PHYS 1901 Physics Advanced
Tutorial 1: Mechanics

Spend the first 10 minutes getting to know your team, the tutors, and reading the *Notes for Students*.

A. Qualitative Questions

1. *Donkey and cart*

Which of the following pairs are action-reaction pairs, and which are not? Explain your answers.

a. A donkey pulls forward on a cart, accelerating it, and the cart pulls backwards on the donkey.

b. A donkey pulls forward on a cart without moving it and the cart pulls backwards on the donkey.

c. A donkey pulls forward on a cart without moving it and the Earth exerts an equal and opposite force on the cart.

d. The Earth's gravitational field pulls down on the cart and the ground pushes up on the cart with an equal and opposite force.

2. *Koala and gum leaves*

A 10 kg koala has a firm hold on a light rope that passes over a frictionless pulley and is attached to a 10 kg bunch of gum leaves. The koala looks upwards, sees the gum leaves, and starts climbing the rope to get them.

a. Draw free-body diagrams for the koala and for the leaves:
(i) When the koala is stationary.
(ii) When the koala is starting to climb the rope.

b. As the koala climbs, do the gum leaves move up, move down, or remain at rest?

c. As the koala climbs, does the vertical separation between the koala and the gum leaves decrease, increase, or remain constant?

d. The koala releases her hold on the rope. What happens to the distance between the koala and the gum leaves as she is falling?

B. Demonstration Questions

1. *Gaining Weight*

a. Can you change (and hold) the reading while standing on one scale, without touching anything else?

b. Can you change (and hold) the reading while standing on one scale and holding a friend? Explain.

c. If you stand with your weight evenly distributed over two bathroom scales, what will be the reading on each scale compared to your weight? Why?

2. *Not a demonstration*

a. If you were standing on a scale and the floor suddenly collapsed, how would the reading on the scale change? Explain why.

b. What happens to your weight?

c. Would the situation be different if you were "stuck" to the scale?

d. How does this situation compare to a person orbiting around the earth in a spacecraft?

3. ***Objects on a rough variable ramp***

Draw a free body diagram for the block.

For a particular angle, is the force needed to keep a block stationary on the ramp larger, smaller or the same for a rough or a smooth ramp surface. Why?

Adjust the angle of inclination and note when the box begins to slide.

How would this angle be different for a smooth ramp?

4. ***Boxes on a trolley***

Several boxes are placed on a stationary trolley. They have the same size, shape and surface material, but have different weights. If the trolley is accelerated, which, if any, box will you expect to slip off the trolley first? Why? Do the experiment and explain your observations.

C. Quantitative Questions

Box on a truck

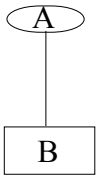
A box is placed on the back of a truck, which accelerates away (to the left). The coefficient of static friction between the surface of the truck and the box is μ_s.

a. Draw a free body diagram showing all the forces acting on the box as the truck accelerates.
b. What is the direction of acceleration of the box?
c. What is the direction of the net force acting on the box?
d. Under what conditions would the box *not* move with the truck?
e. What is the maximum acceleration of the truck before the box starts to slide?

Extra question:

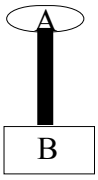
Blocks and String

Two blocks are tied to the ends of a piece of string. One block is held at a position and the other hangs suspended below it. Consider the three cases shown below.



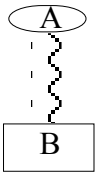
I: The string is a very light, inextensible string.

I



II: The string is a heavy, inextensible rope.

II



III: The string is very light and very stretchable.

III

a. If both blocks are stationary, is the magnitude of the force that the string exerts on A equal to the magnitude of the force that the string exerts on B in some or all of the cases?
b. If both blocks are moving upwards with the same constant velocity, how do the magnitudes of the two forces compare in each case?
c. If block A is pulled upwards so that it is accelerating upwards, how do the magnitudes of the two forces compare in each case?
d. If the string passes over a pulley, what other factors may need to be considered? How would your answers to **a**, **b** and **c** change (for case I only)?