See the HiHW grading rubric posted on Carmen

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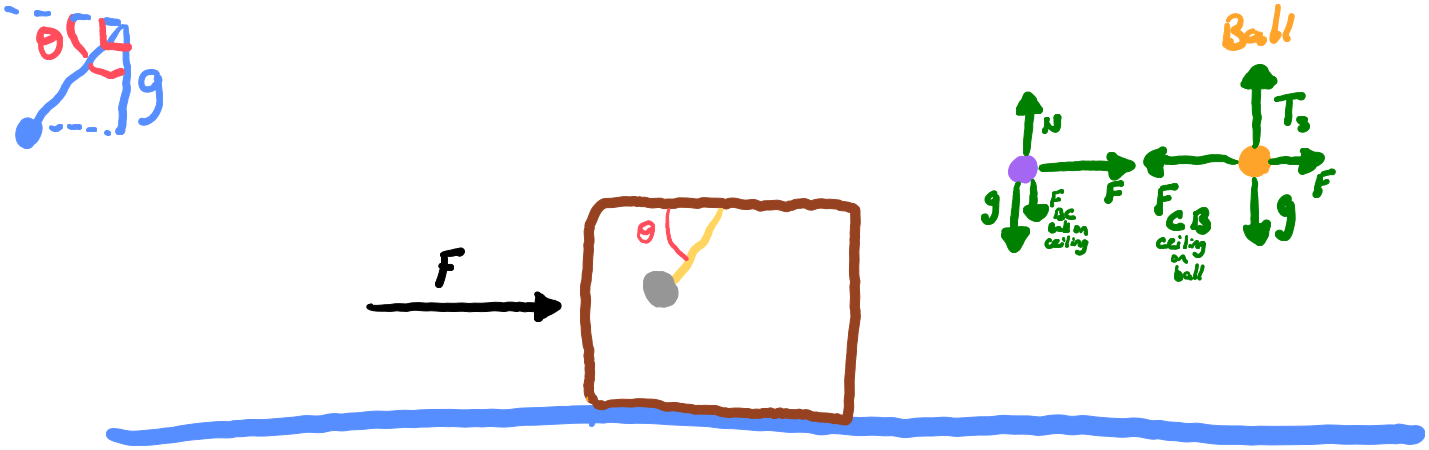
A metal ball ($m = 1.9$ kg) hangs by a light string from the ceiling of a wooden crate ($M = 5.2$ kg). The crate is then pushed with a constant horizontal force F along some friction-less ice. This causes the ball hang inside the crate at an angle of $\theta = 40°$ with respect to the vertical. What is the value of F ?(Hint: if the ceiling of the crate is pulling on the ball, then the ball is pulling back on the ceiling of the crate.) For the limit check, investigate what happens to F as the angle θ drops to zero.

Representation:	0	1	2
Physics Concept(s):	0	1	2
Initial Equation(s):	0	0.5	1
Symbolic Answer:	0		1
Units Check:	0	0.5	1
Limits Check:	0	0.5	1
Neatness:	-2	-1	0
Total:			
Correct Answer:	Y	N	

Representation $m = 1.9\,kg$ $M = 5.2\,kg$ $\theta = 40°$



Physics Concept(s) (Refer to the list posted on Carmen)

(1) Newton's Laws of Motion

Initial Equations

$F = ma$

$\tan\theta = \frac{O}{A}$

↓ Show Your Equation Work On Next Page ↓

Algebra Work (Symbols only. Don't plug in any numbers yet.)

$F_g = mg$

$\theta_i = 90 - \theta$

$\tan\theta_i = \frac{F}{F_g} \rightarrow F = F_g \tan\theta_i$

Ball

$\sum f_x = m a_x$

$T\sin\theta = ma$ [Eq. 1]

$\sum f_y = m a_y$

$T\cos\theta - mg = 0$

$T\cos\theta = mg$

$T = \frac{mg}{\cos\theta}$ [Eq. 3]

Crate

$\sum f_x = M_c a_x$

$-T\sin\theta + f = M_c a$ [Eq. 2]

Eq. 1 + Eq. 2

$a = \frac{f}{M_c + m}$

$f = g\tan\theta(M_c + m)$

Symbolic Answer: $F = F_g \tan\theta_i$

Units Check

$F_g = mg$

$N = kg \cdot m/s^2$ ✓

$F = F_g \tan\theta_i$

$N = N \cdot ?$ ✓

Limits Check

a) As $\theta \rightarrow 0°$, what limit does F approach?

$\lim_{\theta \rightarrow 0°} F = \infty$

b) Why does the result make physical sense?

The angle approaching 0° means that the force is increasing

Numerical Answer: (Obtain this by plugging numbers into your symbolic answer.)

$F_g = 18.62\,N$

$F = 22.19\,N$