics from different chapters. The first step is to identify the physical principles known and unknowns involved in the problem. The second step is to resolve the unknown, in this case using Newton's second law. Finally, let us look at our response to make sure it is reasonable. These techniques for integrated concept problems will be useful in the use of physics outside the physics course, as in your profession, in other scientific disciplines and in everyday life. Check your understanding of 6.4 The footballer stops after completing the game described above, but now notices that the ball is in a position to be stolen. If she now gets the force of 126 N to try to steal a ball 2.00 yards from it, how long will it take her to get to the ball? What kind of force does the helicopter model work for? The 1.50 kg model helicopter has a speed of 5,00j^m/s5.00j^m/s at t=0.t=0. It accelerates at a constant speed of two seconds (2,00 s) at which it has a speed (6.00i^+12.00j^)m/s.(6.00i^+12.00j^)m/s. What is the size of the force that is the result of acting on a helicopter at this time interval? StrategyMomprany set the coordinate system in which the x-axis (direction is^(i^) is horizontal and y-axis (direction j^(j^) is vertical. We know that Δt=2.00sΔt=2.00s and Δv=(6.00i^+12.00j^m/s)−(5.00j^m/s).Δv=(6.00i^+12.00^m/s)−(5.00j^m/s). From this we can calculate acceleration by definition; Then we can use Newton's second law. Solution We have a=ΔvΔt=(6.00i^+12.00j^m/s)−(5.00j^m/s)2.00s=3.00i^+3.50j^m/s2a=ΔvΔt=(6.00i+^12.00j^m/s)(5.00j^m/s)2.00s=3.00i^+3.50 ^m/s2 ∑F→=ma→=(1.50kg)(3.00i^+3.50j^m/s2)=4.50i^+5.25^j. N.∑F→=ma→=(1.50kg)(3.00i^+3.50j^m/s2)=4.50i^+5.25j^N. The force magnittude is now easily found: F=(4,50N)2+(5,25N)2=6,91N. F=(4,50N)2+(5,25N)2=6.91N. The meaning of the original problem was stated in terms of i^−j^i^−j^ vector components, so we used vector methods. Compare this case to the previous case. Check Your Understanding 6.5 To Find Direction results for the 1.50-kg helicopter model. The image of the baggage tractor 6.8(a) shows the luggage tractor pulling luggage from the aircraft. The tractor has a mass of 650,0 kg and trolley A has a mass of 250,0 kg and a basket B weighing 150,0 kg. The driving force, which works for a short period of time, accelerates the rest system and operates at 3.00 s. (a) The driving force gives F=(820,0t)N,F=(820,0t)N, find the speed after 3.00 seconds. (b) What is the horizontal force acting on the connecting cable between the tractor and trolley A at this time? Figure 6.8 (a) A free body diagram is shown indicating all external forces in the system consisting of tractor and luggage for the carriage of air luggage. (b) Only for the calculation of the voltage in the cable on trolleys is shown only a diagram of the tractor's free body. Strategy The free body diagram shows the driving force of the tractor, which gives the system its acceleration. All we need to think about is moving in a horizontal direction. Vertical forces balance each other and do not need to be taken into account. For part b, we only use a diagram of the tractor→'s free body to determine the force between→ it and the trolley A. Solution ∑Fx=msystemax∑Fx=msystemax and ∑Fx=820.0t,∑Fx=820.0t, so 820.0t=(650.0+250.0+150.0)aa=0.7809t.820.0t=(650.0+250.0+150.0)aa=0.7809t. Because acceleration is a function of time, the speed of the tractor can be determined using a=dvdta=dvdt with the initial condition that v0=0v0=0 is at t=0.t=0. Integrate from t=0t=0 to t=3:t=3: dv=adt,∫03dv=∫03.00adt=∫03.000.7809tdt,v=0.3905t2]03.00 =3.51m/s.dv=adt,∫03dv=∫03.00adt=∫03,000.7809tdt,v=0.3905t2]03.00=3.51m/s. See free body diagram in Figure 6.8(b). ∑Fx=mtractorax820.0t−T=mtractor(0.7805)t(820,0)(3,00)−T=(650.0)(0.7805)(3.00)T=938N.∑Fx =mtractorax820.0t−T=mtractor(0.7805)t(820.0)(3.00)−T=(650.0)(0.7805)(3.00)T=938N. Significance Since the force varies with time, We have to use the bill to solve the problem. See how the total mass of the system was important in the rescue figure 6.8(a), using only the mass of the lorry (from the supply of force) in Figure 6.8(b). Remember that v=dsdtv=dsdt and a=dvdta=dvdt. If acceleration is a function of time, we can use computational formats developed in Straight Line Movement as shown in this example. Sometimes, however, acceleration is a function of displacement. In this case, we can pull an important result from these computational relationships. Rescue for dt in each, we have dt=dsv=dsv and dt=two.dt=two. Now, the equation of these terms, we have dsv=dva.dsv=two. You can rearrange this to get ads=vdv.ads=vdv. The vertically fired missile shell of the 10,0 kg mortar shell shall be fired vertically upstream of the ground at an initial speed of 50,0 m/s (see Figure 6.9). Specify the maximum height to travel if the atmospheric resistance is measured as FD=(0.0100v2)N,FD=(0.0100v2)N, where it is at speed at any time. Figure 6.9 (a) Minoba fires the shell straight up; We think it's the force of friction that air provides. (b) A free body diagram is shown indicating all forces on the Shell. (credit memo: change of part os541/DoD; The appearance of visual information from the U.S. Department of Defense (DoD) does not constitute or represents a doD.) Strategy Known force per mortar may be associated with its acceleration using the equation of motion. Kinematics can then be used to connect the acceleration of the mortar shell to its position. Initially the solution y0=0y0=0 and v0=50,0m/s.v0=50,0m/s. At maximum height y=h,v=0.y=h,v=0. The free body diagram shows the FDFD to run down as it slows the movement of the mortar shell upwards. This is how we can write −FD−w=May−0.0100v2−98.0=10.0aa=−0.00100v2−9.08 0.−FD−w=may−0.0100v2−98.0=10.0aa=−0.00100v2−9.80. Acceleration depends on the in and is therefore variable. Since a=f(v),a=f(v) is a versus the ds rearrangement described above can be used, so we have 100 vertical-direction transactions, ady=vdv,(−0.00100v2−9.80)dy=vdv.ady=vdv, (−0.00100v2−9.80)dy=vdv. Now we separate the variables (v's and dv's on one side; dy on second): ∫0hdy=∫50.00vdv(−0.00100v2−9.80)∫0hdy=−∫5 0 .00vdv(0.00100v2+9.80)=(−5×103)ln(0.00100v2+9.08 0)|50.00.∫0hdy=∫50.00vv(−0.00100v2−9.80)∫0hdy=−∫50.0 0.00100v2+9.80)=(−5×103)ln(0.00100v2+9.80)|50.00. Thus, h=114m.h=114m. Importance Notice the need to use calculation, since the force is not constant, which also means that acceleration is not a constant. To make matters worse, the force depends on (not t), so we have to use the trick that was explained before the case. The answer for height indicates a lower altitude if there was an air resistance. We will look more closely at the effects of air resistance and other forces pulling in drag forces and terminal speed. Check your understanding 6.6 If atmospheric resistance is ineauth, look for maximum height for the mortar. Does this solution require calculation? Explore the forces at work in this simulation when you try to push the filing cabinet. Create the force used and see the resulting frictional force and the total force applied to the closet. The charts show the forces, position, speed, and acceleration vs. time. See a diagram of the free body of all forces (including gravitational and normal force). forces).

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