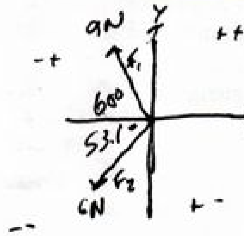
2008-10-05 Physics practice test — Richard X. Thripp

1. Vectors F1 and F2 act on a point. F1 has a magnitude of 9.00N and an angle of 120 degrees. F2 has a magnitude of 6.00N and an angle of 233.1 degrees. Find (a) the x and y components of the resultant force; (b) the magnitude of the resultant force.



(a) $\vec{R} = \vec{F}_1 + \vec{F}_2$

$\vec{F}_1 = -9\cos 60° i + 9\sin 60° j = -4.5i + 7.7942j$

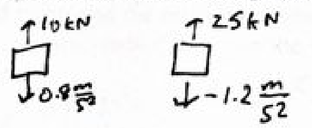
$\vec{F}_2 = -6\cos 53.1° i - 6\sin 53.1° j = -3.6025i - 4.7981j$

$\vec{R} = (-4.5 - 3.6025)i + (7.7942 - 4.7981)j =$ $\boxed{-8.1025i + 2.9961j}$

(b) $R = \sqrt{R_x^2 + R_y^2} = \sqrt{(-8.1025)^2 + (2.9961)^2}$

$= \boxed{8.6387\ N}$

2. A spacecraft descends vertically near the surface of Planet X. An upward thrust of 25.0 kN makes its speed decrease by 1.20 m/s². An upward thrust of 10.0 kN makes its speed increase by 0.8 m/s². Applying Newton's laws, what is the spacecraft's weight near the surface of Planet X?



$\vec{F} = m\vec{a}$

~~$10000N = m(0.8\ m/s^2)$~~

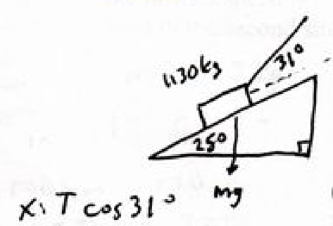
~~$25000N = m(-1.2\ m/s^2)$~~

$10000N + 0.8m = 25000N - 1.2m$

$2m = 15000$

$\boxed{w = 7500\ kg}$

3. A light cable holds a 1130-kg car in place on a frictionless ramp. The cable makes an angle of 31 degrees above the ramp, and the ramp makes an angle of 25 degrees above the horizontal. Find (a) the tension in the cable; (b) the force the surface of the ramp exerts on the car.



(a) $T = \dfrac{1130kg \cdot 9.8\frac{m}{s^2} \cdot \sin 25°}{\cos 31°} = \boxed{5459.9314\ N}$

x: $T\cos 31°$

y: $mg\sin 25°$

(b) $mg\cos 31° - T\sin 25° = F_{ramp}$

$F_{ramp} = (1130kg)(9.8\frac{m}{s^2})(\cos 25°) - (5459.9314 \sin 31°)$

$=$ ~~7184.8090 N~~ $\boxed{7224.3799\ N}$

4. A 60N block rests atop a table. A cable connects it to a 12N hanging weight at a right angle, balanced by a cable connected to a hook on the wall at an angle of 45 degrees above the horizontal. The coefficient of static friction between the block and the table is 0.25. The system is in equilibrium. Find (a) the friction force exerted on block A; (b) the maximum weight w for which the system will remain in equilibrium (hint: greater than 12N).

60N T_2/ 45 degrees
A →T_1+/ - - - -
90° |
table | T_3
w 12N

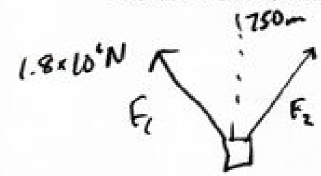
(a) $T\cos\theta - mg\sin\theta = 0$

$T_1 = \dfrac{mg\sin\theta}{\cos\theta} = \dfrac{12N\sin 90^\circ}{\cos 45^\circ}$

$= \boxed{16.9706\ N}$

(b) $\mu_s = f_s \cdot n = 0.25 \cdot 60N = \boxed{15N}$

5. Two tugboats pull a disabled ship. Each tugboat exerts a constant force of 1.80 X 10^6 N, one 14 degrees west of north and the other 14 degrees east of north. The tugboats pull the ship 0.75 km due north. What is the total work they do on the ship? Joules



$W = FS\cos\theta + FS\cos\theta$

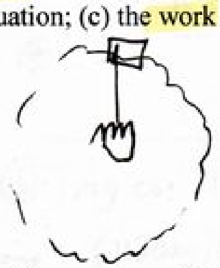
$W = 2(1.8\times10^6 N)(750m)(\cos 14^\circ)$

$= \boxed{2619798461\ J}$

6. Someone spins a 0.12 kg block in a uniform circle with a radius of 0.4 m by an attached cord. The block is revolving with a speed of 0.7 m/s. Then, the cord is retracted so the circle's radius is 0.1 m, and the block's speed is 2.8 m/s. Find (a) the tension in the cord in the first situation; (b) the tension in the cord in the second situation; (c) the work done by the person pulling the cord. Work-energy theorem

$m = 0.12kg$

initial	final
$r = 0.4m$	$r = 0.1m$
$v = 0.7\frac{m}{s}$	$v = 2.8\frac{m}{s}$



(a) $f_c = m\dfrac{v^2}{r} = 0.12kg \cdot \dfrac{(0.7\frac{m}{s})^2}{0.4m}$

$= \boxed{0.147N}$

(b) $0.12kg \cdot \dfrac{(2.8\frac{m}{s})^2}{0.1m} = \boxed{9.408N}$

(c) $W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$= \frac{1}{2}(0.12kg)(2.8\frac{m}{s})^2 - \frac{1}{2}(0.12kg)(0.7\frac{m}{s})^2$

$= \boxed{0.441\ J}$