Chapter 5 Discussion
Force and Motion

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1. If an object is at rest, can you conclude that there are no forces acting on it? Explain.

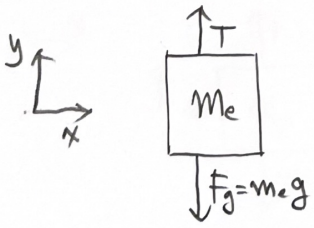
No, there is force but net force ($\Sigma \vec{F}$) is zero.
there might be no forces acting on it but it can also have forces which their sum is 0 ($\Sigma \vec{F} = 0$)

2. If a force is exerted on an object, is it possible for that object to be moving with constant velocity? Explain. Constant velocity means 0 acceleration,,

No, if there is a force exerted there must be an acceleration on related to exerted force.

3. For each scenario below, draw a free body diagram for the relevant mass(es) with all relevant forces displayed. Pay attention to the direction *and magnitude* of the force vectors you draw. Then choose a coordinate system and write the net force components ΣF_x and ΣF_y with respect to your coordinates. Finally, apply Newton's 2nd Law. Do not bother to perform any additional algebra.

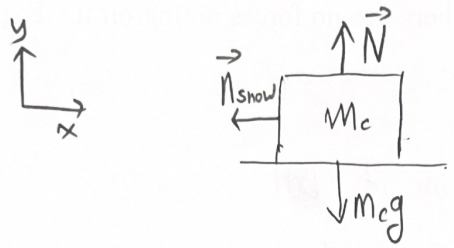
(a) An elevator suspended by a cable is descending at constant velocity.



$\Sigma F_x = 0$

$\Sigma F_y = T - m_e g = 0$

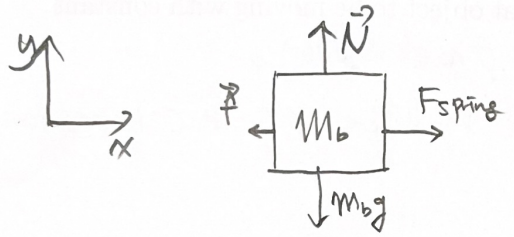
(b) A car on a very slippery icy road is sliding headfirst into a snowbank, where it gently comes to rest with no one injured.



$$\sum F_x = -n_{snow} = -ma$$

$$\sum F_y = N - m_c g = 0$$

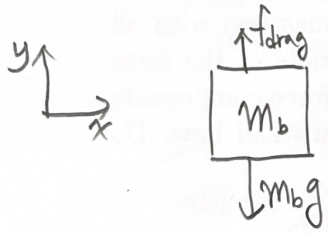
(c) A compressed spring is pushing a block across a rough horizontal table.



$$\sum F_x = F_{spring} - f = ma$$

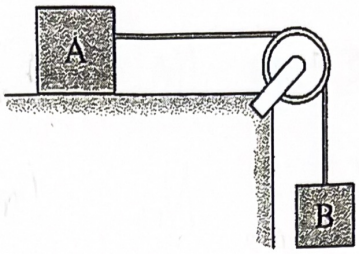
$$\sum F_y = N - m_b g = 0$$

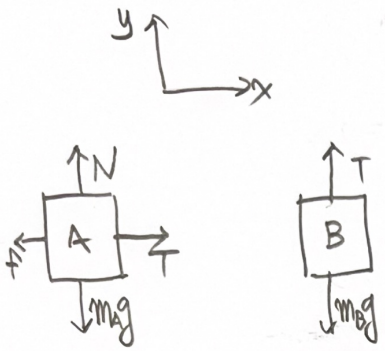
(d) A brick is falling from the roof of a three-story building.



$$\sum F_y = f_{drag} - m_b g = -ma$$

(e) Blocks A and B are connected by a string passing over a pulley. Block B is falling and dragging block A across a rough table. Analyze both blocks.



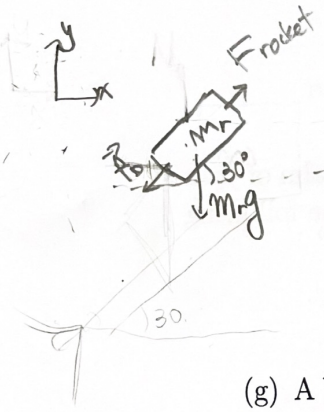


$$\Sigma F_{Ay} = N - m_A g = 0$$

$$\Sigma F_{Ax} = T - f = m_A a$$

$$\Sigma F_{By} = T - m_B g = -m_B a$$

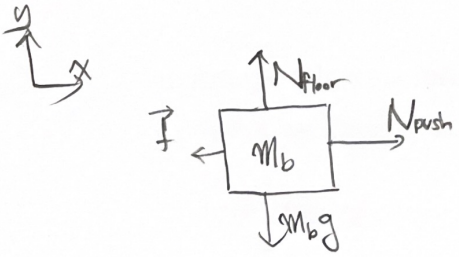
(f) A rocket is launched at a 30° angle. Air resistance is not negligible.



