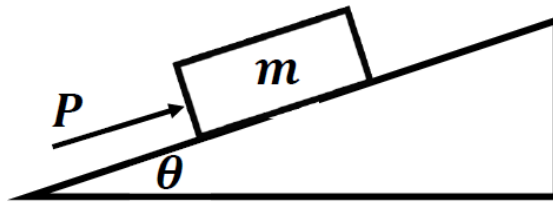


PH 220 Homework Assignment Chapter on Work and Energy – 25 Problems Total

1. How high will a model rocket ($m = 1.34 \text{ kg}$) go if the engine of the model does 393 J of work on it. Assume the rocket rises in a straight line. Neglect any effects of air resistance.

Solution for Problem 1

2. What is the minimum work required to push a car (1235 kg) up an inclined plane which is inclined an angle ($\theta = 7.50^\circ$) a total distance of 560 m ? Ignore both air resistance and friction.

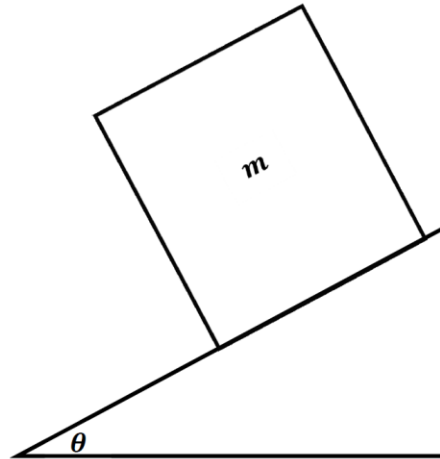


Solution for Problem 2

3. An object is accelerated from rest by a net force across a floor at a rate of 1.87 m/s^2 for a time of 13.3 s . The object has a mass of 5.19 kg . What is the net work done on the object?

Solution for Problem 3

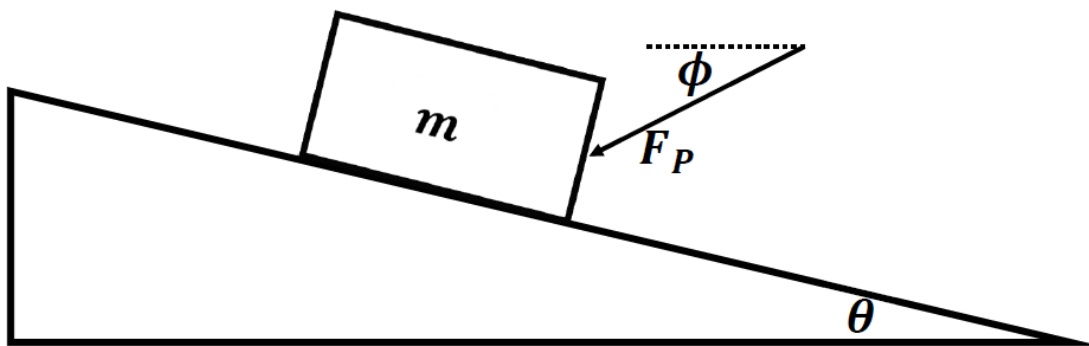
4. A delivery person is helping to deliver a 95-inch-high definition television before the Super Bowl. The tv has a mass of 69.4 kg. The tv is riding on a set of frictionless castors. The delivery person is exerting a force on the tv up and parallel to the incline plane of the ramp to keep the tv from accelerating down the ramp. The ramp is inclined by an angle of 26.0° above the horizontal. The ramp is distance of 4.28 m long.



- (a) What is the force of the delivery person on the tv?
- (b) What is the work done by the delivery person on the tv?
- (c) What is the work done by the force of gravity on the tv?
- (d) What is the net work done on the tv?

Solution for Problem 4

5. A crate has a mass of 19.4 kg is being pushed up a ramp with a constant speed by a force F_P which acts on the crate as shown below at an angle of $\phi = 11.1^\circ$ below the horizontal. The ramp is inclined at an angle $\theta = 24.3^\circ$ above the horizontal. The crate moves a distance of 17.9 m up the inclined ramp. Ignore all effects of air resistance and friction. Find the net work done by the forces of Gravity (mg), Normal force (N), and the constant pushing force (F_P).



