Name: _____ Student I.D.: _____

# Exam 2A

Physics 100, Spring 2007

Wednesday, March 16, 2007

## 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 $m/s^2$

$$Impulse = Force \times Time$$

$$Work = Force \times Distance$$

$$Gravitational\ Potential\ Energy = mass \times (Acceleration\ of\ Gravity) \times Height$$

$$Kinetic\ Energy = \frac{1}{2}\ mass \times (speed)^2$$

$$Momentum = mass \times Velocity$$

$$Force = mass \times Acceleration$$

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

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

| | |
|---|---|
| $20\ m/s = 45\ mph$ | $1\ mile/minute = 60\ mph$ |
| $1\ pound\ of\ force = 4.5\ Newton$ | $1\ km = 0.6\ miles$ |
| $\sqrt{3^2+4^2} = 5$ | $1\ hour = 3,600\ seconds$ |
| $1\ minute = 60\ seconds$ | $1\ g = 10\ m/s^2$ |
| $1\ m/s = 3.6\ km/hour$ | $1\ Newton = 1\ \frac{kg\ m}{s^2}$ |
| $1\ m = 3.2\ feet$ | $1\ Joule = kg\ m^2/s^2$ |
| $\sqrt{200} = 14.14$ | $1\ Calorie = 1,000\ calories$ |
| $1\ Calorie = 4,200\ J$ | $\frac{1}{6} = 0.167$ |

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

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*Relax! Be sure to write you name and SID on all of the pages. Show your work on all short answer questions! Look on page 1 for a list of handy equations and relations! Keep in mind that this is a long test, so if you're stuck on a problem, move on to the next one!*

*IF YOU HAVE QUESTIONS ON ANYTHING,*
*RAISE YOUR HAND AND I WILL COME TO YOU!*

***Good luck!***

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

_____ To throw a ball, you do not need to exert any impulse on it.

_____ Kinetic Energy, just like momentum, is a vector quantity and special care must be taken when adding kinetic energies together.

_____ It is possible for you to produce a net impulse on an automobile by sitting inside and pushing on the dashboard.

_____ Lifting a 50 kg sack a vertical distance of 2 m requires more work than lifting a 25 kg sack a vertical distance of 4 m.

_____ If something doubles its speed, both its momentum and kinetic energy double.

_____ The source of energy that we get when we eat food ultimately came from nuclear fusion occurring in the sun.

_____ Hydrogen promises to transfer energy in a clean-burning way, possibly eliminating smog and pollution generated by cars.

_____ Long-range cannons have long barrels because the force of the expanding gasses exerted on the shell (the ballistic) acts over a longer distance, increasing the amount of work done on the shell and thereby giving it more kinetic energy.

_____ The kinetic energy of a pendulum is at its maximum when it is at the lowest point of its swing.

_____ The gravitational potential energy of a pendulum is at its maximum when it is at the lowest point of its swing.

_____ An adult 5,000 kg elephant moving at 2 m/s has more kinetic energy than a younger 2,500 kg elephant moving at 5 m/s.

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Section 2. **Multiple Choice (2 pts. each)**
*Choose the single best answer unless instructed to do otherwise.*

1. Which of the following are *vector* quantities? (Circle all that apply)
   (a) Energy
   (b) Momentum
   (c) Speed
   (d) Velocity
   (e) Force
2. As you take this exam, you are sitting in a chair. What is the reaction to the force the chair is exerting on you?
   (a) The force of gravity acting on you caused by the Earth
   (b) The force of gravity acting on the Earth caused by you
   (c) There is no reaction force in this case because you are not accelerating
   (d) The force you are exerting on the chair
3. Why do padded dashboards make automobiles safer in collisions?
   (a) Because they reduce the amount of impulse that is imparted on the passengers when they hit them
   (b) Because they reduce the amount by which the passengers' momentum change
   (c) Because they increase the stopping force
   (d) None of the above
4. A punch with a bare fist is more powerful than with a boxing glove because:
   (a) A bare fist can impart more impulse
   (b) The glove and fist can impart the same impulse, but the glove will do so with a lower force for a longer time
   (c) The punch with a glove is more powerful because it is larger and can provide more force than the fist
   (d) None of the above are true
5. The potential energy of a skydiver falling at a *constant* velocity (i.e. her *terminal velocity*) is transformed into which of the following (circle all that apply):
   (a) Kinetic Energy
   (b) Thermal Energy (Heat)
   (c) Noise
   (d) Momentum
   (e) This is a trick question: a skydiver falling with a *constant velocity* does not change potential energy

6. A chocolate glazed cake donut from Dunkin Donuts has nearly 300 Calories in it. This is the same amount of energy required to accelerate a $1,000\ kg$ car up to a speed of _____? ( *Hints: (1) Ignore air resistance. (2)The conversions between different units are all correct.*)
   (a) $\sqrt{2 \times 0.3}\ m/s$, which is roughly 0.77 m/s or 1.7 mph
   (b) $\sqrt{2 \times 1,260,000}\ m/s$, which is roughly 1587 m/s, or 3,550 mph
   (c) $\sqrt{2 \times 1,260}\ m/s$ which is roughly 50 m/s or 112 mph
   (d) None of the above
7. If gasoline has 42,000 J per gram, then a 2,000 Calorie per day diet is equivalent, in energy, how many grams of gasoline per day?
   (a) 21 grams of gasoline per day
   (b) 200 kg of gasoline per day
   (c) 20 grams of gasoline per day
   (d) 200 grams of gasoline per day

**Continue on to the next page...**

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Section 3. **Short Answer Questions (5 pts. each)**

8. A skydiver that weighs 600 N jumps out of an airplane. Just after opening her parachute, she experiences an upward resistive force of 2,000 N. **(A)** What is this upward resistive force called? **(B)** What is the magnitude and direction of her acceleration? **(C)** Is her speed increasing or decreasing?

