# PHYSICS ON ICE FOR 4U! /44 NAME: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**PARTNER: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Activities and Questions: Learning Your Principles (physics that is!)**

Please answer using complete sentences and use concepts of physics in your answer.

**Before** we begin….

(3) Define Inertia

Define Force

Differentiate between motion and force

1. **(3) Frames of reference**

a) Two people skate side by side at a constant velocity. Are they in motion relative to each other? \_\_\_\_\_\_\_\_\_\_\_\_ With respect to the earth? \_\_\_\_\_\_\_\_\_\_\_\_\_

b) Person A accelerates past Person B who is moving at a constant velocity. Which person can act as an inertial frame of reference? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **Newton’s first law: Inertia**

a) (2) Is a puck sliding across the ice a true example of inertia? Explain why or why not.

b) (2) Draw a diagram of the **forces** **only** on the puck (free-body diagram) shown below while it is in contact with the stick and after it has left the stick.

In Contact After Contact (no stick)

1. **Static and Kinetic Friction**

(2) Using the equipment (ice, people, pucks etc**), create and describe an example** that shows that static friction is greater than kinetic friction and describe it to me here. Don’t just give me definitions! Think that you are trying to teach this concept to a grade eleven student (yourself last year!).

1. **Newton’s Second Law: Force and motion**
2. (3) As above, **create and describe an example** that illustrates the relationship between acceleration and force and describe it here. Also sketch a graph of ‘F vs a’.

F

a

1. (3) Do the same for the relationship between acceleration and mass.

a

m

1. **Newton’s Third Law: Action - Reaction**

(3) Again, **create and describe a situation** that illustrates Newton's Third Law and describe it here. Remember you must include two objects and describe the forces on each object and motions of each object. You may use a diagram or fbd to illustrate.

1. **Conservation of Momentum (mass times velocity)**
2. Have two pucks (or people on skates of same mass). Hit one puck (A) straight at the second (B) or have the first person skates slowly into the second.
3. (1) Draw arrows above each box to show which way they are moving after the collision. Use relative size of arrows to show relative magnitude of velocities!

BEFORE AFTER COLLISION

A A

B B

1. (1) Sketch a v-t graph of the motion of both objects on the same graph. Note the line for puck B won’t start until a little later.

v

+

0 t

-

1. (2) Explain why you think the collision happens this way.
2. Repeat (a) with two people/objects of different mass.
3. (1) Let A (more massive) slide into B (less massive). Again draw arrows to show relative velocities after the collision.

BEFORE AFTER COLLISION

A A

B B

1. (1) Sketch a v-t graph put both A and B on the line. Again one person starts before the other.

v

+

0 t

3) (1) Let B (smaller) slide into A (bigger). Draw arrows to show relative motion after collision.

BEFORE AFTER COLLISION

A A

B B

1. (2) Explain what you think makes the results different for all three collisions?
2. (2) Find someone who can spin in circles on skates. If they start spinning with their arms out and then pull them in. Do they spin faster or slower when they pull their arms in? \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Explain why. Note, it has nothing to do with air resistance.

**7. A Final experiment:** When an astronaut and their ship are in orbit, they are in free fall so there is no normal or support force. This makes certain actions very difficult. Like turning a wrench. You push on the wrench, which is attached to your arm which is attached to your body which is attached to your legs and so to your feet which are pressed against the ground because of the force gravity. Since you are on a surface the support force provides friction between the surfaces of your feet and the ground so that you are, in essence, behaving like you are attached to the earth.

1. (2) Go to the penalty box or any door that opens onto the ice. Stand in front of the open door with skates blades parallel. Pull the door closed, towards you. Describe what happens to you and the door.

door

skate blades

1. (2) Why do you and the door move this way? Use physics concepts to explain.
2. (2) Create examples of what you could do to solve this problem on the ice **and** in space.

**8. Obstacle course.**

After observing the medicine ball race it is obvious that skates allow one to glide easier and to turn easier than shoes on ice. Clearly explain the reason for each.

(2) Skates glide easier than shoes on ice because

(2) Skates make it easier to turn on ice than shoes because

(2) Describe another way than the one we used to modify your shoes to help gain traction and explain it here and how it works. Don't carry out this method unless you've checked with the instructor first!