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Name: _____ Date: _____

Heat Transfer and Your Electric Bill

1 During summertime in most parts of Texas, temperatures outside can soar to over 100°F (38°C). After being outside in this weather, it can be a real relief to enter a cool, air-conditioned building. Sometimes, however, it might seem like the air conditioner is running non-stop. Since these machines run on electrical power, soaring summer temperatures can also bring soaring electric bills. Everywhere you turn, there are advertisements from home improvement companies. Many claim to be able to save you money on your cooling expenses. Let us take a look at the science behind keeping your home cool. Then we can better evaluate some of those products and services.

2 When we say that it is hot outside, we are talking about temperature. Temperature is a measure of the average kinetic energy of the atoms and molecules in a system. Temperature is one component of thermal energy, which is the total internal energy of a system. The other is heat. Heat is simply thermal energy in transit. When heat is transferred, thermal energy is exchanged from one physical system to another. As the heat enters the system, the kinetic energy and particle movement within the system increase. This increase in kinetic energy and particle speed will thereby increase the temperature of the system.

3 There are three processes involved in heat transfer: convection, conduction, and radiation. In all three cases, the kinetic energy of the particles of the substance will increase if the substance absorbs thermal energy. The kinetic energy of the particles will decrease if the substance releases thermal energy. Conduction is the transfer of thermal energy that occurs when two objects of different temperatures are in direct contact. Convection is the transfer of thermal energy that occurs in currents of gas or liquid when substances of different temperatures mix. Radiation is the transfer of thermal energy through empty space. Unless all objects are the same temperature, thermal energy will continue to move from one object to another. In order to keep a home cool and comfortable, methods must be employed to block the transfer of heat.

4 There are a lot of choices when it comes to making your home more energy efficient. Most are different ways to block heat transfer. Many companies offer services and products to help. A service is a task that a company performs for you. In contrast, a product is an actual item that you will purchase and keep. Different products are designed to stop different heat transfer processes.

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5 Insulation is the first thing that most people think about to keep their home a comfortable temperature. There are many kinds of insulation, but most block heat transferred by conduction. The outside surfaces of walls will get hot. The thermal energy moves through the wall to the inside surfaces by conduction. Insulation is placed inside the walls to block this heat transfer. The same is done on attic floors to block heat transfer to the interior ceiling. Insulation is made of materials that are resistant to conduction. This includes foam or fiberglass mesh, both with many pockets of trapped air. Because of the wide spacing of gas molecules, conduction through air is very slow. Some companies sell double-paned windows. These have two plates of glass separated by air to reduce conduction through windows.

6 Earth is heated by radiation from the Sun. Solar radiation heats the air and the surfaces that absorb it. Solar radiation can also heat the inside of a building when it passes through a plain glass window. You can put light-colored blinds or a special transparent coating on the window glass. This can stop heat transfer by reflecting the radiation back outside.

7 Solar radiation also heats the roof. In the summertime, rooftops can be heated to between 150°F and 180°F (65–82°C). At these temperatures, the roof itself will begin to radiate heat, raising the temperature in the attic. This can heat the home directly, through the ceiling. Indirectly, a hotter attic can make your air conditioner work less efficiently. Most of the air ducts carrying the cooled air run through the attic. A hotter attic results in warmer air coming out of your air-conditioning ducts. A radiant barrier can block the heat transfer. It is made of reflective material applied about an inch away from the inside surface of the roof.

8 Gaps around doors or windows can allow hot, outside air to enter the house. The mixture of gases of two different temperatures is convection. The hot air from outside of the house raises the indoor temperature. The air conditioner has to work harder. The solution is to find the leaks and plug them with weather stripping, caulk, or foam. Most often, air leaks in around the edges of old or improperly installed doors and windows.

9 How do you know which of these products your home needs to lower its cooling costs? The best place to start with an existing building is with a service called a home energy audit. A home energy audit is performed by an inspector called an auditor. The auditor will examine the home’s structure, appliances, and the habits of the family. The auditor will evaluate how energy efficient the home is and recommend ways to improve it. One test that should be performed is a thermographic scan, pictured at the beginning of this passage. The scanning device displays an infrared image of the house and is used inside as well as outside. This can help the auditor find areas with insufficient insulation or excessive energy loss. A blower door test can be used to find spots where air is leaking into the building.

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10 A home energy audit is a worthwhile service and is recommended by the US Department of Energy. However, it is important to choose the right person to audit your home. The auditor you choose should be certified. You should read reviews and references and check for complaints about the company. Be especially wary if a company that sells insulating products offers a free inspection. They may exaggerate their findings to influence you to purchase their product. It is best to hire an independent auditor who is not trying to sell you something.

11 As we have seen, heat moves into a system such as a building by the processes of conduction, convection, and radiation. We want to keep a comfortable temperature inside our home, but this can be difficult when summer temperatures soar. Products that block heat transfer into the home help the air conditioner keep us cool inside without working so hard. This will result in money saved on our summertime electric bill.

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1 You purchase several rolls of fiberglass insulation and pay extra for installation. Have you purchased a product or a service?

A A product

B A service

C Both a product and a service

D Neither

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2 Replacing old windows with high-tech new windows can block which types of heat transfer?

A Radiation

B Conduction

C Conduction and radiation

D Conduction, convection, and radiation

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3 What has happened when the air temperature in a room has gone up?

A Thermal energy has transferred into the room, and the kinetic energy of the air molecules has increased.

B Thermal energy has transferred into the room, and the kinetic energy of the air molecules has decreased.

C Thermal energy has transferred out of the room, and the kinetic energy of the air molecules has increased.

D Thermal energy has transferred out of the room, and the kinetic energy of the air molecules has decreased.

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4 In the winter, hot air from the heater rises, making the air near the ceiling warmer than the air near the floor. Many ceiling fans have a setting said to reduce heating energy costs. How could that work?

A The ceiling fan is in contact with the ceiling and heats the room by conduction.

B The spinning blades radiate heat through the air and heat the room by radiation.

C The spinning blades cause the hot air on the ceiling to mix through the rest of the room and heat the room by convection.

D It cannot work. Ceiling fans can only cool rooms.

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5 A homeowner pastes a radiant barrier directly onto the inside attic wall but finds no reduction of summertime attic temperatures. What is the most likely reason?

A In contact with the wall, the radiant barrier can transfer heat by conduction.

B A radiant barrier works like a blanket to keep the attic warmer in the winter.

C A radiant barrier cannot stop air leaks when touching the walls.

D The paste helps the thermal radiation penetrate the radiant barrier.

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6 The products described in this passage keep your home cooler in the summer. How will they affect your heating costs in the winter?

A They limit heat coming in and make the house cooler. Heating costs will go up.

B They limit heat going out and make the house warmer. Heating costs will go down.

C They only work in the summer. Heating costs will stay the same.

D It is impossible to predict the change in heating costs.