بنك أسئلة شامل الوحدتين 11-12 منهج انسباير

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وزارة التربية والتعليم
MINISTRY OF EDUCATION

Question Bank
Physics Inspire Grade 12 Advanced
Second Term of 2025- 2026

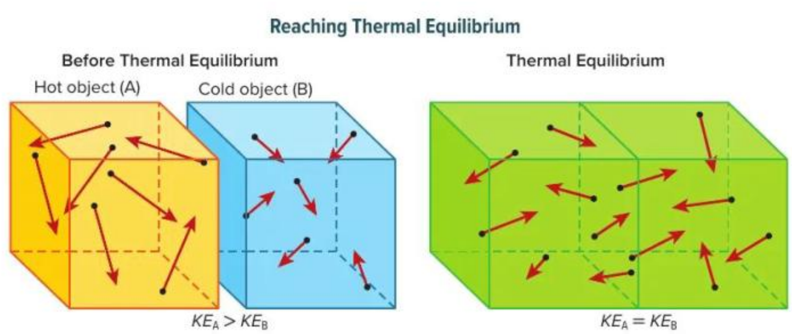
Module 11: Thermal Energy

MCQ

Temperature, Heat and Thermal Energy

what happens when a cool thermometer is placed in a person's mouth?

A. The thermometer's particles transfer all their energy to the body until the thermometer reaches absolute zero.
B. The body's particles stop moving once they touch the cooler surface of the thermometer.
C. Energy is transferred through particle collisions until the rate of energy transfer between the body and the thermometer is equal.
D. The thermometer immediately displays the body's temperature because no energy transfer is required for a reading.



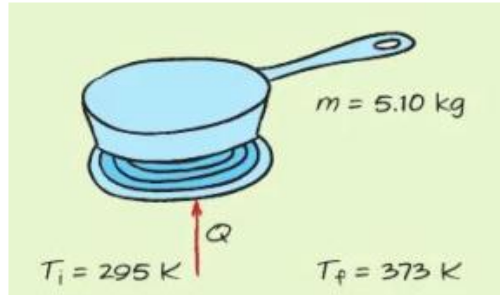
How does a standard household alcohol thermometer indicate an increase in temperature?

A.	The thermometer's particles collide with the body's particles until they reach absolute zero.
B.	The liquid crystal molecules inside the tube rearrange to change color at specific temperatures.
C.	Electronic circuits inside the thermometer take rapid measurements and display them digitally.
D.	Thermal energy is transferred to the colored alcohol, causing it to expand and rise higher in the tube.

why is –273.15°C considered "absolute zero"?

A.	It is the temperature at which helium liquefies and can no longer be cooled by lasers.
B.	It represents the point where all removable thermal energy has been removed and atoms would become motionless.
C.	It is the maximum temperature the interior of the Sun can reach before particles stop colliding.
D.	It is the specific temperature where colored alcohol in a household thermometer stops expanding.

How much thermal energy is transferred to a 5.10 kg cast-iron skillet when it is heated from 295 K to 373 K? {Specific heat of iron: 450 J/(kg·K)}



A. 1.2×10^5 J
B. 1.8×10^5 J
C. 2.3×10^5 J
D. 3.6×10^5 J

A copper water pipe with a mass of 2.3 kg is heated from 20.0°C to 80.0°C. Given that the specific heat capacity of copper is 385 J/kg.K, how much thermal energy is absorbed by the pipe?

A. 1.7×10^4 J
B. 5.3×10^4 J
C. 7.7×10^4 J
D. 5.8×10^4 J

Electrical power companies sell electrical energy by the kilowatt-hour, where 1 kWh = 3.6×10^6 J. Suppose that it costs \$0.15 per kWh to run your electric water heater. How much does it cost to heat 75 kg of water from 15°C to 43°C to fill a bathtub?

A.	0.11**$**
B.	0.36**$**
C.	0.56**$**
D.	1.32**$**

A car engine's cooling system contains 20.0 L of water (1 L of water has a mass of 1 kg).

a. What is the change in the temperature of the water if 836.0 kJ of thermal energy is added?

A.	10 K
B.	34 K
C.	76 K
D.	21 K

b. Suppose that it is winter, and the car's cooling system is filled with methanol. The density of methanol is 0.80 g/cm3$0.80$g/cm3. What would be the increase in temperature of the methanol if it absorbed 836.0 kJ of thermal energy?

