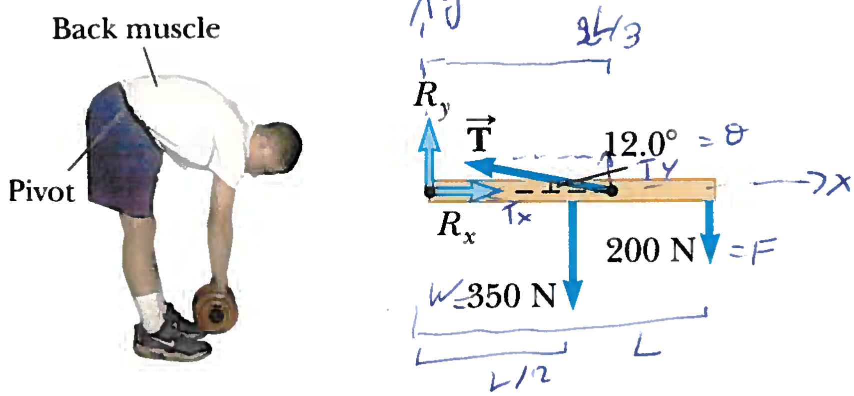
STUDENT: **SCHOOL:**

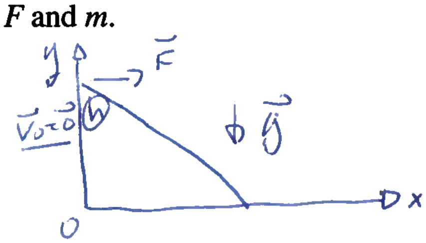
3. A person bends forward to lift a 200-N weight, until his spine becomes almost horizontal (figure on the left). The person's spine pivots mainly on the fifth lumbar vertebra, with the main muscle force provided by the erector spinalis muscle in the back. A schematic lever representation of the system is shown on the right. The spine is represented as a horizontal rod pivoted on the left point, at the base of the spine. The weight of the spine and upper body is 350 N, acting in the middle of the rod. The muscle, shown as a vector **T** acting at a point two-thirds up the spine, maintains the position of the back. The angle between the spine and the muscle is 12°, as shown. Calculate the horizontal (R_x) and vertical (R_y) components of the reaction force, **R**, with the correct sign.



(a) R_x = 2646.4 N, R_y = -12.4 N *
(b) R_x = -2646.4 N, R_y = -12.4 N
(c) R_x = 12.4 N, R_y = 2646.4 N
(d) R_x = 2646.4 N, R_y = 12.4 N
(e) R_x = -2646.4 N, R_y = 12.4 N

$x: R_x - T\cos\theta = 0 \Rightarrow R_x = T\cos\theta$ (1)
$y: R_y - W - F + T\sin\theta = 0 \Rightarrow R_y = W + F - T\sin\theta$ (2)
torques: $\tau_R = 0$ $\tau_W = WL/2$ $\tau_F = FL$
$\tau_T = -T\sin\theta \frac{2L}{3}$ $\Rightarrow$
$W\frac{L}{2} + FL - T\sin\theta\left(\frac{2L}{3}\right) = 0 \Rightarrow$
$T\sin\theta = \frac{W/2 + F}{2/3} \Rightarrow T = \frac{W/2 + F}{(2/3)\sin\theta} = \frac{375\ N}{0.1386} = 2705.5\ N$ (3)
(1),(3) $\Rightarrow R_x = 2646.4\ N$
(2),(3) $\Rightarrow R_y = 350\ N + 200\ N - 2705.5\sin 12° \Rightarrow$
$R_y = -12.5\ N$

4. An object of mass *m* is released from rest at the top of a building having a height *h*. A wind blowing along the side of the building exerts a constant horizontal force of magnitude *F* on the object as it drops. The air exerts no vertical force. How far from the building will the object hit the ground? Express your result as a function of *h*, *F* and *m*.



(a) $\frac{Fh}{2mg}$
(b) $\frac{Fh}{mg}$ *
(c) $\frac{2Fg}{mh}$
(d) $\frac{gh}{mF}$
(e) $\frac{Fh}{4mg}$

$x: a_x = F/m \Rightarrow x = \frac{1}{2}a_x t^2 = \frac{1}{2}\frac{F}{m}t^2$ (1)
$y: a_y = -g \Rightarrow y = h - \frac{1}{2}gt^2$
$y = 0 \Rightarrow h = \frac{1}{2}gt^2 \Rightarrow t^2 = \frac{2h}{g}$ (2)
(1),(2) $\Rightarrow x_{max} = \frac{1}{2}\frac{F}{m}\frac{2h}{g} = \frac{Fh}{mg}$