Rotational Dynamics Concepts Name _____

Guidelines:
Please answer all questions on a separate sheet of paper.
With all calculations, please write out the formulas and specific numbers used.
Written questions should be at least two sentences long.
In written problems, points are awarded primarily of using correct science vocabulary and referring correctly to principles and formulas in explaining phenomena.

Part A: Inertia

Inertia

Resistance to change in motion

- Any object that is not moving will resist beginning to move.
- Any object that is moving will resist any change in velocity. [an increase in magnitude, a decrease in magnitude, or a change in direction]

Inertial Mass

In any typical linear motion, the quantity of inertia is simply equal to an object's mass.

If mass is used in the context of inertia, it is called *inertial mass*.
(When mass is used in the contexts of weight and gravity, it is called *gravitational mass.*)

Newton's Second Law

$$\vec{F} = m\vec{a}$$

F represents a force, an attempt to change the motion of the object.
m represents the inertial mass of an object, its ability to resist any changes in motion.
$\vec{a}$ represents the change in acceleration of an object, its change in velocity (which can indicate any change in direction or magnitude of velocity)

Acceleration and inertial mass are inversely proportional!

This indicates that a higher inertial mass will mean less change in velocity, in accordance with the definition of inertial mass.

True or false:

A.1 Acceleration and inertial mass are directly proportional.

A.2 Acceleration and inertial mass are inversely proportional.

A.3 Objects resist any change in motion.

A.4 Turning is a change in the velocity of an object

Gravitational vs. inertial mass:
For each statement, select if it refers to gravitational or inertial mass:

A.5 All masses resist any change in motion.

A.6 All masses are attracted to all other masses.

A.7 The earth orbits the sun because of its attraction to the sun.

A.8 Any moving object will resist a chance to make it turn into a new direction.

A.9 On earth, some objects are very heavy (have a high weight)

A.10 An object that is not moving will resist any attempt to make it move.

A.11 All objects on earth are pulled towards the center of the earth.

A.12 It is difficult to pick up a car.

A.13 It is difficult to push a car forward (though not quite as difficult as it is to pick up the car).

A.14 Mass is inversely proportional to acceleration.

Written Problem 1: Crates on Wheels
In your travels, you come across two crates, each with wheels.
One of the crates is full of bricks and the other is full of pillows, but you can't see inside, and you are *not allowed* to life the crates (the lawyers said no).
How can you tell which crate is full of bricks and which is full of pillows?

Written Problem 2: The anvil and a stuffed bear in space
You are in space. You come across an anvil and a stuffed bear.
You need to push both of these objects into the trunk of your space ship.
How can you get this done? Which is going to be more difficult?

Written Question 3: A big jar of liquid nitrogen
An actual true story.
In 2016, Mr. Kuncik brought liquid nitrogen to class. In order to do this, he needed to drive a giant tank (it probably held 20 gallons of liquid) from Fall River 40 minutes to Freetown. He held the tank in the passenger seat (his trunk is too small). When he was on the way there, and the tank was empty, it was very dangerous situation….the tank kept falling over and falling backwards. Then, Mr. Kuncik got the entire tank filled with liquid nitrogen.
It was not extremely heavy and had frost all over it from extremely low temperature.
However, the tank *no longer* was falling over all the time. It largely stayed in place and never did anything bad all the way back to Fall River.

What's going on? It's very counterintuitive that a tank full of cryogenic fluid is easier and safer to drive with than an empty tank!

Answers:

Written Problem 1 Answers:
3 points
1 point for indicating you need to push the crates in order to tell what is inside
1 point for indicating the crate that is harder to push is the one with the bricks
1 point for correctly using the term *inertia* or (even better) *inertial mass*
You get a zero if you used the word *heavy*….because this term refers only to *weight* and *gravitational mass*.

Written Problem 2 Answers:
2 points:
1 point for mentioning that you can push any object in space in the absence of friction
1 point for mentioning the anvil is harder to push because it has more *inertia* or *inertial mass* (you need to use the term correctly for full credit)
You get a zero if you used the word *heavy*, nothing has weight in space so nothing is heavy!

Bonus if you mentioned that because of Newton's Third and First laws, if you push anything in space you are liable to fly backwards in the other direction for all eternity. Hopefully you brought a tether or a jet pack.