A. 10 K
B. 34 K
C. 76 K
D. 21 K

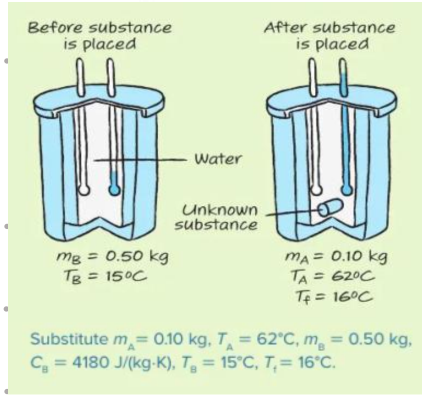
c. Which coolant, water or methanol, would better remove thermal energy from the car engine? Explain.

A. Methanol, because it has a lower boiling point and evaporates faster to carry heat away.
B. Water, because it can absorb more heat with less of a temperature change compared to methanol.
C. Methanol, because its lower density allows it to circulate through the engine faster.
D. Water, because it is less corrosive to the metal components of the engine block.

how is energy transferred and transformed when a hot substance is placed into a calorimeter?

A.	Energy is created by the chemical reaction between the substance and the water, increasing the total thermal energy of the system.
B.	Energy leaves the system and is lost to the external environment, causing both the substance and the water to cool down.
C.	Energy is transferred from the warmer substance to the cooler water until they reach thermal equilibrium, where the energy lost by the substance equals the energy gained by the water.
D.	Energy is transformed into mechanical work by the stirrer, which prevents the temperature of the water from rising.

A calorimeter contains 0.50 kg of water at 15 °C. A 0.10 kg block of an unknown substance at 62 °C is placed in the water. The final temperature of the system is 16 °C. What is the substance?



A. 350 J/(kg.K)
B. 400 J/(kg.K)
C. 550 J/(kg.K)
D. 450 J/(kg.K)

A 1.00×10^2–g aluminum block at 100.0 °C is placed in 1.00×10^2 g of water at 10.0 °C. The final temperature of the mixture is 26.0 °C. What is the specific heat of the aluminum?

A.	9.04×10^2 J/(kg.°C)
B.	8.64×10^2 J/(kg.°C)
C.	5.5×10^2 J/(kg.°C)
D.	10.3×10^2 J/(kg.°C)

Three metal fishing weights, each with a mass of 1.00×10^2 g and at a temperature of 100.0°C, are placed in 1.00×10^2 g of water at 35.0°C. The final temperature of the mixture is 45.0°C. What is the specific heat of the metal in the weights?

A.	7.14×10^2 J/(kg.°C)
B.	3.52×10^2 J/(kg.°C)
C.	2.53×10^2 J/(kg.°C)
D.	5.23×10^2 J/(kg.°C)

A 2.00×10^{2}-g sample of water at 80.0°C is mixed with 2.00×10^{2} g of water at 10.0°C in a calorimeter. What is the final temperature of the mixture?

A.	15°C
B.	30°C
C.	45°C
D.	60°C

A 1.50×10^{2}-g piece of glass at a temperature of 70.0°C is placed in a container with 1.00×10^{2} g of water initially at a temperature of 16.0°C. What is the equilibrium temperature of the water?

A.	28.5°C
B.	35.8°C
C.	14.9°C
D.	71.5°C

Challenge A 4.00×10^{2}-g sample of water at 15.0°C is mixed with 4.00×10^{2} g of water at 85.0°C. After the system reaches thermal equilibrium, 4.00×10^{2} g of methanol at 15°C is added. Assume there is no thermal energy lost to the surroundings. What is the final temperature of the mixture?

A. 61.5°C
B. 35.8°C
C. 57.9°C
D. 71.5°C

MAIN IDEA The hard tile floor of a bathroom always feels cold to bare feet even though the rest of the room is warm. Is the floor colder than the rest of the room?

A. Yes; tile naturally maintains a lower internal temperature than its surroundings.
B. Yes; the smooth surface of the tile reflects heat away, staying cooler.
C. No; the tile is at the same temperature, but it conducts heat away from your feet more efficiently.
D. No; the tile is actually warmer, but the moisture on your feet creates a cooling sensation.

Temperature Make the following conversions:

a. 5°C to kelvins

b. 34 K to degrees Celsius

a.

A. 272K
B. -272K
C. 278K
D. -278K

b.

