

Exam 1A

Physics 100, Spring 2007

Wednesday, February 14, 2007

Happy Valentines Day!

Useful Equations and Numbers

Acceleration due to gravity...

on Earth = 10 m/s^2 on Mars = 3.7 m/s^2 on the Moon = 1.6 m/s^2

$$(\text{change in position}) = \frac{1}{2} \times (\text{acceleration}) \times (\text{time})^2$$

$$(\text{change in speed}) = (\text{acceleration}) \times (\text{time})$$

$$(\text{speed}) = \frac{(\text{distance traveled})}{(\text{time})}$$

$$(\text{acceleration}) = \frac{(\text{change in velocity})}{(\text{time})}$$

$$(\text{force of gravity}) = (\text{mass}) \times (\text{acceleration due to gravity})$$

$$\text{speed of light} = 299,790,000 \text{ m/s}$$

$$20 \text{ m/s} = 45 \text{ mph}$$

$$1 \text{ mile/minute} = 60 \text{ mph}$$

$$1 \text{ pound of force} = 1 \text{ Newton}$$

$$1 \text{ km} = 0.6 \text{ miles}$$

$$1 \text{ furlong} = 201 \text{ meters}$$

$$1 \text{ hour} = 3,600 \text{ seconds}$$

$$1 \text{ minute} = 60 \text{ seconds}$$

$$1 \text{ g} = 10 \text{ m/s}^2$$

$$1 \text{ m/s} = 3.6 \text{ km/hour}$$

$$1 \text{ Newton} = 1 \frac{\text{kg m}}{\text{s}^2}$$

$$1 \text{ m} = 3.2 \text{ feet}$$

$$1 \text{ Joule} = 10,000,000 \text{ ergs}$$

$$\sqrt{200} = 14.14$$

$$\frac{5}{3} = 1.667$$

$$\frac{4}{5} = 0.800$$

$$\frac{1}{6} = 0.167$$

**DO NOT OPEN EXAM UNTIL INSTRUCTED TO DO SO!
TURN OFF YOUR CELL PHONE!**

Answer Key for Exam A

Section 1. True/False (2 pts. each)

Warm up!

- False Copernicus believed the Earth rotated around the Sun because the concept of inertia says that things will continue to move in a straight line at the same speed unless acted on by an outside force
- True Inertia is the property of things to resist changes in motion.
- False An object cannot be in equilibrium if it is moving.
- False An object can never have a speed of zero and be accelerating.
- True A car filled with passengers accelerates slower than a car without any passengers because it has a higher inertia.
- True Aristotle thought that 'violent motion' resulted from pushing or pulling forces acting on an object, which would otherwise tend to rise or fall through 'natural motion.'
- False The net force acting on an object points in the opposite direction of its acceleration.

Section 2. Fill-in-the-Blanks (3 pts. each)

Note: The size of the blank does not vary with the length of the answer.

1. When the acceleration and velocity vectors point in the same direction, the speed increases.
2. The velocity of an object is given if you know both its speed and direction.
3. Consider a pair of forces, one having a magnitude of 50 N and the other a magnitude of 20 N. The maximum net force possible for these two forces is 70 N and the minimum is 30 N.
4. When the acceleration and velocity vectors point in opposite directions, the speed decreases.
5. Shake something to and fro and you're measuring its inertia/mass. Lift it against gravity and you're measuring its weight.
6. The horizontal force that must be applied to produce an acceleration of 2.0 g's (20 m/s^2) for a 3.0 kg puck on a frictionless air table is equal to 60 N.

Section 3. Multiple Choice (2 pts. each)

Choose the single best answer unless instructed to do otherwise.

Hint: they're not all (C)!

7. A ball rolled across a floor doesn't continue rolling indefinitely because...
- (a) ... its inertia prevents it from moving forever.
 - (b) ... friction, air resistance, and other forces slow it down to a stop.
 - (c) ... the ball is composed mainly from the element *earth* and naturally comes to rest on the ground.
 - (d) ... gravity pushes it away.
8. Consider a ball at rest in the middle of a toy wagon. When the wagon is pulled forward, the ball rolls against the back of the wagon. This is an example of which of the following:
- (a) Gravity
 - (b) Acceleration
 - (c) Inertia
 - (d) Velocity
9. Which of the following are cases where an object is moving at constant velocity (circle all that apply):
- (a) A car driving in a circle at constant speed
 - (b) A book sitting at rest on a table
 - (c) A can of paint falling from a two story building
 - (d) A jet airplane flying in a straight line at constant speed
10. If you throw a ball straight up into the air, it will start with an initial speed, v_i , it will rise up to some maximum height and fall back into your hand. At the moment it falls back into your hand (i.e. the same height at which it was released into the air), how will it's final speed, v_f , compare to it's initial speed v_i , if we assume there is no air resistance?
- (a) v_f will be equal to v_i because the amount gravity accelerated it downward is the same going up and down
 - (b) v_f will be less than v_i because there was no extra push force
 - (c) v_f will be greater than v_i because gravity was accelerating it downward the entire time
 - (d) v_f 's relationship to v_i cannot be determined unless the *force* of gravity is specified
11. If a Space Cat has a mass of 5 kg on Earth, on Planet Mouseatron, where the acceleration due to gravity is 4 m/s^2 , the Space Cat will have a mass of...
- (a) 5 kg
 - (b) 50 N
 - (c) 20 N
 - (d) None of the above

Section 4. **Short Answer Questions (5 pts. each)**

Show your work for all calculations. Partial credit is a good thing!

12. Shown in Figure 1 are two painters, Burl and Vern. One of them weighs 700 N and the other weighs 800 N. The scaffolding they're on weighs 500 N. The tension in the left rope is 950 N. What is the (A) weight of Burl, (B) the weight of Vern, and (C) the tension in the right cable (T_R)?

