This test has 6 pages and 15 questions. The test should take no longer than 50 minutes. You may use a calculator and one 5"×3" index card with your own hand-written notes, if you wish. Assume that the acceleration due to gravity in all problems is $g = 10 \text{ m/s}^2$. Good luck!

Multiple Choice Part (1 point per question)
Please choose the best answer to each question, and fill in the appropriate bubble on the provided answer-sheet. Be sure to fill in the identifying information on the top of your answer sheet. You may use pen or pencil when filling in the circles. IMPORTANT: There are multiple versions of this test. On your bubble sheet, please fill in A for version.

1. If all of the light bulbs shown below are identical, which of the following statements is true?

![Circuits Diagram]

A. All circuits emit different amounts of light, and circuit 1 emits the most light.
B. All circuits emit different amounts of light, and circuit 2 emits the most light.
C. All circuits emit different amounts of light, and circuit 3 emits the most light.
D. Circuits 2 and 3 emit the same amount of light, which is more than that emitted by circuit 1.
E. Circuits 2 and 3 emit the same amount of light, which is less than that emitted by circuit 1.
2. My 10 year old daughter wants to have water in her tree house. She takes a hose and attaches it to outdoor faucet at the back of the house, which is about 1 metre off the ground. She runs the hose along the ground, up the tree, over a branch which is 3 metres up, and into the tree house which is a platform about 2 metres above the ground. At the end of the hose in the tree house there is a spray handle which holds the water in, unless she wants to spray her sister from above. In the evening, she leaves the hose where it is with the water-pressure on, forgetting to turn it off at the faucet. Some time during the night, the hose springs a leak and by the morning the backyard is flooded. The most likely spot for the leak is

A. on the way up the tree – the most vertical portion of the hose.
B. on the ground – the lowest point on the hose.
C. at the faucet – the first point on the hose.
D. at the spray handle – the last point on the hose.
E. at the point where the hose goes over the branch – the highest point on the hose.

3. A refrigerator is a type of heat pump that uses electric power to move heat against its natural direction of flow. In such a heat pump electrical power must be converted to thermal energy because

A. the entropy of the system must be conserved.
B. Newton’s laws of motion prevent heat from moving from a cool region to a warm region.
C. the flow of heat from a cool region to a warm region alone would decrease the entropy of the system.
D. the flow of heat from a cool region to a warm region alone would violate the conservation of energy.
E. it is needed to power the light bulb inside the refrigerator.

4. A sound wave travels through the air at 340 m/s, and has a frequency of 500 Hz. The period of this wave is

A. 0.68 seconds
B. 0.002 seconds
C. 170,000 seconds
D. 0.000006 seconds
E. 1.5 seconds

5. High voltage power lines are usually supported by glass insulators. An electric current cannot flow easily through a piece of glass because

A. glass contains only positively charged particles.
B. glass contains only negatively charged particles.
C. the electrons in the glass completely fill its valence levels and can’t shift from one level to another to transport charge through the glass.
D. glass does not contain any electrically charged particles.
E. glass is a solid; electric current can only flow easily through a liquid or gas.

6. If a compass is moved from the northern hemisphere to the southern hemisphere, its magnetic needle will change direction

A. by 180 degrees.
B. depending on where the measurement is taken.
C. by 90 degrees.
D. hardly at all.
E. by 270 degrees.
7. A wire is wrapped around a nail, as shown.

![Image of a wire wrapped around a nail]

Electric current travels from the +, up the wire around the nail many times, then down towards the -.

The nail
   A. will become magnetic, with N pointing to the right.
   B. will become magnetic, with N pointing to the left.
   C. will become electrically charged.
   D. will not be affected, as it is not in the circuit.
   E. will become gravitationally charged.

8. You are filling a large lightweight dry cleaning bag with helium. At first, the plastic bag does not float. But as you keep adding helium to the bag, it eventually begins floating because
   A. at the same pressure and temperature, the upward buoyant force on a helium-filled bag is larger than the buoyant force on an air-filled bag with the same volume.
   B. the average density of the helium-filled bag decreases even though the buoyant force on the bag remains constant as it fills.
   C. as the volume of displaced air increases, the buoyant force increases until it is larger than the weight of the helium-filled bag.
   D. the helium-filled bag's weight decreases as you put more lightweight helium particles inside it.
   E. none of these.

9. The brake system in most cars makes use of a hydraulic system. This system consists of a fluid filled tube connected at each end to a piston. Assume that the piston attached to the brake pedal has a cross sectional area of one half a square centimetre and the piston attached to the brake pad has a cross section area of two square centimetres. When you apply a force of 10 Newtons to the piston attached to the brake pedal, the force at the brake pad will be
   A. 5 Newtons.
   B. 10 Newtons.
   C. 20 Newtons.
   D. 40 Newtons.
   E. cannot be determined from the information given.

10. A Thermos bottle has double glass walls with silver coating on the glass surfaces that face one another. The silver coating reduces the energy that is transferred by
   A. conduction
   B. convection
   C. radiation
   D. friction
   E. none of these
Written Answer Part
Please answer the following questions. Show all your reasoning and work legibly in the blank space provided. Fill numerical answers with units in the boxes provided.

11. (2 points) Briefly describe the difference between AC and DC electricity.

12. (3 points) A series circuit is set up with a 30 Volt battery, a 20 Ohm resistor and a 10 Ohm resistor, as shown. Estimate the currents and voltages at points A, B and C.

Current through point A =
Current through point B =
Current through point C =

Voltage at point A =
Voltage at point B =
Voltage at point C =
13. **(3 points)** A large rock sits totally submerged in the water at bottom of the lake near the beach. In the outside air, this rock would weigh 50 Newtons. If you hold your breath and swim to the bottom, how much force will it take to lift the rock up when it is completely submerged in the water? Assume that the density of the rock is twice that of water.

14. **(2 points)** If you open the door of your refrigerator with the hope of cooling your room, you will find that the room’s temperature actually increases somewhat. Why doesn’t the refrigerator remove heat from the room?
15. **(3 points)** A positively charged glass rod is held near a neutral metal ball (zero net electric charge on the metal ball). Will the force between the glass rod and ball be attractive or repulsive? Describe how it is possible for a neutral object to have an electric force on it.