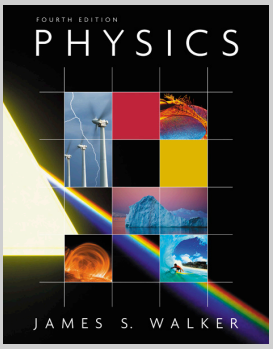

ConcepTest Clicker Questions

Chapter 16

Physics, 4th Edition

James S. Walker

Question 16.1 Degrees

Which is the largest unit: one Celsius degree, one Kelvin degree, or one Fahrenheit degree?

a) one Celsius degree
b) one Kelvin degree
c) one Fahrenheit degree
d) both one Celsius degree and one Kelvin degree
e) both one Fahrenheit degree and one Celsius degree

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The Celsius degree and the Kelvin degree are the same size. The scales only differ by an offset, not by the size of the degree unit. For Fahrenheit, there are 180 degrees between boiling and freezing (212°F–32°F). For Celsius, there are 100 degrees between the same points, so the Celsius (and Kelvin) degrees must be larger.

Question 16.2 Freezing Cold

It turns out that –40°C is the same temperature as –40°F. Is there a temperature at which the Kelvin and Celsius scales agree?

a) yes, at 0°C
b) yes, at −273°C
c) yes, at 0 K
d) no

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c) yes, at 0 K
d) no

The Celsius and Kelvin scales differ only by an offset, which is 273 degrees. Therefore, a temperature on one scale can never match the same numerical value on the other scale. The reason that such agreement is possible for Celsius and Fahrenheit is the fact that the actual degree units have different sizes (recall the previous question).

Question 16.3 Thermometers

You may notice that if a mercury-in-glass thermometer is inserted into a hot liquid, the mercury column first drops, and then later starts to rise (as you expect). How do you explain this drop?

a) the mercury contracts before the glass contracts
b) the glass contracts before the mercury contracts
c) the mercury contracts before the glass expands
d) the glass expands before the mercury expands
e) the mercury expands before the glass contracts

Question 16.3 Thermometers

You may notice that if a mercury-in-glass thermometer is inserted into a hot liquid, the mercury column first drops, and then later starts to rise (as you expect). How do you explain this drop?

a) the mercury contracts before the glass contracts
b) the glass contracts before the mercury contracts
c) the mercury contracts before the glass expands
d) the glass expands before the mercury expands
e) the mercury expands before the glass contracts

The hot liquid touches the glass first, so initially the glass expands slightly. This increases the volume inside the glass, and so the mercury level drops slightly. Once the mercury heats up, it begins to expand and then the characteristic rise in the mercury column follows, indicating the increase in temperature that you expected to measure.

Follow-up: Is it possible to have the mercury first rise and later drop?

Question 16.4 Glasses

Two drinking glasses are stuck, one inside the other. How would you get them unstuck?

a) run hot water over them both
b) put hot water in the inner one
c) run hot water over the outer one
d) run cold water over them both
e) break the glasses

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d) run cold water over them both
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Running hot water over only the outer glass will allow the outer one to expand, while the inner glass remains relatively unchanged. This should loosen the outer glass and free it.

Question 16.5a Steel Expansion I

A steel tape measure is marked such that it gives accurate length measurements at room temperature. If the tape measure is used outside on a very hot day, how will its length measurements be affected?

a) measured lengths will be too small
b) measured lengths will still be accurate
c) measured lengths will be too big

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a) measured lengths will be too small
b) measured lengths will still be accurate
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The tape measure will expand, so its markings will spread out farther than the correct amount. When it is laid down next to an object of fixed length, you will read too few markings for that given length, so the measured length will be too small.

Question 16.5b Steel Expansion II

Metals such as brass expand when heated. The thin brass plate in the movie has a circular hole in its center. When the plate is heated, what will happen to the hole?

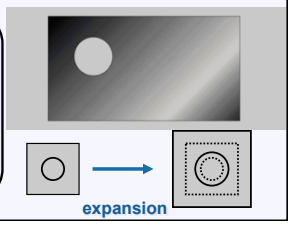
a) gets larger
b) gets smaller
c) stays the same
d) vanishes

Question 16.5b Steel Expansion II

Metals such as brass expand when heated. The thin brass plate in the movie has a circular hole in its center. When the plate is heated, what will happen to the hole?

a) gets larger
b) gets smaller
c) stays the same
d) vanishes

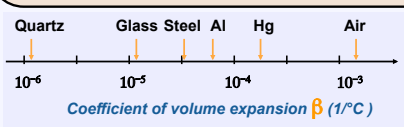
Imagine drawing a circle on the plate. This circle will expand outward along with the rest of the plate. Now replace the circle with the hole, and you can see that the hole will expand outward as well. Note that the material does *NOT* "expand inward" to fill the hole!!

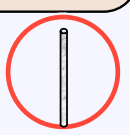


Question 16.6a Steel Ring I

A steel ring stands on edge with a rod of some material inside. As this system is heated, for which of the following rod materials will the rod eventually touch the top of the ring?

a) aluminum
b) steel
c) glass
d) aluminum and steel
e) all three





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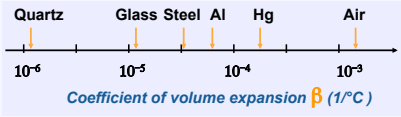
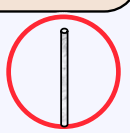


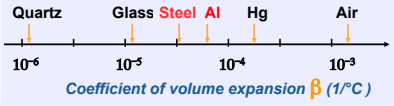


Aluminum is the only material that has a larger β value than the steel ring, so that means that the aluminum rod will expand more than the steel ring. Thus, only in that case does the rod have a chance of reaching the top of the steel ring.

