PHY1014

## Heat and Heat transfer Methods

Read chapter 14

<https://openstax.org/books/college-physics/pages/14-introduction-to-heat-and-heat-transfer-methods>

# 1

*On a hot day, the temperature of an 80,000-L swimming pool increases by* *. What is the net heat transfer during this heating? Ignore any complications, such as loss of water by evaporation.*

**Read again**

*On a hot day, the temperature of an 80,000-L swimming pool increases by* *. What is the net heat transfer during this heating? Ignore any complications, such as loss of water by evaporation.*

**We know:** volume of water, change in temperature;

We can find the specific heat value for water in the table with specific heat value for different substances.

Specific heat for water is 4185 J/kg C.

**We need to find:** net heat transfer.

 **Strategy and formula**

Thus, problem is about heat transfer due to temperature change.

**Heat transfer and temperature change**

$Q=cmΔT=cm (T\_{2}-T\_{1})$,

$Q$ is heat, $c$ is specific heat (depends on the material and phase), $m$ is mass, $ΔT$ is change in temperature.

SI units of $Q$ is J (joule), SI units of $T$ is K (kelvin), SI units if $m$ is kg, SI units of $c$ is J/kg \*C.

Specific heat value can be found in a table with values for specific heat for various materials.

**NOTE**: in this case we will use temperature in degrees C.

**Calculations**

There is $m$ (mass of water) in the formula. We do not know mass but can find it using the volume and density of water. Density of water can be found in the table with densities for various substances.



Then substitute this value into the formula for heat transfer:



# 3

*To sterilize a 50.0-g glass baby bottle, we must raise its temperature from*  *to**. How much heat transfer is required?*

**Read again**

*To sterilize a 50.0-g glass baby bottle, we must raise its temperature from*  *to**. How much heat transfer is required?*

**We know:** mass of glass, initial and final temperature (we can find change in temperature ( $△T=T\_{2}-T\_{1}$), specific heat value for glass can be found from the table with specific heat values for various substances.

**We need to find:** heat transfer.

NOTE: mas is not in SI units.

**Formula**

**Heat transfer and temperature change**

$Q=cmΔT=cm (T\_{2}-T\_{1})$,

$Q$ is heat, $c$ is specific heat (depends on the material and phase), $m$ is mass, $ΔT$ is change in temperature.

SI units of $Q$ is J (joule), SI units of $T$ is K (kelvin), SI units if $m$ is kg, SI units of $c$ is J/kg \*C.

Specific heat value can be found in a table with values for specific heat for various materials.

**NOTE**: in this case we will use temperature in degrees C.

**Calculations**



# 11

*How much heat transfer (in kilocalories) is required to thaw a 0.450-kg package of frozen vegetables originally at*  *if their heat of fusion is the same as that of water?*

**Read again**

*How much heat transfer (in kilocalories) is required to thaw a 0.450-kg package of frozen vegetables originally at*  *if their heat of fusion is the same as that of water?*

**We know:** mass, heat fusion (from the table)

**We need to find:** heat transfer.

**Formula**

**Phase change and latent heat**

**Melting/freezing**

$Q=mL\_{f}$,

$Q$ is heat, $m$ is mass, $L\_{f}$ is latent heat of fusion.

**Calculations**



NOTE: we use the value of heat of fusion in kcal/kg not in SI Units J/kg.

# 15

*On a trip, you notice that a 3.50-kg bag of ice lasts an average of one day in your cooler. What is the average power in watts entering the ice if it starts at*  *and completely melts to*  *water in exactly one day []?*

**Read again**

*On a trip, you notice that a 3.50-kg bag of ice lasts an average of one day in your cooler. What is the average power in watts entering the ice if it starts at*  *and completely melts to*  *water in exactly one day []?*

**We know:** mass of ice, an find from the table heat of fusion for ice.

**We need to find**: power entering the ice.

Recall: power = work/time or power = energy/time.

In this case, energy = heat transfer.

**Formulas**

**Phase change and latent heat**

**Melting/freezing**

$Q=mL\_{f}$,

$Q$ is heat, $m$ is mass, $L\_{f}$ is latent heat of fusion.

**Calculations**



# 24

*A 0.0500-kg ice cube at*  *is placed in 0.400 kg of*  *water in a very well-insulated container. What is the final temperature?*

**Read again**

*A 0.0500-kg ice cube at*  *is placed in 0.400 kg of*  *water in a very well-insulated container. What is the final temperature?*

**We know**: mass of ice and its initial temperature, mass of water and its initial temperature. We can find from tables specific heat value for water and heat of fusion for ice.

**Strategy and Formula**

In this problem two processes will happen:

* Ice will melt;
* Water will change its temperature.

So, we will need to use two formulas for heat transfer:

**1 - Phase change and latent heat**

**Melting/freezing**

$Q=mL\_{f}$,

$Q$ is heat, $m$ is mass, $L\_{f}$ is latent heat of fusion.

**2 - Heat transfer and temperature change**

$Q=cmΔT=cm (T\_{2}-T\_{1})$,

$Q$ is heat, $c$ is specific heat (depends on the material and phase), $m$ is mass, $ΔT$ is change in temperature.

**Calculations**

|  |
| --- |
| First bring the ice up to  and melt it with heat This lowers the temperature of water by  Now, the heat lost by the hot water equals that gained by the cold water ( is the final temperature): |

# 32

*Calculate the rate of heat conduction out of the human body, assuming that the core internal temperature is* *, the skin temperature is* *, the thickness of the tissues between averages , and the surface area is .*

**Read again**

*Calculate the rate of heat conduction out of the human body, assuming that the core internal temperature is* *, the skin temperature is* *, the thickness of the tissues between averages , and the surface area is .*

**We know:** two different temperatures, thickness of tissues, and surface area.

**We need to find:** the rate of heat conduction

NOTE: thickness is not in SI units.

**Formula**

**Rate of conductive heat transfer**

$\frac{Q}{t}=\frac{kA(T\_{2}-T\_{1})}{d}$,

$ Q$ is heat, $t$ is time, $k$ is the thermal conductivity, $A$ is surface area, $d$ is thickness, $T$ is temperature.

This formula will be used in case we need to find the rate of conductive heat transfer through a slab of material.

Thermal conductivity can be found in a table with values for various materials.

**Calculations**