A. 239°C
B. -239°C
C. 245°C
D. -245°C

Units Are the units the same for heat, (*Q*) and specific heat (*C*)? Explain.

A. Yes; both are forms of energy and are measured in Joules (J).
B. No; heat is measured in Joules (J), while specific heat is measured in Joules per kilogram-kelvin (J/(kg.K)).
C. No; heat is measured in Watts (W) and specific heat is measured in Joules (J).
D. Yes; both use the unit calories per gram (cal/g) in the SI system.

Types of Energy Describe the mechanical energy and the thermal energy of a bouncing basketball.

A. The ball only has mechanical energy, which remains constant throughout the bounce.
B. Thermal energy is converted into kinetic energy every time the ball leaves the ground.
C. The ball has kinetic energy in motion and gravitational potential energy when above the ground; upon impact, some kinetic energy transforms into thermal and sound energy.
D. The ball's thermal energy is independent of the total energy of its internal particles.

Thermal Energy Could the thermal energy of a bowl of hot water equal that of a bowl of cold water? Explain your answer.

A. No; "hot" by definition always means more thermal energy regardless of mass.
B. Yes; thermal energy is the total energy of all molecules, so a larger mass of cold water could equal the energy of a smaller mass of hot water.
C. No; temperature measures the total energy of the system, so the hot bowl is always higher.
D. Yes; if the bowls are identical and contain the same amount of water, their energies are equal.

Cooling On a dinner plate, a baked potato always stays hot longer than any other food. Why?

A. It has a small specific heat and conducts heat very quickly.
B. It has a large specific heat and conducts heat poorly.
C. Its surface area is too large to allow for efficient cooling.
D. It absorbs thermal energy from the plate rather than losing it.

Heat and Food It takes much longer to bake a whole potato than potatoes that have been cut into pieces. Why?

A.	Cutting the potato changes its chemical composition and specific heat.
B.	Whole potatoes have a higher density than sliced potatoes.
C.	Cutting the potato increases the surface area, which increases the rate of thermal energy flow into the food.
D.	Potatoes are excellent conductors of heat, so size does not actually matter.

Cooking Stovetop pans are made from metals such as copper, iron, and aluminum. Why are these materials used?

A.	They are good thermal conductors and have low specific heats.
B.	they are poor conductors that retain heat for a long time.
C.	They have high specific heats, allowing them to stay cool while cooking.
D.	They transform thermal energy into mechanical energy for better cooking.

Specific Heat If you take a plastic spoon out of a cup of hot cocoa and put it in your mouth, you are not likely to burn your tongue. However, you could very easily burn your tongue if you put the hot cocoa in your mouth. Why?

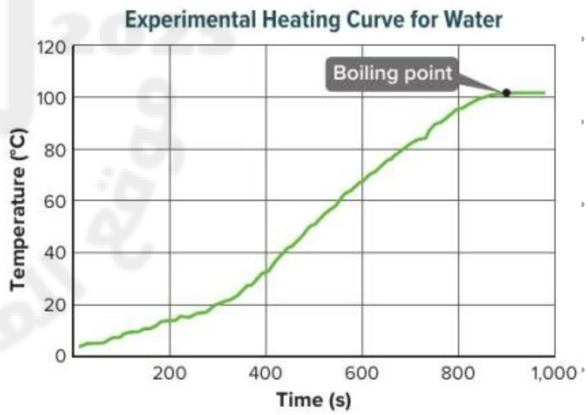
A.	Plastic is a better conductor than liquid cocoa.
B.	The spoon has a lower specific heat than the cocoa, so it does not transmit much thermal energy to your tongue.
C.	Plastic does not contain any thermal energy.
D.	The spoon cools to room temperature instantly upon leaving the cup.

Critical Thinking As water heats in a pot on a stove, it might produce some mist above its surface right before the water begins to roll. What is happening?

A. The water is reaching its maximum density.
B. Molecules are evaporating at the surface and then condensing into liquid water again upon contacting the cold air.
C. The water is releasing trapped oxygen gas.
D. The pot is radiating infrared energy into the air.

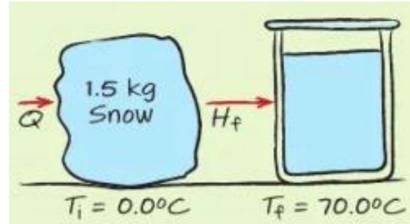
Changes of State and Thermodynamics

why must thermal energy be added at a constant rate to calculate the specific heat of water?



