

Name \_\_\_\_\_

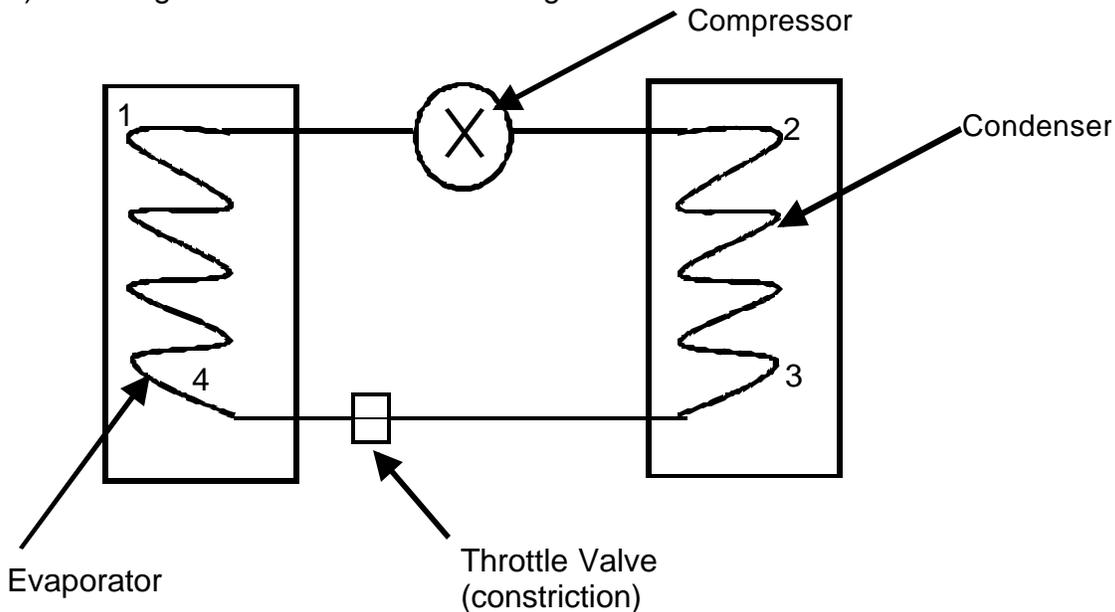
## Physics 104 - Exam 2

November 9, 1999

### Instructions

- ❑ Put your name on every page first! (5 points will be deducted if your name is not on every page).
- ❑ Please answer all questions in the space provided on these pages. (If you need more room use the back of the page and say (OVER)).
- ❑ Read all the questions first. Then start on the ones you find easiest..
- ❑ If you don't understand what a question is asking raise your hand and ask.
- ❑ Write clearly and make drawings whenever it will help explain what you mean. Partial credit will be given only if we can figure out what you are trying to do or say.

1) In the figure below an air conditioning unit is shown:



For each of the four marked locations (1-4) answer in the chart below whether: the fluid is a liquid or gas; the fluid is hot, warm, cool or cold; heat is flowing into or out of the fluid; the fluid is at high or low pressure and finally is the location inside or outside the house. (Each answer is worth 1 point).

Location	State: Liquid or Gas	Temperature: Hot, Warm, Cool or Cold	Heat Flow: In, Out, None	Pressure: High or Low	Inside the house or Outside
1	Gas	Cool	In (or None)	Low	Inside
2	Gas	Hot	Out	High	Outside
3	Liquid	Warm	Out (or None)	High	Outside
4	Liquid(or gas)	Cold	In	Low	Inside

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2) The air has suddenly become very cold and cools down a pond:

a) (2 points) As the pond water cools and eventually freezes how does its entropy change?

It decreases.

b) (2 points) How does the entropy of the cold air change as it gains heat from the warmer pond water?

It Increases.

c) (2 points) How does the entropy of the entire system change?

It Increases.

d) (4 points) Does the **first** law of thermodynamics prohibit the water from getting warmer by spontaneously drawing heat from the colder air? Explain.

The first law says that energy is conserved. It doesn't say anything about which direction heat will flow. So, it is OK with the first law.

e) (5 points) Explain why the situation described in part d) (above) doesn't happen.

The 2<sup>nd</sup> law tells us that the entropy of an isolated system always increases. In this case the entropy of the warm water would increase less than the cool air would decrease. Thus the 2<sup>nd</sup> law says it can't happen!

3) Explain what happens during each of the four strokes of the internal combustion engine. Make sure to mention whether the piston is moving down or up during each stroke. (5 points each)

a) Induction (Intake):

The piston moves down creating a vacuum that sucks air and fuel into the cylinder. The intake valve is open.

b) Compression:

The piston moves up compressing the fuel air mixture. (Valves are closed).

c) Power:

The piston moves down as the spark plug ignites the mixture and it explodes. This creates very high pressure and pushes the piston down very hard. (Valves are closed).

d) Exhaust:

The piston pushes the burnt fuel out the exhaust. (The exhaust valve is open).

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4) Use words and equations to explain what Coulomb's Law is and how it is used. (10 points)

Coulomb's Law gives the force between two charges.

$$F = K q_1 q_2 / r^2$$

Force is proportional to the product of the charges and the force decreases with the square of the distance between them.

5) (5 points) The force between two charges separated by 1m is 10N. If one of the charges is quadrupled what is the separation that gives the same 10N force?

Separation is 2m.

Since the product of the charges is 4 times as great you need distance squared to be 4 times as great or the distance to be twice as large.

6) In a photocopier a photoconductor is initially negatively charged by a corona wire.

a) (5 points) What happens to the charge on the area of the photoconductor which is hit by light?

The photoconductor starts to conduct so that the negative charges are free to move to the positive charges on the opposite side of the belt and cancel each other out. So the area hit by the light is neutralized.

b) (5 points) What charge must be applied to the toner so that it is picked up by the photoconductor? Explain.

The photoconductor starts out negative so the areas we want to pick up toner are negative (i.e. those areas not hit by light). So we charge the toner positive to be attracted to the belt.

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7) Answer only **four out of** the following **six** questions (5 points each):

a) What is the difference between Direct Current and Alternating Current?

With direct current the current is always flowing in the same direction through a circuit. In alternating current the direction of current flow alternates periodically.

b) What will happen if you bring a magnet toward a loop of wire.

Because of Lenz's law the conductor develops a current in a direction to oppose the change in magnetic flux. So in this case the induced current produces a magnetic field opposite to the magnet. This causes the loop to be repelled by the magnet.

c) Why can alternating current be used in a transformer and not direct current?

Because the direction and size of the current is continually changing it can be used to generate changing magnetic fields in the primary coil. This changing magnetic field can then be used to induce a current in the secondary coil.

d) If you open a refrigerator door will the room get warmer, cooler or stay the same? Explain why.

The room will get warmer. The heat removed by the refrigerator is less than the heat put out. This is from the additional work needed to make the refrigeration cycle work. This is due to the 2<sup>nd</sup> Law.

e) What is an electromagnet?

A magnet produced by the movement of charge, or current.

f) What causes knocking in a car engine and how can it be avoided?

During the compression stroke in an engine the air-fuel mixture gets heated. If the temperature gets hot enough it will ignite the mixture prematurely which causes "knocking". This can be avoided by using high octane fuel which has a higher ignition temperature.