Physics

Quiz 1

(November 2007)

Name:_____

1) A sled with mass of 20 Kg is pulled at a constant velocity (no acceleration) across a horizontal snow surface. If a force of 8.0×10^{1} N is being applied to the sled rope at an angle of 53° to the ground and a second force of unknown magnitude is applied to the opposite direction, what is the magnitude of the second force acting on the sled?

Given

$F = 8.0 \times 10^{1}$ N

$\theta = 53°$

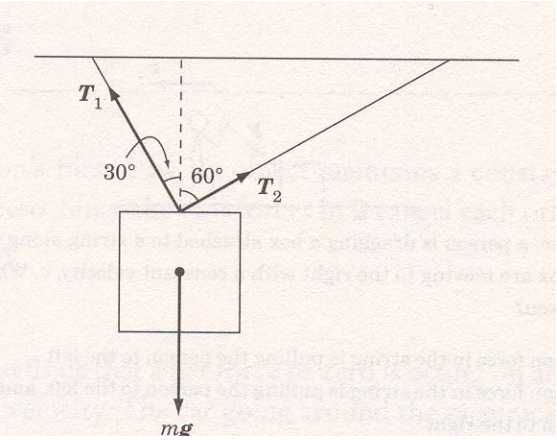
Solution

$$\Sigma F_x = F_f - F_{applied,x} = 0$$

$$F_f = F_{applied,x} = F\cos\theta = (8.0 \times 10^{1}\ \text{N})(\cos 53°) = 48\ \text{N}$$

2) As shown in the following figure, a block is suspended from two ropes, so that it hangs motionless in the air. If the magnitude of T_2 is 10.0N, what is the magnitude of T_1?

EC) Find the mass of the block:



$$\Sigma F_x = T_1\cos 120 + T_2\cos 30 = 0$$

$$T_1(-1/2) + 10(0.86) = 0$$

$$\Rightarrow T_1 = 17.32N$$

EC) $T_1\sin 120 + T_2\sin 30 + mg = 0$

$\Rightarrow 19.7 + mg = 0$

$\Rightarrow m = 2.01Kg$

3) A sailboat with a mass of 2.0×10^3 kg experiences a tidal force of 3.00×10^3 N directed to the east and a wind force against its sails with a magnitude of 6.00×10^3 N directed toward the northwest (45.0° N of W). What is the magnitude of the resultant acceleration of the boat?

Given

$$\mathbf{F}_1 = 3.00 \times 10^3 \text{ N, east}$$

$$\mathbf{F}_2 = 6.00 \times 10^3 \text{ N, 45.0° N of W}$$

$$m = 2.0 \times 10^3 \text{ kg}$$

Solution

$$F_{net,x} = \Sigma F_x = F_1 - F_{2,x} = F_1 - F_2 \cos\theta$$

$$F_{net,x} = \left(3.00 \times 10^3 \text{ N}\right) - \left(6.00 \times 10^3 \text{ N}\right)(\cos 45.0°) = 1.24 \times 10^3 \text{ N, west}$$

$$F_{net,y} = \Sigma F_y = F_{2,y} = F_2 \sin\theta$$

$$F_{net,y} = \left(6.00 \times 10^3 \text{ N}\right)(\sin 45.0°) = 4.24 \times 10^3 \text{ N, north}$$

$$F_{net} = \sqrt{\left(F_{net,x}\right)^2 + \left(F_{net,y}\right)^2}$$

$$a = \frac{F_{net}}{m} = \frac{\sqrt{\left(F_{net,x}\right)^2 + \left(F_{net,y}\right)^2}}{m} = \frac{\sqrt{\left(1.24 \times 10^3 \text{ N}\right)^2 + \left(4.24 \times 10^3 \text{ N}\right)^2}}{\left(2.0 \times 10^3 \text{ kg}\right)}$$

$$a = 2.2 \text{ m/s}^2$$

4) An Olympic skier moving at 20.0 m/s on a straight line encounters a hill with an angle of 30.0°; assuming there is no friction or air resistance:

A) How long will it take for him to stop?
B) How far does he slide up the hill?
C) Assuming he has a mass of 70 Kg, what force does he encounter as he is moving up the hill?

$$v_i = 20.0 m/s$$
$$v_f = 0.0 m/s$$
$$a = g \sin 30 = -4.9 m/s^2$$

A) $v_f = v_i + at$

$0 = 20.0 + (-4.9)(t)$

$=> t = 4.1s$

B) $(v_f)^2 - (v_i)^2 = 2ax$

$0 - 400. = -9.8x$

$=> x = 41m$

C) $F = mg \sin \theta$

$F = 70 \times -4.9 = -343N$

5) A man shoots a ball hoping that it would hit a target placed 20 m above the ground. If he shoots the ball with a velocity of 40m/s at an angle of 30 degrees with horizontal:
(Let $a = g = -10m/s^2$)

A) How long does it take for the ball to hit the target?
B) How far from the target is the man standing?
C) At what horizontal velocity does the ball hit the target?
D) At what vertical velocity does the ball hit the target?

$$v_y = v_i \sin 30 = 20.0m/s$$

$$v_x = v_i \cos 30 = 34.6m/s$$

$$x_y = 20m$$

$$g = -10m/s^2$$

A) $x_y = \frac{1}{2}gt^2 + v_i t$

$$20 = -5t^2 + 20t$$

$$\Rightarrow t = 2s$$

B) $x_x = v_x t$

$$x_x = 34.6 \times 2 = 69.2m$$

C) $v_x = 34.6m/s$

D) $v_f = v_i + gt$

$$v_f = 20 + (-10)(2) = 0m/s$$

E) $s = \sqrt{(34.6m/s)^2 + 0^2} = 34.6m/s$