Solution for Problem 5

6. A constant force $\vec{F} = (3.00 \hat{i} + 4.00 \hat{j})\text{N}$ acts on an object as it moves along a straight-line path. The object's displacement is $\vec{S} = (5.00 \hat{i} + 12.0 \hat{j})\text{m}$. Determine the work done by the force if we consider alternate ways of resolving the dot product in the work expression.

(a) $W = \vec{F} \cdot \vec{S} = F_x S_x + F_y S_y$

(b) $W = \vec{F} \cdot \vec{S} = |\vec{F}| |\vec{S}| \cos(\theta_{FS})$

Solution for Problem 6

7. Vector $\vec{A} = 7.45 \hat{i} - 11.2 \hat{j}$ and Vector $\vec{B} = -13.7 \hat{i} - 9.42 \hat{j}$ exist in the x-y plane. Find Vector \vec{C} also in the x-y plane. Vector \vec{C} should be perpendicular to Vector \vec{A} and the dot product between Vector \vec{C} and Vector \vec{B} should equal 19.8.

Solution for Problem 7

8. Find the direction cosines the vector $\vec{V} = -17.0 \hat{i} + 23.0 \hat{j} + 13.0 \hat{k}$ makes with the coordinate axes for x, y, and z.

Solution for Problem 8

9. Find a vector of unit length in the xy plane that is perpendicular to vector $\vec{V} = -5.00 \hat{i} + 12.0 \hat{j}$

Solution for Problem 9

10. A particular mechanical spring needs 39.6 J of work to stretch the spring a distance of 3.00 cm. How far will the spring stretch if 158.4 J of work is used?

Solution for Problem 10

11. A new material for containing sharp objects safely is being tested. The force exerted on an object trying to penetrate the material is $\vec{F}_{\text{oppose}} = -kx^3 \hat{i}$. What is the work required for a sharp object to penetrate the material a distance d?

Solution for Problem 11

12. There is a force which is described by the relationship

$$F = \frac{B}{\sqrt{y}}$$

This force acts on a particle as it moves along the y axis from $y = 0.00$ m to $y = 1.30$ m. The constant $B = 3.45 \text{ Nm}^{1/2}$. At the point $y = 0.00$ m, clearly the force goes to infinity. Calculate the work done as the particle moves along the y axis as given. Is this work finite in value?

Solution for Problem 12

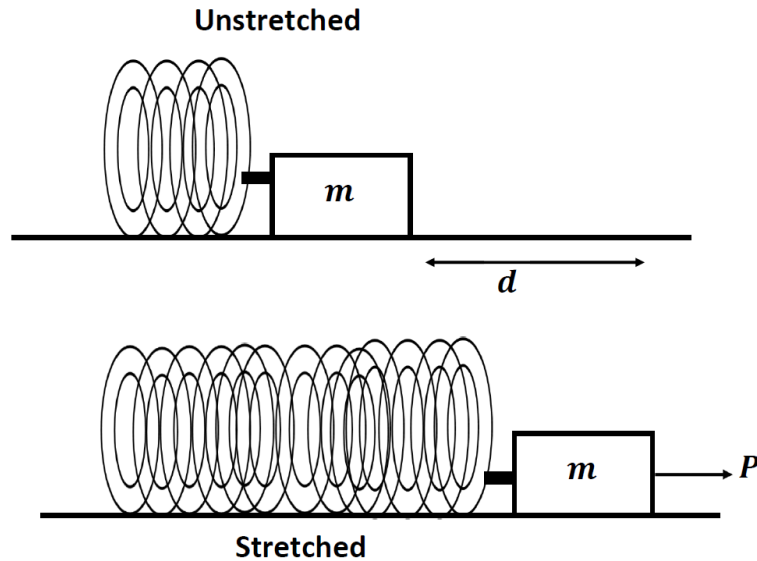
13. How much work is needed to stop a runaway truck ($m = 4.24 \times 10^4$ kg) which is traveling with a speed of 129 km/h . This feat is usually accomplished by a runaway truck lane on a highway.