Question 16.6b Steel Ring II

You want to take apart a couple of aluminum parts held together by steel screws, but the screws are stuck. What should you do?

a) heat the thing up
b) cool the thing down
c) blow the thing up



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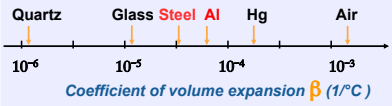

Because aluminum has a larger β value that means aluminum expands more than steel. Thus, by heating the part, the aluminum holes will expand faster than the steel screws and the screws will come loose.

Question 16.7 Grandfather Clock

A grandfather clock uses a brass pendulum to keep perfect time at room temperature. If the air conditioning breaks down on a very hot summer day, how will the grandfather clock be affected?

a) clock will run slower than usual
b) clock will still keep perfect time
c) clock will run faster than usual

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c) clock will run faster than usual

The pendulum will expand, so its length will increase. The period of a pendulum depends on the length, as shown below, so the period will also increase. Thus, the clock will run slow.

$$T = 2\pi\sqrt{\frac{L}{g}}$$

Follow-up: Roughly how much slower will it run ?

Question 16.8a Thermal Contact I

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 temperature
b) the one with the lower initial temperature
c) the one with the greater mass
d) the one with the smaller mass
e) the one with the higher specific heat

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c) the one with the greater mass
d) the one with the smaller mass
e) the one with the higher specific heat

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

Question 16.8b Thermal Contact II

Two different objects receive the same amount of heat. Which of the following choices is NOT a reason why the objects may have different temperature changes?

a) they have different initial temperatures
b) they have different masses
c) they have different specific heats

Question 16.8b Thermal Contact II

Two different objects receive the same amount of heat. Which of the following choices is NOT a reason why the objects may have different temperature changes?

a) they have different initial temperatures
b) they have different masses
c) they have different specific heats

Because $Q = m\,c\,\Delta T$ and the objects received the same amount of heat, the only other factors are the masses and the specific heats. Although the initial temperature is certainly relevant for finding the final temperature, it does not have any effect on the temperature change ΔT.

Question 16.9 Two Liquids

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

Question 16.9 Two Liquids

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

Both liquids had the same increase in internal energy, because the same heat was added. But the cooler liquid had a lower temperature change.

Because $Q = mc\Delta T$, if Q and m are both the same and ΔT is smaller, then c (specific heat) must be bigger.

Question 16.10a Night on the Field

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 off faster in the evening when the sun goes down?

a) the concrete parking lot
b) the baseball field
c) both cool off equally fast

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a) the concrete parking lot
b) the baseball field
c) both cool off equally fast

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."

Question 16.10b Night on the Beach

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

a) from the ocean to the beach
b) from the beach to the ocean
c) either way, makes no difference

Question 16.10b Night on the Beach

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

a) from the ocean to the beach
b) from the beach to the ocean
c) either way, makes no difference

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

$c_{sand} < c_{water}$

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

Question 16.11 Calorimetry

1 kg of water at 100°C is poured into a bucket that contains 4 kg of water at 0°C. Find the equilibrium temperature (neglect the influence of the bucket).

a) 0°C
b) 20°C
c) 50°C
d) 80°C
e) 100°C

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b) 20˚C
c) 50˚C
d) 80˚C
e) 100˚C

Because 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).

$$Q_1 = Q_2$$
$$m_1 c \Delta T_1 = m_2 c \Delta T_2$$
$$\Delta T_1 / \Delta T_2 = m_2 / m_1$$

Question 16.12 More Calorimetry

A 1 kg block of silver (c = 234 J/kg˚C) is heated to 100°C, then dunked in a tub of 1 kg of water (c = 4186 J/kg˚C) at 0°C. What is the final equilibrium temperature?

a) 0°C
b) between 0°C and 50°C
c) 50°C
d) between 50°C and 100°C
e) 100°C

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a) 0°C
b) between 0°C and 50°C
c) 50°C
d) between 50°C and 100°C
e) 100°C

Because $c_{water} >> c_{silver}$ 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.

$$Q_1 = Q_2$$
$$mc_1 \Delta T_1 = mc_2 \Delta T_2$$
$$\Delta T_1 / \Delta T_2 = c_2 / c_1$$

Question 16.13 Heat Conduction

Given your experience of what feels colder when you walk on it, which of the surfaces would have the *highest thermal conductivity?*

a) a rug
b) a steel surface
c) a concrete floor
d) has nothing to do with thermal conductivity

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The heat flow rate is $k\,A\,(T_1 - T_2)/l$. All things being equal, bigger k leads to bigger heat loss.
From the book: Steel = 40, Concrete = 0.84, Human tissue = 0.2, Wool = 0.04, in units of J/(s.m.C°)

Question 16.14 Radiation

If the Sun's surface temperature falls to half the current surface temperature, by what factor will the radiant energy reaching the Earth change?

a) increase by factor of 16
b) increase by factor of 4
c) it will remain the same
d) decrease by factor of 4
e) decrease by factor of 16

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b) increase by factor of 4
c) it will remain the same
d) decrease by factor of 4
e) decrease by factor of 16

Radiation energy is proportional to T^4. So if temperature is halved, radiation energy will decrease by a factor of 16.