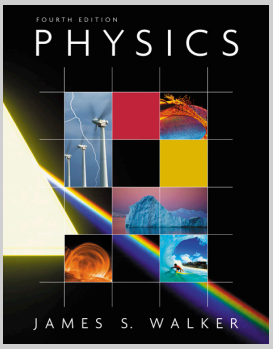

ConcepTest Clicker Questions

Chapter 17

Physics, 4th Edition

James S. Walker

Question 17.1a Nitrogen and Oxygen I

Which has more molecules—a mole of nitrogen (N_2) gas or a mole of oxygen (O_2) gas?

a) oxygen
b) nitrogen
c) both the same

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A mole is defined as a quantity of gas molecules equal to Avogadro's number (6.02×10^{23}). This value is independent of the type of gas.

Question 17.1b Nitrogen and Oxygen II

Which weighs more—a mole of nitrogen (N_2) gas or a mole of oxygen (O_2) gas?

a) oxygen
b) nitrogen
c) both the same

Question 17.1b Nitrogen and Oxygen II

Which weighs more—a mole of nitrogen (N_2) gas or a mole of oxygen (O_2) gas?

a) oxygen
b) nitrogen
c) both the same

The oxygen molecules have a molecular mass of 32, and the nitrogen molecules have a molecular mass of 28.

Follow-up: Which one will take up more space?

Question 17.2a Ideal Gas Law I

Two identical cylinders at the same temperature contain the same gas. If A contains three times as much gas as B, which cylinder has the higher pressure?

a) cylinder A
b) cylinder B
c) both the same
d) it depends on temperature *T*

Question 17.2a Ideal Gas Law I

Two identical cylinders at the same temperature contain the same gas. If A contains three times as much gas as B, which cylinder has the higher pressure?

a) cylinder A
b) cylinder B
c) both the same
d) it depends on temperature T

Ideal gas law: $PV = nRT$

Solve for pressure: $P = \frac{nRT}{V}$

For constant V and T, the one with more gas (the larger value of n) has the higher pressure P.

Question 17.2b Ideal Gas Law II

Two identical cylinders at the same pressure contain the same gas. If A contains three times as much gas as B, which cylinder has the higher temperature?

a) cylinder A
b) cylinder B
c) both the same
d) it depends on the pressure P

Question 17.2b Ideal Gas Law II

Two identical cylinders at the same pressure contain the same gas. If A contains three times as much gas as B, which cylinder has the higher temperature?

a) cylinder A
b) cylinder B
c) both the same
d) it depends on the pressure P

Ideal gas law: $PV = nRT$

Solve for temperature: $T = \frac{PV}{nR}$

For constant V and P, the one with less gas (the smaller value of n) has the higher temperature T.

Question 17.2c Ideal Gas Law III

Two cylinders at the same temperature contain the same gas. If B has twice the volume and half the number of moles as A, how does the pressure in B compare with the pressure in A?

a) $P_B = \frac{1}{2} P_A$
b) $P_B = 2 P_A$
c) $P_B = \frac{1}{4} P_A$
d) $P_B = 4 P_A$
e) $P_B = P_A$

Question 17.2c Ideal Gas Law III

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d) $P_B = 4 P_A$
e) $P_B = P_A$

Ideal gas law: $PV = nRT$

Because B has a factor of twice the volume, it has a factor of two less the pressure. But B also has half the amount of gas, so that is another factor of two reduction in pressure. Thus, B must have only one-quarter the pressure of A.

Question 17.3 Soda Bottle

A plastic soda bottle is empty and sits out in the sun, heating the air inside. Now you put the cap on tightly and put the bottle in the fridge. What happens to the bottle as it cools?

a) it expands and may burst
b) it does not change
c) it contracts and the sides collapse inward
d) it is too dark in the fridge to tell

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a) it expands and may burst
b) it does not change
c) it contracts and the sides collapse inward
d) it is too dark in the fridge to tell

The air inside the bottle is warm, due to heating by the sun. When the bottle is in the fridge, the air cools. As the temperature drops, the pressure in the bottle also drops. Eventually, the pressure inside is sufficiently lower than the pressure outside (atmosphere) to begin to collapse the bottle.

Question 17.4 Balloon in Freezer

What happens to the volume of a balloon if you put it in the freezer?

a) it increases
b) it does not change
c) it decreases

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What happens to the volume of a balloon if you put it in the freezer?

a) it increases
b) it does not change
c) it decreases

According to the Ideal Gas Law, when the temperature is reduced at constant pressure, the volume is reduced as well. The volume of the balloon therefore decreases.

$$PV = nRT$$

Follow-up: What happens to the volume when the balloon rises in the air?

Question 17.5 Adding Heat

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

a) yes
b) no

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

a) yes
b) no

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.

Follow-up: Does that depend on the substance?

Question 17.6 Hot Potato

Will potatoes cook faster if the water is boiling faster?

a) yes
b) no

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Will potatoes cook faster if the water is boiling faster?

a) yes
b) 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. Because the water stays at the same temperature, regardless of how fast it is boiling, the potatoes will not cook any faster.

Follow-up: How can you cook the potatoes faster?

Question 17.7 Water and Ice

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

- L_F = 80 cal/*g*
- c_{water} = 1 cal/*g* °C

a) 0°C
b) between 0°C and 50°C
c) 50°C
d) greater than 50°C

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a) 0°C
b) between 0°C and 50°C
c) 50°C
d) greater than 50°C

How much heat is needed to melt the ice?

$Q = mL_f = (1000\ g) \times (80\ cal/g) = 80{,}000\ cal$

How much heat can the water deliver by cooling from 50°C to 0°C?

$Q = c_{water}\, m\, \Delta T = (1\ cal/g\ °C) \times (1000\ g) \times (50°C) = 50{,}000\ cal$

Thus, there is not enough heat available to melt all the ice!!

Follow-up: How much more water at 50°C would you need?

Question 17.8 Ice and Steam

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

- L_F = 80 cal/*g*, L_v = 540 cal/*g*
- c_{water} = 1 cal/*g* °C

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

Question 17.8 Ice and Steam

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

- L_F = 80 cal/*g*, L_v = 540 cal/*g*
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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

How much heat is needed to melt the ice?

$Q = mL_f = (1000\ g) \times (80\ cal/g) = 80{,}000\ cal$

How much heat is needed to raise the water temperature to 100°C?

$Q = c_{water}\, m\, \Delta T = (1\ cal/g\ °C) \times (1000\ g) \times (100°C) = 100{,}000\ cal$

But if all of the steam turns into water, that would release 540,000 cal
Thus, some steam is left over, and the whole mixture stays at 100°C.

Follow-up: How much more ice would you need?

Question 17.9 You're in Hot Water!

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...

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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...

Although the water is indeed hot, it releases only 1 cal/g of heat as it cools. The steam, however, first has to undergo a phase change into water and that process releases 540 cal/g, which is a *very large amount of heat*. That immense release of heat is what makes steam burns so dangerous.

Question 17.10 Spring Break

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 both places
b) Philadelphia
c) Phoenix

Question 17.10 Spring Break

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 both places
b) Philadelphia
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.