Solution for Problem 13

14. An arrow used in hunting has a mass of 3.08×10^{-2} kg. After being released from the bow, the arrow has a speed of 85.0 m/s . If the arrow was in contact with the bowstring over a distance of 0.750 m, what is the average force of the bowstring on the arrow?

Solution for Problem 14

15. A mass is attached to a spring which is stretched a distance d by a pulling force P . The spring and the mass are touching a frictionless horizontal surface and shown below. Assume the mass is at rest when it is stretched the distance d . When the pulling force is removed, how fast is the mass moving when it is:



- (a) Back to the unstretched length of the spring.
- (b) When it is halfway to the unstretched length (i.e. $\frac{d}{2}$)
- (c) When it is past the unstretched length a distance one third the original stretched length (i.e. $-\frac{d}{3}$)

Solution for Problem 15

16. What happens to the minimum braking distance for a vehicle if the vehicle's speed is increased by some percentage? Ignore any driver reaction time and assume the maximum braking force is unchanged.

- (a) Find an expression for change in braking distance in relation to change in vehicle speed by a percentage P .
- (b) Find how much the braking distance changes if that percentage is 50 % faster.
- (c) Find how much the braking distance changes if that percentage is 50 % slower.

Solution for Problem 16

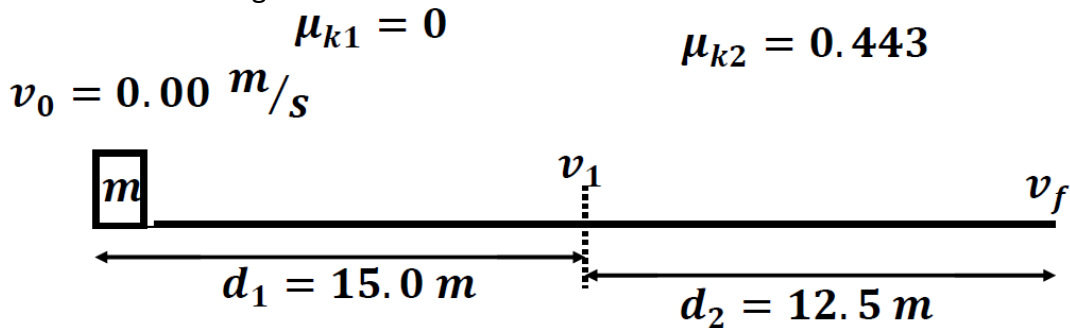
17. An object has a mass of 6.76 kg is moving in two dimensions. At time $t = 0.00$ s, velocity is expressed as $\vec{v}_1 = (3.74 \hat{i} - 1.87 \hat{j}) \text{ m/s}$. Force \vec{F} acts on the object for a time of 4.00 s. The velocity for the object is now $\vec{v}_2 = (-13.2 \hat{i} + 9.47 \hat{j}) \text{ m/s}$. How much work was done on the object by the force \vec{F} ?

Solution for Problem 17

18. A driver trying to avoid colliding with a guard rail on a rainy night locks her brakes up and creates a skid mark that is measured to be 98.0 m long. The initial velocity of the car was 27.0 m/s . What was the coefficient of kinetic friction between the tires and the road surface.

Solution for Problem 18

19. A box has a mass of 39.0 kg is at rest on a horizontal surface. A constant force of $P = 187.0 \text{ N}$ is applied in the East direction. For the first 15.0 m the surface is frictionless. But the next 12.5 m there is a coefficient of kinetic friction of $\mu_k = 0.443$. What is the final speed after the box has gone 27.5 m?



Solution for Problem 19

20. A moving object has a mass of 0.20 kg and two forces are acting on it. $\vec{F}_1 = (1.50 \hat{i} - 0.80 \hat{j} + 0.70 \hat{k}) \text{ N}$ and $\vec{F}_2 = (-0.70 \hat{i} + 1.20 \hat{j}) \text{ N}$. The displacement is described as $\vec{S} = (8.00 \hat{i} + 6.00 \hat{j} + 5.00 \hat{k}) \text{ m}$. What is the net work done on the object by the two forces?