$$\Sigma F_y = F_{rocket} \times \sin 30^\circ - m_r g - f_{drag} \times \sin 30^\circ = -ma$$

$$\Sigma F_x = F_{rocket} \times \cos 30^\circ - f_{drag} \times \cos 30^\circ = +ma$$

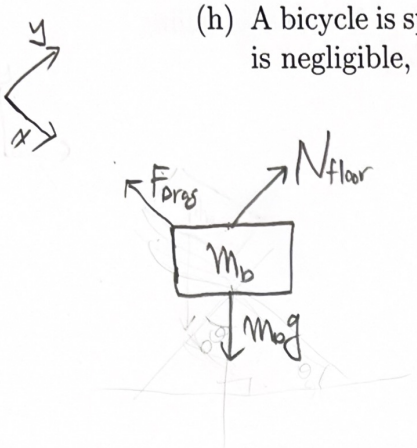
(g) A boy is pushing horizontally on a box, moving it across the rough floor at a steadily increasing speed. Analyze the box.



$$\Sigma F_y = N_{Floor} - m_b g = 0$$

$$\Sigma F_x = N_{push} - f = ma$$

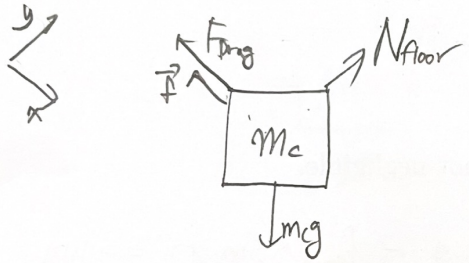
(h) A bicycle is speeding up as it rolls down a hill with an angle of inclination θ. Friction is negligible, but air resistance is not.



$$\Sigma F_x = (m_b g \cdot \sin\theta) - F_{drag} = ma$$

$$\Sigma F_y = N_{Floor} - (m_b g \cdot \cos\theta) = 0$$

(i) You've slammed on your car brakes while going down a hill of inclination angle θ. You're skidding to a halt.

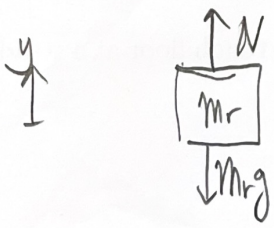


$$\Sigma F_x = (m_c g \times \sin\theta) - F_{drag} - f = ma$$

$$\Sigma F_y = N_{floor} - (m_c g \times \cos\theta) = 0$$

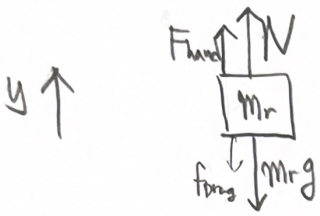
(j) You are going to toss a rock *straight up* into the air by placing it on the palm of your hand, then pushing your hand up very rapidly. Analyze the rock for the following parts of the toss:

i. As you hold the rock at rest in your palm, before moving your hand.



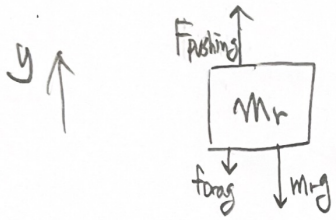
$$\Sigma F_y = N - m_r g = 0$$

ii. As your hand is moving up but before the rock leaves your hand.



$$\Sigma F_y = N + F_{hand} - m_r g - f_{drag} = ma$$

iii. One-tenth of a second after the rock leaves your hand.



$$\Sigma F_y = F_{pushing} - f_{drag} - m_r g = ma$$

iv. After the rock has reached its highest point and is now falling straight down.

$$\Sigma F_y = -m_r g = -ma$$

4. Are the following inertial reference frames? Why or why not?

(a) A car driving at steady speed on a straight and level road.

inertial reference frame, constant speed on a straight means 0 acceleration

(b) A car driving at steady speed up a 10° incline.

not inertial reference frame, when it changes the direction means not 0 acceleration

(c) A car speeding up after leaving a stop sign.

No, speeding up means not 0 acceleration

(d) A car driving at steady speed around a curve.

No, around the curve means it has acceleration

(e) A hot air balloon rising straight up at steady speed.

Yes, one direction and steady speed means 0 acceleration

(f) A skydiver just after leaping out of a plane.

No, there would be a g (downward) acceleration for the sky diver

(g) A space station orbiting the Earth.

No, orbiting the Earth means moving in a circle (rotating) means not 0 acceleration.

5. A constant force is applied to an object, causing the object to accelerate at 10 m/s^2. What will the acceleration be if $F = ma$

(a) the force is halved?

When force is halved acceleration would be also halved

(b) the object's mass is halved?

In order to get same F, when mass is halved acceleration is doubled.

(c) the force and the object's mass are both halved?

then acceleration would be same, we can multiply 2 to both equation to get original equation

(d) the force is halved and the mass is doubled?

$\frac{1}{2}F = 2m\square a$ $\therefore \square = \frac{1}{4}$

then acceleration would be one-fourth to get constant force.