Answer: The upward forces must cancel the downward forces. The downward forces sum:

$$F_{down} = 500\text{ N} + 700\text{ N} + 800\text{ N} = 2,000\text{ N}$$

The upward forces sum

$$F_{up} = 950\text{ N} + T_R$$

Equating $F_{up} = F_{down}$:

$$950\text{ N} + T_R = 2,000\text{ N}$$

From this we find that $T_R = 1050\text{ N}$. Because the tension in the right cable is higher than the tension in the left cable, Vern must be the heavier of the two. Therefore the answers are (A) Burl weighs 700 N, (B) Vern weighs 800 N, and (C) $T_R = 1050\text{ N}$.

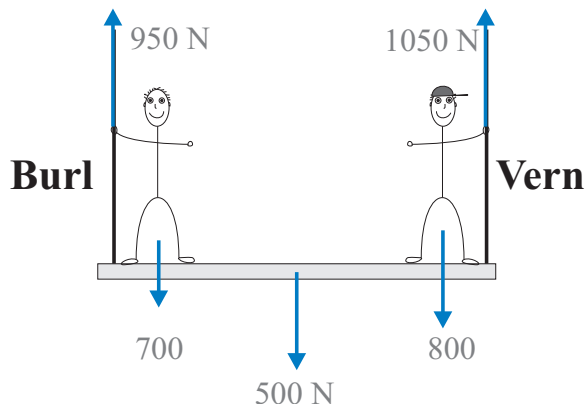


Figure 1: Solution to Problem 12

13. Two forces act on a parachutist falling straight down in the air: weight (gravity) and air drag. If the fall is steady, with no gain or loss of speed, (A) is the parachutist in dynamic equilibrium? (B) How do the magnitudes of weight and air drag compare? (C) How do their directions compare?

Answer: (A) The parachutist is in dynamic equilibrium because her speed and direction of motion are constant (falling straight down; no gain or loss of speed). (B) Since she is in dynamic equilibrium, the net force acting on the parachutist must be zero. This can only happen in the case of two forces if they have equal magnitudes and (C) are directed in opposite directions (gravity down; air drag up).

14. A particular car can go from rest to 90 km/h in 9 seconds on a straight track. (A) What is its (average) acceleration during this time? (B) If the car has a mass of 1,000 kg, what is the magnitude of the force accelerating it?

Answer: (A) For linear motion, we can write

$$acceleration = \frac{\text{change in speed}}{\text{time interval}} = \frac{90 \text{ km/hr}}{9 \text{ s}}$$

Solving, we find the acceleration is equal to $10 \text{ km}/(\text{hr s})$. Equivalent answers are $25/9 \text{ m/s}^2$, or 2.8 m/s^2 . (B) Newton's Second Law tells us that $Force = mass \times acceleration$. Using $1,000 \text{ kg}$ for the mass, and 2.8 m/s^2 for the acceleration, we find the force:

$$force = (1,000 \text{ kg}) \times (2.8 \text{ m/s}^2) = 2,800 \text{ N}$$

Equivalently, $force = 10,000 \text{ (kg km)}/(\text{hrs})$.

15. Is it possible to move on a curved path in the absence of a force? Defend your answer (a 'yes' or 'no' is not sufficient, you must also explain why).

Answer: No! If something is moving along a curved path, it is changing its velocity because velocity is defined as speed *and* direction. If something changes its velocity, then by definition, it is accelerating. Newton's Second Law tells us that if something is accelerating, then a non-zero net force is acting on it. Therefore, if something is moving along a curved path, it must have a force acting on it.

16. As you drive along the highway at constant velocity, the net force on the car is zero. Why, then, do you have to keep running your engine and burning all that precious gas?

Answer: That is because there are forces of friction and air drag that are trying to slow the car down. If you turned off the engine, the net force would no longer be zero, but would be equal to the sum of the frictional and air drag forces which would point in the opposite direction as the car's velocity and slow it down, in accordance with Newton's Second Law. You have to keep the engine running and burn all that gas to provide a force to cancel out friction and air drag.

Exam 1B

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Answer Key for Exam **B**

Section 1. True/False (2 pts. each)

Warm up!

False Copernicus believed the Earth rotated around the Sun because the concept of inertia says that things will continue to move in a straight line at the same speed unless acted on by an outside force

True Aristotle thought that 'violent motion' resulted from pushing or pulling forces acting on an object, which would otherwise tend to rise or fall through 'natural motion.'

True A car filled with passengers accelerates slower than a car without any passengers because it has a higher inertia.

False An object can never have a speed of zero and be accelerating.

False An object cannot be in equilibrium if it is moving.

True Inertia is the property of things to resist changes in motion.

False The net force acting on an object points in the opposite direction of its acceleration.

Section 2. Fill-in-the-Blanks (3 pts. each)

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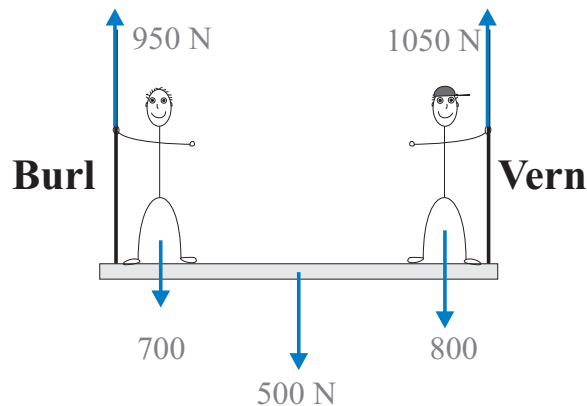


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Exam #1 Histogram