Solution for Problem 20

21. An object is displacing as described by $\vec{S} = (5.00 \hat{i} + 12.0 \hat{j} - 13.0 \hat{k})$ m. The mass of the object is 14.3 kg. A force $\vec{F} = (25.00 \hat{i} - 16.0 \hat{j})$ N.

- (a) Find the work done by the force.
- (b) What is the angle between the force and the displacement vector?

Solution for Problem 21

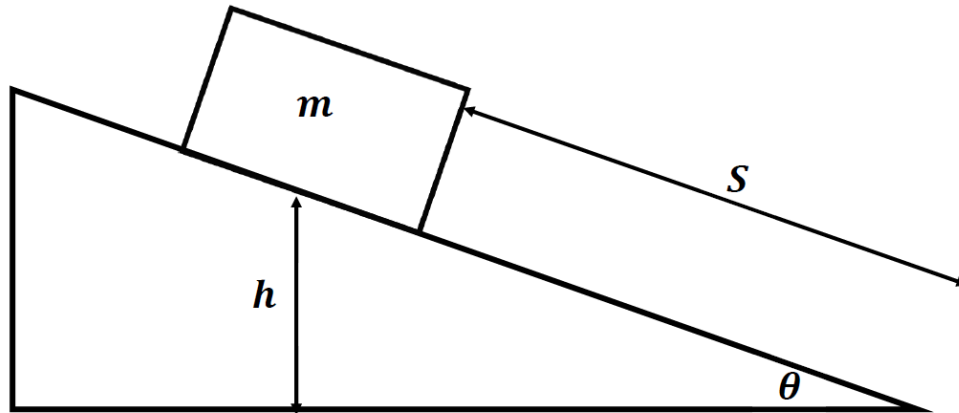
22. An MLB Major League baseball has a mass of 0.145 kg. A knuckle ball is thrown with a speed of 29.1 m/s horizontally. A knuckle ball is effective due to air resistance making the ball “dance” Assuming the horizontal speed decreases by 15% over a distance of 18.4 m, what is the average force of air resistance acting on the ball?

Solution for Problem 22

23. A fighter jet has a mass of 2.45×10^4 kg lands with a speed of 66.7 m/s and comes to rest. What would the spring constant have to be on a spring that brings the plane to rest with a maximum acceleration of 5g's?

Solution for Problem 23

24. A child in a go cart starts at rest on coasts down a hill which makes an angle of $\theta = 5.50^\circ$ with the horizontal. Mass of the child and the go cart is 97.3 kg. Consider the distance along the hill traveled by the cart is 458. m.

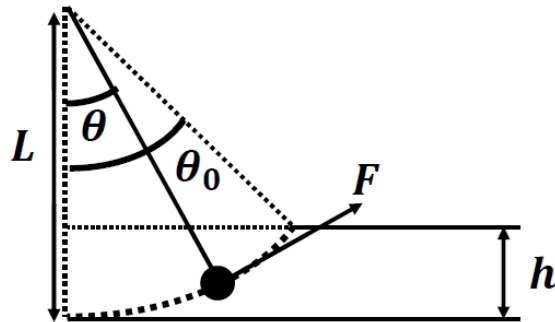


- (a) What is the net work done by gravity in this case?
- (b) What is the speed of the go cart and child at the bottom of the distance. Ignore air resistance and friction.

Solution for Problem 24

25. A mass m is attached to a cord of length L which is attached to the ceiling and the mass is free to move as a pendulum would move along a circular arc of radius L . A force F is moving the mass along the arc as shown keeping the cord taut at all times. The force is adjusted so that the speed of the mass is constant along the arc. At an angle $\theta = \theta_0$ the mass has risen a height h above the lowest point of the arc which is when $\theta = 0.00^\circ$. Demonstrate that the work done by the force F going from $\theta = 0.00^\circ$ to $\theta = \theta_0$ is equivalent to moving the mass straight up a distance h .

Hint: when the angle is changed by $d\theta$ this is equivalent to the mass moving a distance $Ld\theta$ along the arc.



Solution for Problem 25

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