Review

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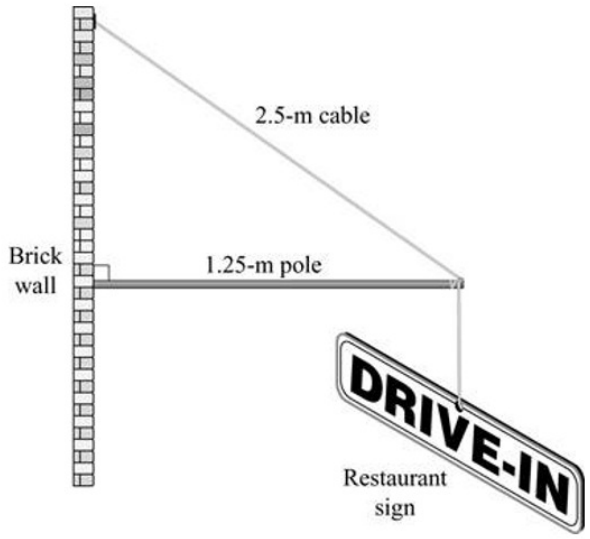
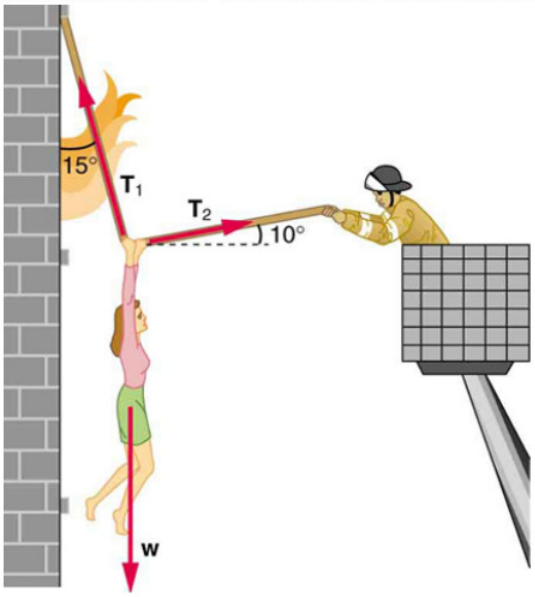
1. Three forces act on an object. A 35-N force acts at an angle of 20° relative to a 60-N force. A 40-N force acts at an angle of 75° relative to the 60-N force on the opposite side of the 35-N force. Determine the equilibrant of the three forces.

2. A steel wire 40 m long is suspended between two fixed points 20 m apart. A force of 375 N pulls the wire down at a point 15 m from one end of the wire. State the tension in each part of the wire.

3. A 25-kg restaurant sign hangs from a 1.25-m horizontal pole with one end fastened at right angles to the brick wall of a restaurant, and the other end fastened to a 2.5-m cable, as shown below. Determine the tension in the cable and the force counteracting the compression acting on the pole.



4. Find the tension in each wire if the woman being saved weighs 50kg.



5. Find the tension in each wire if the person weighs 60kg and the angle Θ is 30° .

6. A box sits on a frictionless ramp inclined at 25° to the horizontal. The force of gravity acting on the box perpendicular to the ground is 150 N.

a) Determine the static friction and normal forces that would keep the box from moving.

b) Determine the tension in a rope fastened to the middle of the top of the box that pulls the box at an angle of 45° relative to the top surface of the box and will keep the box from moving. What is the normal force now? Ignore friction for (b)

7. A pilot wishes to fly to an airfield $S20^{\circ}\ E$ of his present position. If the average airspeed of the plane is 520 km/h and the wind is from $N80^{\circ}\ E$ at 46 km/h,

a. in what direction should the pilot steer?

b. what will the plane's ground speed be?

8. A sailor climbs a mast at 0.5 m/s on a ship travelling north at 12 m/s, while the current flows east at 3 m/s. What is the speed of the sailor relative to the ocean floor?

9. A car is 260 m north and a truck 170 m west of an intersection. They are both approaching the intersection, the car from the north at 80 km/h, and the truck from the west at 50 km/h. Determine the velocity of the truck relative to the car.

10. Suppose $\vec{c}$ = 60 km/h represents the velocity of an eastbound car, $\vec{t}$ = 80 km/h represents the velocity of a westbound truck, and $\vec{b}$ = 40 km/h represents the velocity of a westbound bus. For each situation, state and draw the velocity vector.

a) the velocity of the car as it appears relative to the driver of the truck

b) the velocity of the bus as it appears relative to the driver of the truck

c) the velocity of the bus as it appears relative to the driver of the car

11. A boat on a lake is heading at a bearing of 30°. The boat is travelling at a velocity of 40 km/h and the current is flowing from the southeast at 9 km/h. Determine the heading of the boat and the resultant velocity relative to the ground

12. Does $\vec{a} \downarrow (\vec{b} + \vec{c}) = \vec{a} \downarrow \vec{b} + \vec{a} \downarrow \vec{c}$? Prove your answer.

