# PHYSICS ON ICE FOR 4C /46 + Quiz NAME: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

**Recapping what you have learned….and a bit more!**

Participation marks will be given for active involvement in the activities and investigations required for this assignment. Please answer using complete sentences where space is provided. Use physics concepts (Newton’s Laws, friction, etc) in your answers.

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

Please answer clearly. Use concepts of physics (Newton's Laws, friction etc) in your answer.

**1. Newton’s first law: Inertia**

a) (2) Push off on skates, or hit a hockey puck with a stick. Does the velocity remain constant or does it change after you stop pushing? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Explain why using Newton’s First Law.

b) (1) Which one of the following v-t graphs shows the motion of the skater or puck **AFTER** it is hit? \_\_\_\_\_ Your answer should reflect your answer in (a).

**A B C D**

v

t

1. t
2. (2) The following is a list of forces that may or may NOT be acting on the puck:

Fstick, , Fgravity, Ffriction, Fsurface

On the drawing of the puck below, draw arrows on the puck to indicate which forces are acting on it when it is (A) in contact with the stick and (B) after it has left the stick. Just use arrows to show the force directions **and label them** (eg. Fstick).

**Coordinate system A - In Contact B - After Contact (no stick)**

UP

RIGHT

DOWN

**2. Static and Kinetic Friction**

a) (2) Choose two people of similar mass, one in skates (A) and one in shoes (B). Both of these individuals should be initially at rest. Let a third person push on person A and then do the same to person B. Which person is easier to move?\_\_\_\_\_\_\_\_\_

Why? (Talk about the forces.)

1. (1) Once the person is already in motion, keep pushing them. Is the force required to keep them moving greater or smaller than that to get them moving? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3. Newton’s Second Law: Force and motion**

a) (2) With the **SAME** force, push on two separate people (or carts with bricks on them) of different mass, both with skates on. Which one is easier to get moving? Smaller (A) or bigger (B) one? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Why?

b) (1) If you push constantly with the **same** force on each one, which one has the greatest velocity **just** as you stop pushing? Smaller (A) or bigger (B) one?\_\_\_\_\_\_\_\_\_\_\_\_\_

1. (2) Sketch a v-t graph of the motion of each person **while** they are being pushed. Put both lines on the same graph. Line A – less mass, Line B – greater mass.

v

t

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

a) i) (2) Two people (about the same mass and both wearing skates) are facing each other. Person A pushes on person B. AFTER the push, Person A moves \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (faster, slower, at about the same speed as ) Person B. They both move in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (same/opposite) direction.

ii) (2) Draw the forces (use arrows) on each individual. Again label your forces.

Just use these: Fperson A , FPerson B (there are others but this will suffice for now)

**Person A Person B**

UP

RIGHT

DOWN

1. (2) Repeat (a). This time let person A have a smaller mass than person B. Which person is going faster when you stop pushing?\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Why are the results different than before?

c) (2) Have 2 people on the ice, on skates with blades parallel, facing each other. Let person (A) holding a medicine ball toss the ball horizontally to their partner (B). Fill in the blanks to understand why both people move backwards (away from each other). Remember which law you are investigating!

**Looking at Person A:**

The action force is : Person A pushes forward on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_

The reaction force: The ball pushes back on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Looking at the Ball:**

The action force: The ball pushes on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The reaction force: Person B pushes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

d) (2) Considering Newton’s Third Law, when you shoot a puck at the boards, why does the puck bounce back but the wall does not move?

**5. Studying Momentum (mass times velocity) and Energy Transfer and Conservation**

a) 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.

1. (1) Draw arrows above each box to show which way they are moving **after** the collision. Use relative size of arrows to show relative sizes of velocities!

BEFORE AFTER COLLISION

A A

B B

1. (1) In an ideal situation, if the masses are equal, A comes to a stop and B moves off with the same velocity as A had. Explain this idea using Newton’s Third Law.

b) Repeat (a) with two people/objects of different mass.

1. (1) Let A (more massive) slide into B (less massive). Again draw arrows of appropriate size to show relative velocities after the collision.

BEFORE AFTER COLLISION

A A

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

BEFORE AFTER COLLISION

A A

B B

3) (1) Explain what you think is the biggest factor that makes the results different for all three collisions?

c) (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 is NOT because of air resistance!

6. **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.

a) (1) Go to the penalty box or any door that opens onto the ice. Stand in front of the open door with skates blades parallel to each other but perpendicular to the door (see sketch). Pull the door towards you. As the door moves towards you, what happens to you?

door

skate blades

b) (1) Use Newton’s Third Law to explain why you and the door move this way.

c) (1) What could you do to stop you from moving towards the door?

d) (1) If you were the astronaut mentioned above, with no support force, how could you solve the problem of trying to turn the wrench?

**7. Obstacle course. Friction? No Friction?**

a) (1) Person A has runners on. Person B has runners with sandpaper attached to them. Person C has skates on. Which one finishes the course first? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Explain why!

b) (1) Why do skates make it easier to **glide** on the ice than shoes?

(1) Why do skates make it easier to **turn** on the ice than with shoes?

c) (1) Why does sandpaper win over shoes?

1. (6) Other investigations. Come up with at least two other activities that you can try out. Clearly describe the “test” and the results and give an explanation for what happened in each case using physics principles.

ACTIVITY ONE:

* what we did
* what happened
* why it happened that way (physics explanation)

ACTIVITY TWO:

* what we did
* what happened
* why it happened that way (physics explanation)