Name _____ Class_____Date_____

Skills Worksheet

Math Skills

Work

After you study each sample problem and solution, work out the practice problems on a separate sheet of paper. Write your answers in the spaces provided.

PROBLEM

A car has run out of gas. Fortunately, there is a gas station nearby. You must exert a force of 715 N on the car in order to move it. By the time you reach the station, you have done 2.72×10^4 J of work. How far have you pushed the car?

SOLUTION

Step 1: List the given and unknown values.

Given: *force*, $F = 715$ N

work, $W = 2.72 \times 10^4$ J

Unknown: *distance*, $d = ?$ m

Step 2: Rearrange the work equation to solve for distance.

$work = force \times distance \qquad W = Fd$

$$\frac{W}{F} = \frac{\not{F}d}{\not{F}} = d$$

Step 3: Insert the known values into the equation, and solve.

$$d = \frac{2.72 \times 10^4 \text{ J}}{715 \text{ N}} = \frac{2.72 \times 10^4 \text{ N} \cdot \text{m}}{715 \text{ N}}$$

$d = 38.0$ m

PRACTICE

1. You must exert a force of 4.5 N on a book to slide it across a table. If you do 2.7 J of work in the process, how far have you moved the book?

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2. A catcher picks up a baseball from the ground. If the unbalanced force on the ball is 7.25×10^{-2} N and 4.35×10^{-2} J of work is done to lift the ball, how far does the catcher lift the ball?

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3. The smallest bird is the Cuban bee hummingbird, which has a mass of only 1.7 g. If this bird did 8.8×10^{-4} J of work by exerting an upward force of 3.4×10^{-4} N, how far did it fly?

PROBLEM

A building under construction requires building materials to be raised to the upper floors by cranes or elevators. A quantity of cement is lifted 76.2 m by a crane, which exerts a force on the cement that is slightly larger than the weight of the cement. If the work done in excess of the work done against gravity is 1.31×10^3 J, what is the unbalanced, overall force exerted on the cement?

SOLUTION

Step 1: List the given and unknown values.

Given: *distance, d* = 76.2 m

work, W = 1.31×10^3 J

Unknown: *force, F* = ? N

Step 2: Rearrange the work equation to solve for force.

work = force × *distance* $W = Fd$

$$\frac{W}{d} = \frac{F\cancel{d}}{\cancel{d}} = F$$

Step 3: Insert the known values into the equation, and solve.

$$F = \frac{1.31 \times 10^3 \text{ J}}{76.2 \text{ m}} = \frac{1.31 \times 10^3 \text{ N} \cdot \text{m}}{76.2 \text{ m}}$$

F = 17.2 N

PRACTICE

4. The world's most powerful tugboats are built in Finland. One of these boats can do 9.8×10^7 J of work through a distance of 35 m. What is the force exerted by the tugboat?

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5. A child pulls a sled up a snow-covered hill. In the process, the child does 405 J of work on the sled. If she walks a distance of 15 m up the hill, how large a force does she exert on the sled?

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6. One of the most powerful forklifts was built in Sweden in 1991. The lift is capable of lifting a 9.0×10^4 kg mass a distance of 2.0 m above the ground. If the work done by the forklift on the mass is 1.8×10^6 J, what is the force that the lift exerts on the mass?

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PROBLEM

An old house is being lifted by a type of crane from its foundation and moved by truck to another location. If the house, which weighs just under 1.50×10^4 N, is lifted 1.52 m from the foundation to the bed of the truck, what is the minimum amount of work done by the crane on the house?

SOLUTION

Step 1: List the given and unknown values.

Given: *force*, $F = 1.50 \times 10^4$ N
distance, $d = 1.52$ m

Unknown: *work*, $W = ?$ J

Step 2: Write out the equation for work.

$work = force \times distance \qquad W = Fd$

Step 3: Substitute force and distance values into the work equation, and solve.

$W = (1.50 \times 10^4 \text{ N}) \times 1.52 \text{ m} = 2.28 \times 10^4 \text{ N} \cdot \text{m}$
$W = 2.28 \times 10^4 \text{ J}$

PRACTICE

7. After the house in the sample problem has been set on the truck bed, the truck accelerates until it reaches a constant speed. If the force required to move the house horizontally a distance of 75.5 m is 3,150 N, how much work has been done on the house?

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8. The largest passenger ship still in service is the SS *Norway*, which has a mass of 7.6×10^7 kg. The force required to accelerate the SS *Norway* from rest to its top cruising speed of 33 km/h is 1.6×10^6 N, assuming that this acceleration takes place over a distance of 2.0 km. How much work must be done on the ship during this period of acceleration?

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9. Suppose an adult blue whale is stranded on a beach. The whale, which lies parallel to the shore, is 15 m from water deep enough for it to swim away in. A group of people line up along the side of the whale to push it back into the ocean. If the whale's weight is 1.5×10^6 N, and the force of friction that must be overcome by the people is 0.25 times the whale's weight, how much work must the people do on the whale in order to return it to the ocean?

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MIXED PRACTICE

10. A mover is loading a 2586 kg crate of hammers onto a truck. The upward force on the crate is 2,470 N, and 3,650 J of work are required to raise the crate from the pavement to the truck bed. How far is the crate lifted?

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11. The mover in problem 10 uses a ramp, which makes the task easier by requiring a smaller force to raise the crate to the truck bed. This force must be exerted over a greater distance, so the work done should be the same. In reality, because of the frictional force between the crate and the ramp, the work required is greater than that needed to lift the crate directly onto the truck. The mover does 4,365 J of work sliding the crate up the ramp. The force the mover exerts on the crate is 1,302 N. How long is the ramp?

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12. A popular and dangerous circus act is the human cannonball, in which a person is shot from a cannon. Suppose the cannon has a barrel that is 3.05 m long and 1.67×10^4 J of work is done to accelerate the acrobat. What is the force exerted by the cannon on the acrobat?

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13. The highest occupied floors of any building are in the Sears Tower in Chicago. The elevators of the central tower of the building lift passengers 436 m above street level. If a continuous force of 2.23×10^4 N is exerted on one of these elevator cars as it travels from the ground to the top floor, how much work is done on the elevator car by the elevator's lifting mechanism?

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14. A freight train leaving a train yard must exert a force of 2.53×10^6 N in order to increase its speed from rest to 17.0 m/s. During this process, the train must do 1.10×10^9 J of work. How far does the train travel?

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15. In 1947, Northrop Aircraft developed and built a deceleration sled to test the effects of extreme forces on humans and equipment. In this sled, a test pilot with a mass of 70.0 kg undergoes a sudden negative acceleration of 4.90×10^2 m/s^2. This deceleration occurs over a distance of 8.05 m. How much work is done against the pilot's body during the deceleration?

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