9. The ThrustSSC is a (near) supersonic car, which uses two jet engines. It has a mass of roughtly 10,000 kg, and the two engines combined provide a thrust force of almost 100,000 N. How fast would the ThrustSCC be moving after traveling 5 m, if it started rest?

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10. Figure 1 depicts a roller coaster. Ignoring friction and air resistance, **(A)** at which point is the roller coaster moving the fastest? **(B)** The slowest? **(C)** Which point does it have the maximum gravitational potential energy? **(D)** If the roller coaster weighs 2,000 N and has a speed of zero at Point A, how fast is it moving at Point E?

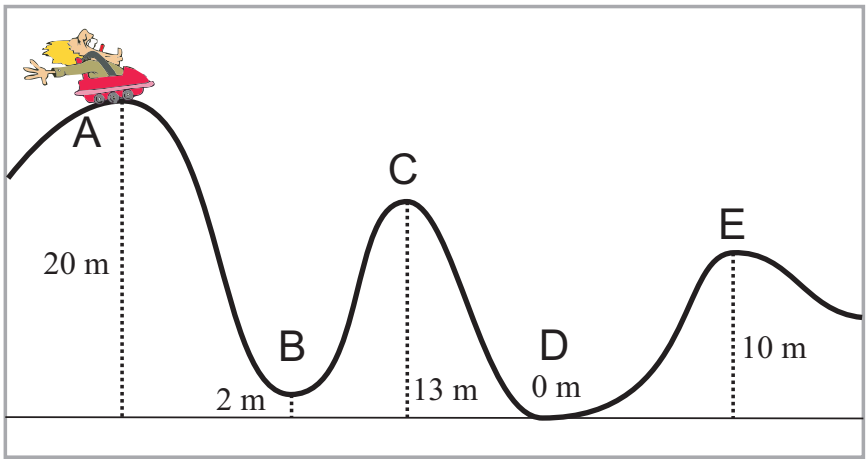


**Figure 1:** The depiction of the roller coaster in Problem 10

11. Consider a sled with a cannon mounted on it sitting at rest on a sheet of ice, as shown in Figure 2. If the cannon fires snowballs with a mass of 1 kg each at a speed of 500 m/s, and the sled and cannon have a combined mass of 500 kg, about how many snowballs must the cannon fire for the sled to be moving at a speed of 10 m/s. *Hint: ignore friction, air resistance, and the change in mass of the cannon and sled due to the firing of the snowballs.*

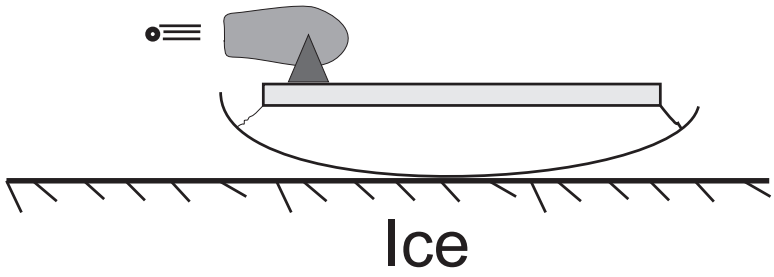


**Figure 2:** Problem 11: A snowball cannon mounted on a sled which is on a sheet of ice.

12. Shown in Figure 3 is the collision between two cars. Just before the collision, one car, with a mass of $m$ was headed North with a speed of $2v$. The other car, with a mass of $2m$, was headed East with a speed of $v$. When they collide, the two cars stick together. On the right-hand side of Figure 3, draw the resulting velocity vector that the two cars (stuck together) have after the collision.

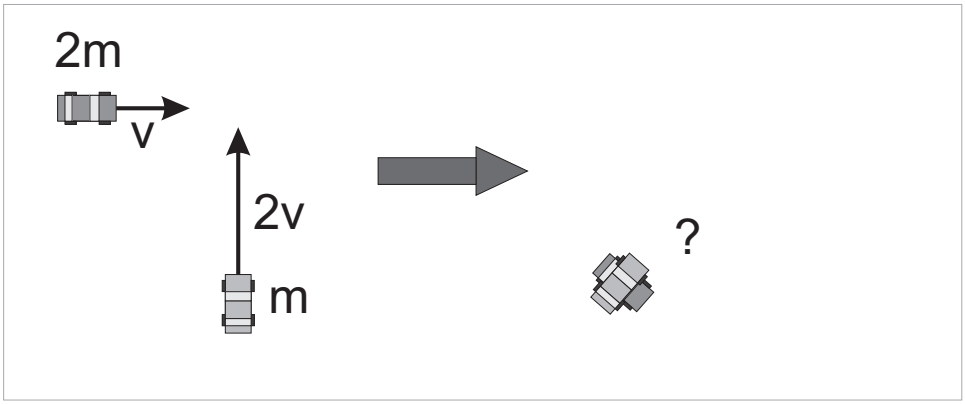


**Figure 3:** Problem 12: Two cars crash together.

THIS IS THE LAST PAGE OF EXAM 2A. CONGRATULATIONS!