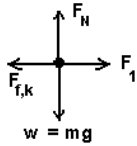


Clown Physics (50,000 points)

1.) Chuckles the Clown is shoving a 115 kg box horizontally across the floor. (a) If the box is accelerating at $a_x = 0.600 \text{ m/s}^2$, find the net force acting on the box.

$$F = ma = (115\text{kg})(0.600\text{m/s}^2) = 69.00\text{N}$$

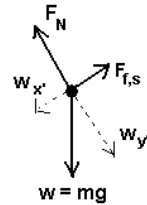
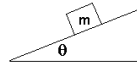
(b) If the coefficients of friction between the box and the floor are 0.700 and 0.500, with what force F_1 must Chuckles be shoving the box?



Need KINETIC friction.

$$\begin{aligned} \sum F_y &= F_N - mg = 0 ; F_N = mg \\ \sum F_x &= F_1 - F_{f,k} = ma_x \\ F_1 &= F_{f,k} + ma_x = \mu_k F_N + ma_x = \mu_k mg + ma_x \\ &= (0.500)(115\text{kg})(9.81\text{m/s}^2) + 69.00\text{N} \\ &= 633.1\text{N} \end{aligned}$$

(c) With these same coefficients of friction, what would be the maximum angle θ of an inclined plane that this box could remain at rest as shown?

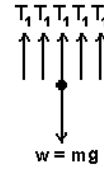


$$\begin{aligned} \mu_s &= \tan \theta_{\text{max}} \\ \theta_{\text{max}} &= \tan^{-1}(\mu_s) \\ &= \tan^{-1}(0.700) \\ &= 35.0^\circ \end{aligned}$$

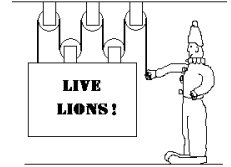
OR

$$\begin{aligned} w_{y'} &= mg \cos \theta \\ w_{x'} &= mg \sin \theta \\ \sum F_{y'} &= F_N - w_{y'} = 0 \\ F_N &= w_{y'} = mg \cos \theta \\ \sum F_{x'} &= F_{f,s,\text{max}} - w_{x'} = 0 \\ F_{f,s,\text{max}} &= w_{x'} \\ \mu_s F_N &= \mu_s mg \cos \theta = mg \sin \theta \\ \mu_s &= \frac{mg \sin \theta}{mg \cos \theta} = \frac{\sin \theta}{\cos \theta} = \tan \theta \\ \theta &= \tan^{-1}(\mu_s) = \tan^{-1}(0.700) = 35.0^\circ \end{aligned}$$

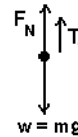
(d) Two lions with a mass of 150. kg *each* are placed in a crate (30.0 kg). Find the tension T_1 in the cable if the loaded crate is suspended at rest as shown.



$$\begin{aligned} m &= 2(150.\text{kg}) + 30.0\text{kg} = 330.0\text{kg} \\ \sum F_y &= 5T_1 - mg = 0 \\ 5T_1 &= mg \\ T_1 &= \frac{mg}{5} = \frac{(330.0\text{kg})(9.81\text{m/s}^2)}{5} \\ &= 647.5\text{N} \end{aligned}$$



(e) Does Chuckles (87.0 kg) weigh enough to hold this loaded crate as shown? If not, what is his acceleration? If you didn't get an answer to (d), use $T_1 = 837 \text{ N}$.

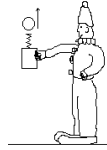


$$\begin{aligned} \sum F_y &= F_N + T_1 - mg = 0 \\ F_N &= mg - T_1 \\ &= (87.0\text{kg})(9.81\text{m/s}^2) - 647.5\text{N} \\ &= 853.5 - 647.5\text{N} \\ &= 206.0\text{N} > 0 \end{aligned}$$

F_N is positive, Chuckles' weight $> T_1$, so YES, he weighs enough to hold this loaded crate.