A. To ensure that the water reaches its boiling point as quickly as possible.
B. To maintain a constant volume of water throughout the heating process.
C. To prevent the beaker from cracking due to sudden changes in temperature.
D. To allow time to be used as a direct proxy for the amount of energy (Q) added to the system.

Suppose that you are camping in the mountains. You need to melt 1.50 kg of snow at 0.0 °C and heat it to 70.0 °C to make hot cocoa. How much heat will you need?



A.	8.7×10^2 kJ
B.	9.4×10^2 kJ
C.	7.7×10^2 kJ
D.	6.8×10^2 kJ

How much thermal energy is absorbed by 1.00×10^2 g of ice at –20.0°C to become water at 0.0°C?

A.	3.75×10^4 J
B.	4.45×10^4 J
C.	7.72×10^4 J
D.	3.85×10^4 J

A 2.00×10^{2}-g sample of water at 60.0°C is heated to water vapor at 140.0°C. How much thermal energy is absorbed?

A.	482 kJ
B.	568 kJ
C.	502 kJ
D.	416 kJ

Use the graph in **Figure 15** to calculate the heat of fusion and heat of vaporization of water.

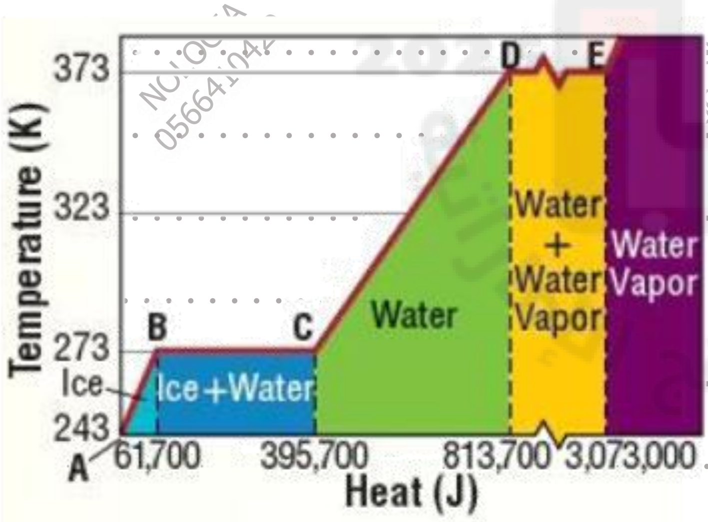


Figure 15

:H_f

A.	334000 J
B.	425000 J
C.	155000 J
D.	410000 J

:H_v

A.	2259000 J
B.	2584000 J
C.	3150000 J
D.	1952000 J

A steel plant operator wishes to change 100 kg of 25°C iron into molten iron (melting point = 1538°C). How much thermal energy must be added?

A.	8.5×10^{7} J
B.	4.5×10^{7} J
C.	7.7×10^{7} J
D.	9.5×10^{7} J

Challenge How much thermal energy is needed to change 3.00×10^{2} g of ice at –30.0°C to water vapor at 130.0°C?

A.	8.70×10^{2} kJ
B.	9.40×10^{2} kJ
C.	7.70×10^{2} kJ
D.	6.80×10^{2} kJ

A gas balloon absorbs 75 J of thermal energy. The balloon expands but stays at the same temperature. How much work did the balloon do in expanding?

A.	0 J
B.	75 J
C.	– 75 J
D.	150

A drill bores a small hole in a 0.40-kg block of aluminum and heats the aluminum by 5.0°C. How much work did the drill do in boring the hole?

A.	1.8×10^3 J
B.	2.8×10^3 J
C.	3.4×10^3 J
D.	4.5×10^3 J

How many times would you have to drop a 0.50-kg bag of lead shot from a height of 1.5 m to heat the shot by 1.0° C?

A.	7 drops
B.	8 drops
C.	9 drops
D.	10 drops

When you stir a cup of tea, you do about 0.050 J of work each time you circle the spoon in the cup. How many times would you have to stir the spoon to heat a 0.15-kg cup of tea by 2.0°C?

A.	3.8×10^4 stirs
B.	2.6×10^4 stirs
C.	4.2×10^4 stirs
D.	5.1×10^4 stirs

Challenge An expansion valve does work on 100 g of water. The system is isolated, and all of the work is used to convert the 90°C water into water vapor at 110°C. How much work does the expansion valve do on the water?

