§ 1 Inaugural Competition Solutions

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1. a) (2 points) Since $F = ma$, $a = \frac{F}{m}$, or $\frac{14.0}{32.5} = \boxed{0.431\ m/s^2}$

   b) (3 points) $v_f = v_0 + at$, so plugging in we get $v_f = 0 + (.431)(10) = \boxed{43.1\ m/s}$

   c) (5 points) $\Delta x = v_0 t + \frac{1}{2}at^2$, so plugging in we get $\Delta x = 0 + (.5)(.431)(10)^2 = \boxed{21.55\ m}$

2. (20 points) $F = ma$, $100 = \frac{(150+50)}{g}(a)$, so $a = 5m/s^2$. So, the force that A exerts on B can be derived from: $F = (50/10)(5) = \boxed{25\ N}$

3. a) (20 points) Drawing a free-body diagram, we can notice that the vertical component of the normal force must be canceled out by the force of gravity. Also, notice that the angle betwen the normal force vector and the horizontal is not 35°, but 55°. With this: $F_N sin(55°) = mg$ so, $F_N = mg \cdot csc(55°) = \boxed{122.1N}$

   b) (32 points) From the previous solution, since $F_N = 122.1$, $F_N \cdot cos(55°) = F_T$, solving, we get $\boxed{F_T = 70.0N}$

4. a) (25 points) First, we should calculate the force of friction and gravity in the parallel direction for each so we have less variables to work with:

For the 4kg block:

$$F_f = (4)(10)(cos(30°)(.25) \approx 8.66N$$

$$F_g = (4)(10)(.5) = 20N$$

For the 8kg block:

$$F_f = (8)(10)(cos30°)(.35) \approx 24.2487N$$

$$F_g = (8)(10)(.5) = 40N$$

Now, write two equations summing the forces of each in the parallel direction, the direction of the net force:

$$\Sigma F = 20 - 8.66 - T = 4a$$

$$\Sigma F = 40 - 24.2487 + T = 8a$$

Adding the equations (canceling out T), gives us the acceleration of both blocks, $\boxed{2.268\ m/s^2}$

   b) (25 points) Now, all we need to do now is plug in 2.268 into our equations, and now there is only one variable, leading us to get the $F_T = \boxed{2.31\ N}$

Tiebreaker

First thing is to notice that since the only forces acting on the hanging object are w and C, the force of tension above it, $\boxed{C = w}$. Now, we must do a summation equation in the vertical and horizontal directions on the middle point of the three ropes, which must be zero, to go any further. Also, make sure understand why the angle in the equation is 30° is used, not 60° .

$$\Sigma F(vertical) = B(sin(45^\circ)) - A(sin(30^\circ)) - w = 0$$

$$\Sigma F(horizontal) = B(cos(45^\circ)) - A(cos(30^\circ)) = 0$$

First, substituting trigonometric functions for decimals instead, we find A in terms of B, then substitute it in the first equation:

$$B = A\sqrt{1.5} \approx 1.225A$$

$$(1.225A)\frac{\sqrt{2}}{2} - \frac{A}{2} - w = 0$$

$$\boxed{A \approx 2.73205w}$$

Plugging in A in terms of w to the horizontal equation:

$$B * \frac{\sqrt{2}}{2} - (2.73205w)\frac{\sqrt{3}}{2} = 0$$

$$\boxed{B \approx 3.34606w}$$