potentially useful equations

\[ x = vt \]
\[ v = v_0 + at \]
\[ x = \frac{1}{2}(v_0 + v)t \]
\[ x = v_0t + \frac{1}{2}at^2 \]
\[ v^2 = v_0^2 + 2ax \]
\[ \mathbf{v}_{AC} = \mathbf{v}_{AB} + \mathbf{v}_{BC} \]

\[ \cos \theta = \frac{\text{adj}}{\text{hyp}} \]
\[ \sin \theta = \frac{\text{opp}}{\text{hyp}} \]
\[ \tan \theta = \frac{\text{opp}}{\text{adj}} \]
\[ a^2 + b^2 = c^2 \]
\[ x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \]
\[ g = 9.80 \text{ m/s}^2 \]
\[ G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{s}^2 \]

\[ F = ma \]
\[ f_k = \mu_k N \]
\[ f_s \leq \mu_s N \]
\[ F = PA \]
\[ F = \frac{GM_1M_2}{R^2} \]
\[ a = \frac{v^2}{R} \]

\[ T \quad 10^{12} \]
\[ G \quad 10^9 \]
\[ M \quad 10^6 \]
\[ k \quad 10^3 \]
\[ c \quad 10^{-2} \]
\[ m \quad 10^{-3} \]
\[ \mu \quad 10^{-6} \]
\[ n \quad 10^{-9} \]
\[ p \quad 10^{-12} \]
1) Snoopy (7.2 kg) is sitting on a box (11.8 kg) on a horizontal floor. The coefficient of friction between the box and the floor is 0.27 and there is no friction between Snoopy and the box. A horizontal force of 73 N to the right pushes on the box.

1.1) [6] Draw a free body diagram for Snoopy and for the box.

1.2) [2] Pick an appropriate set of coordinate axes.

1.3) [8] Apply Newton’s second law to each object in each direction. Include anything about the accelerations that you know without solving.

1.4) [4] Find the acceleration (magnitude & direction) of each object while Snoopy sits on the box.
2) An amusement park ride consists of a wide cylinder (radius=3.8 m). People stand inside with their back against the wall. The cylinder rotates (speed of wall=11 m/s) and then the floor is dropped away and friction holds the riders up. To increase the thrill, the ride can then be tilted by 25°.

2.1) [6] Draw a free body for the rider at the position shown.

2.2) [2] Pick an appropriate set of coordinate axes.

2.3) [8] Apply Newton’s second law to the rider in each direction. Include anything about the accelerations that you know without solving.

2.4) [4] Find the normal force acting on the rider (mass=60kg).
MC.1) [5] A helicopter of mass 3000 kg lifts a 1000 kg car with a steel cable. The helicopter and car are moving upward but slowing at 1.0 m/s². What is the tension in the steel cable?
   a) 1000 N
   b) 8800 N
   c) 9800 N
   d) 10800 N
   e) 43200 N

MC.2) [5] Bob pushes a chair across a floor with a constant velocity. He abruptly stops pushing on the chair. What does the chair do when he quits pushing on it?
   a) continues with a constant velocity
   b) stops immediately
   c) continues with a constant speed for a couple of seconds and then slows to a stop
   d) immediately begins to slow to a stop
   e) speeds up for a second or two and then stops.

MC.3) [5] A coin sits on a turntable (such as a record player). As the turntable spins there is a friction force that pushes the coin toward the pivot of the turntable. What is the Newton’s third law “equal and opposite” force to this friction force?
   a) the weight of the coin
   b) the normal force of the turntable on the coin
   c) the centripetal force on the coin
   d) a second friction force pushing the coin away from the pivot of the turntable
   e) none of these is the Newton’s third law force

MC.4) [5] A refrigerator with a weight of 500 N sits on a floor. The coefficient of kinetic friction is 0.30 and the coefficient of static friction is 0.40. A force of 170 N is applied horizontally to the refrigerator. What is the magnitude of the friction force on the refrigerator? (Hint: does the refrigerator move?)
   a) 0 N
   b) 150 N
   c) 170 N
   d) 200 N
   e) 500 N
MC.5) [5] A “conical pendulum” hangs from a string and swings in a circle. What is the magnitude of the vertical component of the total force acting on the mass at the end of the string?
   a) zero
   b) mg
   c) mg cos θ
   d) mg / cos θ
   e) m v^2 / R

MC.6) [5] Planet Zotar has twice the mass of the Earth and twice the radius of the Earth. How does the weight of an object on the surface of planet Zotar compare to the weight of the same object on the surface of the Earth?
   a) four times bigger
   b) twice as big
   c) the same
   d) half as big
   e) one fourth as big

MC.7) [5] A car drives northward at constant speed on a road that curves to the west. As the car successfully makes the turn, what is the direction of the friction force that the road exerts on the car?
   a) north
   b) south
   c) east
   d) west
   e) northwest