13. Suppose that $|\vec{c}| = 8$, $|\vec{d}| = 3$, and the angle between these two vectors is $\theta = 60°$.
   a. Find $\vec{c} \cdot \vec{d}$.
   b. Determine the dot product of the vectors $\vec{c} - \vec{d}$ and $\vec{c} + 2\vec{d}$.
   c. What value of k would cause the vectors $\vec{c} - \vec{d}$ and $\vec{c} + k\vec{d}$ to be perpendicular?

14. Consider any two vectors in R^3, $\vec{a}$ and $\vec{b}$.
   a. Describe in your own words what the scalar projections of $\vec{a}$ on $\vec{b}$ and $\vec{b}$ on $\vec{a}$ represent geometrically. Draw these projections in your diagram. What does it mean if this scalar projection is positive? What does it mean if this scalar projection is negative? What does it mean if this scalar projection is zero?
   b. Describe in your own words what the vector projections of $\vec{a}$ on $\vec{b}$ and $\vec{b}$ on $\vec{a}$ represent geometrically.

15. For each of the following computations, state whether the result will be a scalar, a vector, or if the computation is meaningless.
   a. $|\vec{a} \times \vec{b}|\vec{c}$
   b. $((\vec{a} \times \vec{b}) \times \vec{c}) \cdot \vec{d}$
   c. $\vec{a} \times \vec{b} + \vec{a} \cdot \vec{b}$
   d. $(\vec{a} \cdot (\vec{b} \times \vec{c})) \cdot \vec{d}$
   e. $(((\vec{a} \times \vec{b}) \times \vec{c}) \cdot \vec{d})|\vec{a} \times \vec{b}|\vec{c}$
   f. $(((\vec{a} \times \vec{b}) \times \vec{c}) \cdot \vec{d}) - |\vec{a} \times \vec{b}|\vec{c}$

16. Consider the following vectors $\vec{a} = 5\vec{i} - \vec{j} + 2\vec{k}$, $\vec{b} = \vec{i} - 4\vec{k}$ and $\vec{c} = -\vec{i} + 6\vec{j}$. Compute the following
   a) $\vec{a} \bullet \vec{b}$
   b) $(2\vec{c} + \vec{b}) \times \vec{a}$
   c) $\vec{b} \downarrow \vec{a}$
   d) $\vec{b} \times \vec{c}$
   e) $(\vec{a} - 3\vec{b}) \bullet \vec{c}$
   f) $|\vec{a} \downarrow \vec{c}|$
   g) Find angle between vectors $\vec{a}$ and $\vec{b}$
   h) If a triangle is defined by vectors $\vec{b}$ and $\vec{c}$, find the area of this triangle.

17. Find work done by the force $\vec{F} = (-2,3,-5)$ when an object is moved from point $A(0,1,4)$ to point $B(-3,0,5)$

18. Find a unit vector perpendicular to both $\vec{a} = (2,-3,0)$ and $\vec{b} = (0,1,-2)$

19. Prove the following relation involving vectors:
$\vec{a} \cdot \vec{b} = \frac{1}{4}|\vec{a} + \vec{b}|^2 - \frac{1}{4}|\vec{a} - \vec{b}|^2$

(20) If $\vec{a}$ and $\vec{b}$ are unit vectors, and $\| \vec{a} - \vec{b} \| = \sqrt{2}$, determine $(2\vec{a} - 3\vec{b}) \cdot (\vec{a} + 2\vec{b})$

(21.) If $\vec{a} + \vec{b} + \vec{c} = \vec{0}$ prove that $\vec{a} \bullet \vec{b} + \vec{b} \bullet \vec{c} + \vec{c} \bullet \vec{a} = -\frac{1}{2}(|\vec{a}|^2 + |\vec{b}|^2 + |\vec{c}|^2)$

(22) A special bicycle computer reports the magnitude of the torque exerted by a cyclist during a strenuous portion of the ride to be $\frac{600}{\sqrt{3}}$ J at the top of his pedal-stroke. If the force exerted by the cyclist at this point is in a direction that is 60° relative to the pedal, and the pedals are 25 cm in length, how much force, in N, must the cyclist be exerting at this moment?

(23) Suppose a box on a frictionless ramp is being pulled by a rope with a tension of 350 N making an angle of 45° to the horizontal ground. If the angle of incline of the ramp is 15°, and the box is pulled 50 m, determine the amount of work done.