Workshop Tutorials for Introductory Physics

TI2: **Heat and Energy**

A. Review of ideas in basic physics.

Use the following words to fill in the blanks:
333 kJ, 0^{o}C, thermal, ice, constant, latent, less, specific, heat

Heat and Energy

Brent and Rebecca have decided to go to the beach. It is a really hot day and they want to take plenty of cold drinks, which they wish to keep cold. They fill their cool box with _______ and put in their drinks. The temperature outside the cool box is much greater than the temperature inside.

As the day progresses _______ energy is transferred through the cool box walls. The flow of thermal energy will be from the outside to inside the cool box. Brent and Rebecca discuss whether the temperature changes as the cool box is heated. They discover that as long as there is some ice the temperature is ________. The heat, i.e. transfer of thermal energy, from the air outside is melting the ice. The thermal energy added is breaking the bonds between the ice molecules and water is forming. While this is happening the inside of the box stays at a constant _________.

Rebecca tells Brent that the energy needed to change the phase of 1 kilogram of a substance is called the _________ heat. For example 333 kJ of energy is needed to melt 1 kilogram of ice. When ice is forming, _________ per kilogram must flow from the freezing water. Not all substances have the same latent heat. Ethyl alcohol needs only 104 kJ per kilogram to freeze. But why then is a form of alcohol, glycol alcohol, used in antifreeze if alcohol needs _________ energy than water to freeze? The answer is that the melting (and freezing point) of alcohol is at least –100^{o}C.

By the end of the day at the beach, all the ice is melted in the cool box. ______ continues to be transferred into the box but now the temperature of the drinks and melted ice starts to increase. The ________ heat of the water and drinks will determine how quickly the contents heat up and the subsequent temperature change. Either it is time to go home or quickly finish off the drinks.

B. Activity Questions:

1. The drinking bird

The toy drinking bird has ether inside its body and a head-of-felt which soaks up water. Liquid ether evaporates rapidly at room temperature.
Use diagrams to explain why the drinking bird behaves in the way it does.

2. A hot bath

Pour about 5 ml of water into a test tube.
Hold a match under the test tube and note the change in temperature of the water.
Use this to determine the energy gained by the water.
Estimate how many matches you need to take a hot bath.

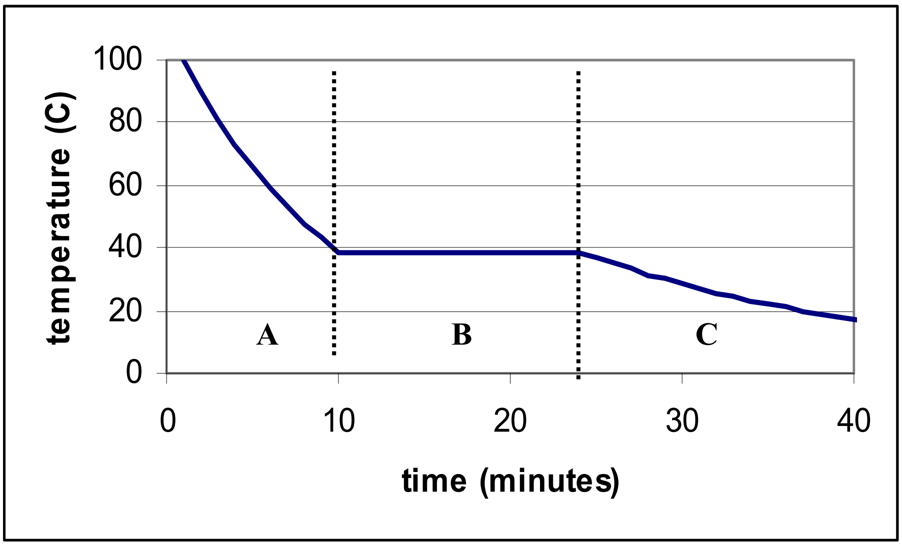
3. Keeping warm or cool

Examine the collection of items which are used to keep other objects hot or cold.
What do these objects have in common?
Measure their temperatures now and a little while later.
Have their temperatures changed significantly?

4. Cooling by evaporation
Dip the face washer in water and then squeeze most of the water out.
Measure the temperature of the moist washer.
Now wave the washer in the air.
Measure the temperature again. Has it changed? Explain why.

C. Qualitative Questions.

1. Rebecca has left the margarine out on the kitchen bench after making toast in the morning. Later in the day Brent finds it all liquid and puts it back in the fridge. Being curious about how long it will take to cool, and how much energy this will take, he puts a thermometer in it and checks it every few minutes. After it has cooled down and solidified he plots the temperature and obtains the cooling curve shown. Explain what is happening in each of regions **A, B,** and **C.**



2. Heat can be added to a substance without causing the temperature of the substance to rise.
a. Does this contradict the concept of heat as energy in the process of transfer because of a temperature difference?
b. Why must heat be supplied to melt ice when, after all, the temperature does not change?
Suppose you have an ice-box with food, drinks, ice and some melt-water from the ice. You want to keep the food cold for as long as possible.
c. Should you retain the cold melt-water, or should you drain it through a convenient one-way valve?

D. Quantitative question

The energy released when water condenses during a thunderstorm can be very large.
Calculate the energy released into the atmosphere for a small storm of 1 km radius and assuming that 2 cm of water is precipitated.

Data:
Density of water = 1000 $kg.m^{-3}$
latent heat of vapourisation = 2257 $kJ.kg^{-1}$.