More Clown Physics! (50,000 points)

2. (a) Chuckles opens a box and a spring pops out a ball (0.100 kg) which flies upwards. If the spring has a Hooke's Law constant $k = 50.0 \text{ N/m}$ and the spring was compressed 0.300 meters, how high h does the ball go? *Don't know about you, but I'd use Conservation of Energy for this problem.*



$$PE_{spring} = KE = PE_{gravity}$$

$$\frac{1}{2} kx^2 = \frac{1}{2} mv^2 = mgh$$

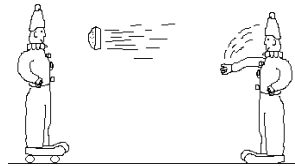
$$\frac{1}{2} kx^2 = mgh$$

$$h = \frac{kx^2}{2mg} = \frac{(50.0 \text{ N/m})(0.300 \text{ m})^2}{2(0.100 \text{ kg})(9.81 \text{ m/s}^2)}$$

$$= 2.294 \text{ m}$$

Starts out all P.E. in the spring, then turned into all K.E., then turned into all gravitational P.E.

(b) Chuckles (87.0 kg) throws a coconut cream pie (0.753 kg) at Smiley the Clown (93.0 kg). Smiley is wearing roller skates and is at rest with essentially no friction with the floor. If the pie is moving through the air at $v_x = -8.50 \text{ m/s}$, find V for the Smiley+pie combination after the totally inelastic collision. *Ignore any motion of the pie in the vertical y-direction.*



$$p_{before} = p_{after}$$

$$-m_1 v_1 + 0 = (m_1 + m_2) V$$

$$-m_1 v_1 = (m_1 + m_2) V$$

$$V = \frac{-m_1 v_1}{(m_1 + m_2)} = \frac{-(0.753 \text{ kg})(8.50 \text{ m/s})}{(0.753 \text{ kg} + 93.0 \text{ kg})}$$

$$= -0.6827 \text{ m/s}$$

(c) Tiny the Baby Elephant (1135 kg) stands 5.00 meters (center to center) from her favorite handler, Teena (50.8 kg). Find the gravitational attraction between elephant and woman.

$$G = 6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$$



$$F_G = \frac{GMm}{r^2} = \frac{(6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2)(1135 \text{ kg})(50.8 \text{ kg})}{(5.00 \text{ m})^2}$$

$$= 1.538 \times 10^{-7} \text{ N}$$

(d) Tiny the Baby Elephant goes running around a loop-the-loop. In order not to fall off at the top of the loop-the-loop, whose radius is $r = 6.00 \text{ m}$, what is the minimum speed v Tiny must be going at the top?



$$\sum F_y = -mg - F_N = -ma_c = -\frac{mv^2}{r}$$

$$-mg - F_N = -\frac{mv^2}{r}$$

$$mg + F_N = \frac{mv^2}{r}$$

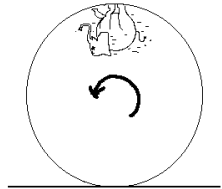
$$mg = \frac{mv^2}{r} \quad (v_{\min} \text{ occurs when } F_N = 0)$$

$$\frac{v^2}{r} = g \quad ; \quad v^2 = gr$$

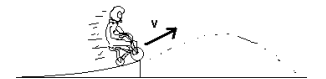
$$v = \sqrt{gr}$$

$$= \sqrt{(9.81 \text{ m/s}^2)(6.00 \text{ m})}$$

$$= 7.672 \text{ m/s}$$



(e) Enrico the stunt rider (77.0 kg) drives his mini-bicycle (8.00 kg) up a ramp, launching at $v_1 = 8.00 \text{ m/s}$ at an unknown angle, but at a height 0.500 m above the ground. Find his speed v_2 when he lands on the ground.



$$mgh_1 + \frac{1}{2} mv_1^2 = mgh_2 + \frac{1}{2} mv_2^2$$

$$mgh_1 + \frac{1}{2} mv_1^2 = \frac{1}{2} mv_2^2$$

$$v_2^2 = v_1^2 + 2gh$$

$$v_2 = \sqrt{v_1^2 + 2gh} = \sqrt{(8.00 \text{ m/s})^2 + 2(9.81 \text{ m/s}^2)(0.500 \text{ m})}$$

$$= 8.591 \text{ m/s}$$