Heat and Temperature!

Physics Clicker Quizzes

Two objects are made of the same material, but have different masses and temperatures. If the objects are brought into thermal contact, which one will have the greater temperature change?

A The one with the higher initial temp
B The one with the lower initial temp
C The one with the greater mass
D The one with the smaller mass
E The one with the higher specific heat

D Smaller Mass

Since the objects are made of the same material, the only difference between them is their mass. Clearly, the object with less mass will be much easier to change temperature since there is not much material there (compared to the more massive object).

Two equal-mass liquids initially at the same temperature are heated for the same time over the same stove. You measure the temperatures and find that one liquid has a higher temperature than the other. Which liquid has a higher specific heat?

A The cooler one
B The hotter one
C Both the same

A

The cooler one

Both liquids had the same increase in internal energy, because the same heat was added. But the **cooler liquid** had a **lower temperature** change. Since $Q = mc\Delta T$, if Q and m are both the same and ΔT is smaller, then c (specific heat) must be bigger.

The specific heat of concrete is greater than that of soil. A baseball field (with real soil) and the surrounding parking lot are warmed up during a sunny day. Which would you expect to cool down faster in the evening when the sun goes down?

A The concrete parking lot
B The baseball field
C Both cool off equally as fast

B

The baseball field

The baseball field, with the lower specific heat, will change temperature more readily, so it will cool off faster. The high specific heat of concrete allows it to "retain heat" better and so it will not cool off so quickly – it has a higher "thermal inertia."

Water has a higher specific heat than sand. Therefore, on the beach at night, the breeze would blow

A From the ocean to the beach
B From the beach to the ocean
C Either way, specific heat makes no difference on air movement

B

From the beach to the ocean

- Daytime
  - sun heats both the beach and the water
    - » beach heats up faster
    - » warmer air above beach rises
    - » cooler air from ocean moves in underneath
    - » breeze blows ocean → land
- Nighttime
  - sun has gone to sleep
    - » beach cools down faster
    - » warmer air is now above the ocean
    - » cooler air from beach moves out to the ocean
    - » breeze blows land → ocean

1 kg of water at 100 degrees C is poured into a bucket that contains 4 kg of water at zero degrees C. The equilibrium temperature is

A 0°C
B 20°C
C 50°C
D 80°C
E 100°C

B 20°C

Since the **cold water mass is greater**, it will have a **smaller temperature change**!

The masses of cold/hot have a ratio of 4:1, so the temperature change must have a ratio of 1:4 (cold/hot).

$$Q_1 = Q_2$$

$$m_1 c \Delta T_1 = m_2 c \Delta T_2$$

$$\Delta T_1 / \Delta T_2 = m_2 / m_1$$

A 1 kg block of silver C = 234 J/kgC is heated to 100 degrees C then dunked in a tub of water C = 4186 J/kgC at zero degrees C. The final equilibrium temperature is

A 0°C
B Between 0°C and 50°C
C 50°C
D Between 50°C and 100°C
E 100°C

B

Between 0°C and 50°C

Since $c_{water} >> c_{silver}$ it takes more heat to change the temperature of the water than it does to change the temperature of the silver. In other words, it is much "harder" to heat the water!! Thus, the final temperature has to be closer to the initial temperature of the water.

If you add some heat to a substance, is it possible for the temperature of the substance to remain unchanged?

Yes

No

Yes

Yes, it is indeed possible for the temperature to stay the same. This is precisely what occurs during a phase change – the added heat goes into changing the state of the substance (from solid to liquid or from liquid to gas) and does not go into changing the temperature! Once the phase change has been accomplished, then the temperature of the substance will rise with more added heat.

Will potatoes cook faster if the water is boiling faster?

Yes

No

No

The water boils at 100 °C and remains at that temperature until all of the water has been changed into steam. Only then will the steam increase in temperature. Since the water stays at the same temperature, regardless of how fast it is boiling, the potatoes will not cook any faster.

You put 1 kg of ice at 0°C together with 1 kg of water at 50°C. What is the final temperature?

A 0°C
B Between 0°C and 50°C
C 50°C
D Greater than 50°C

L_f = 333,000 J/kg for ice
C = 4186 J/kg°C for water

A 0°C

How much heat is needed to melt the ice?
$Q = m L_f$ = (1 kg) (333,000 J/kg) = 333,000J

How much heat can be delivered by cooling from 50 degrees to zero degrees C?
$Q = mC\Delta T$ = (1 kg) (4186 J/kgC) (50°C) = 209,300J

There is not enough heat available to melt the ice!

You put 1 kg of ice at 0°C together with 1 kg of steam at 100°C. What is the final temperature?

A Between 0°C and 50°C
B 50°C
C Between 50°C and 100°C
D 100°C
E Greater than 100°C

L_f = 333,000 J/kg for ice
C = 4186 J/kg°C for water
L_v = 2,260,000 J/kg for steam

D 100 degrees C

How much heat is needed to melt the ice?
$Q = m L_f$ = (1 kg) (333,000 J/kg) = 333,000J

How much heat can be delivered by raising the water temperature from 0 degrees to 100 degrees C?
$Q = mC\Delta T$ = (1 kg) (4186 J/kgC) (100°C) = 418,600J

When added together you get 751,600J

But turning 1kg of steam into water takes:
$Q = m L_f$ = (1 kg) (2,260,000 J/kg) = 2,260,000J
So you have steam left over at 100 degrees C.

Which will cause more severe burns to your skin: 100 °C water or 100 °C steam?

A Water
B Steam
C Both the same
D It depends...

B steam

Kilogram for kilogram, water releases 4,186 J per degree as it cools where steam has to go thru a phase change releasing 2,260,000 J in the process!

You step out of a swimming pool on a hot day, where the air temperature is 90° F. Where will you feel cooler, in Phoenix (dry) or in Philadelphia (humid)?

A Equally cool in either place
B Philadelphia
C Phoenix

C **Phoenix**

In Phoenix, where the air is dry, more of the water will evaporate from your skin. This is a phase change, where the water must absorb the heat of vaporization, which it takes from your skin. That is why you feel cool as the water evaporates.

End of Quiz