A. 50 kJ
B. 100 kJ
C. 200 kJ
D. 400 kJ

MAIN IDEA Describe the energy transformations and transfers made by a heat engine, and explain why operating a heat engine causes an increase in entropy.

A. All thermal energy is converted into mechanical work, keeping entropy constant.
B. Thermal energy transforms into mechanical work and transfers to a cold reservoir, increasing entropy.
C. Work is converted into thermal energy, which flows from a cold reservoir to a hot reservoir.
D. Thermal energy is destroyed as it moves from a hot reservoir to a cold reservoir.

What occurs to entropy when a heat engine operates between a hot and cold reservoir?

A. Entropy decreases because energy is being organized into mechanical work.
B. Entropy remains constant because energy is conserved.
C. Entropy increases because thermal energy flows from a warmer object to a cooler one.
D. Entropy only increases if the engine's efficiency is below 20%.

what happens to energy in an uncontrolled system, such as a hot pizza cooling in a room?

A. Energy is lost and disappears from the system.
B. Energy spontaneously flows from a cooler object to a warmer one.
C. Energy remains concentrated in the hottest object to maintain stability.
D. Energy spreads out toward a more uniform distribution and increases entropy.

Heat of Vaporization Old heating systems sent water vapor into radiators in each room of a house. In the radiators, the water vapor condensed to water. Analyze this process and explain how it heated a room.

A. The water vapor absorbs thermal energy from the air as it turns into a liquid.
B. The water vapor releases its latent heat of vaporization to the surroundings as it condenses.
C. The radiator uses friction from the circulating water to generate heat for the room.
D. The process of condensation lowers the temperature of the radiator, pulling cold air in.

Heat of Fusion How much thermal energy is needed to change 50.0 g of ice at −20.0°C to water at 10.0°C?

A.	50.20 kJ
B.	10.40 kJ
C.	20.80 kJ
D.	16.70 kJ

Heat of Vaporization How much energy is needed to heat 1.0 kg of mercury metal from 10.0°C to its boiling point (357°C) and vaporize it completely? For mercury, $C = 140$ J/(kg·°C) and $H_v = 3.06\times10^5$ J/kg.

A.	2.5×10^5 J
B.	3.5×10^5 J
C.	2.3×10^5 J
D.	3.6×10^5 J

Mechanical Energy and Thermal Energy A man uses a 320-kg hammer moving at 5.0 m/s to smash a 3.0-kg block of lead against a 450-kg rock. When he measured the temperature of the lead block he found that it had increased by 5.0°C. Explain how this happened.

A. Energy was not conserved because 2.0 kJ of energy disappeared during the impact.
B. All of the hammer's kinetic energy was converted into the internal thermal energy of the lead block.
C. Approximately half of the hammer's kinetic energy was transferred to the lead block, while the rest was transferred to the surroundings or the rock.
D. The lead block gained more energy than the hammer provided due to the large mass of the rock.

Mechanical Energy and Thermal Energy James Joule carefully measured the difference in temperature of water at the top and the bottom of a waterfall. Why did he expect a difference?

A. The water at the top has higher kinetic energy, making it warmer than the water at the bottom.
B. Gravitational potential energy at the top is dissipated into thermal energy when the water splashes at the bottom.
C. The water loses thermal energy to the air as it falls, making the bottom colder.
D. Atmospheric pressure is higher at the bottom, which directly increases the water's temperature.

Mechanical Energy and Thermal Energy For the waterfall in **Figure 23,** calculate the temperature difference between the water at the top and the bottom of the fall. Assume that the potential energy of the water is all converted to thermal energy.

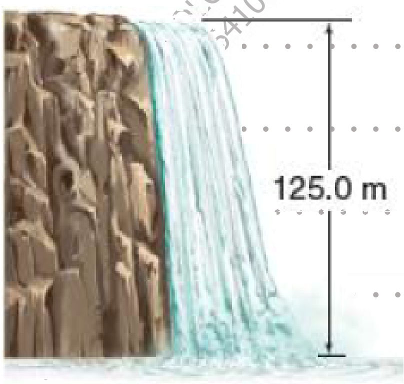


Figure 23

A. 0.239°C
B. 0.293°C
C. -0.239°C
D. -0.293°C

Entropy Evaluate why heating a home with natural gas results in increased entropy.

A.	The natural gas molecules are combined into more complex, ordered structures.
B.	The thermal energy is concentrated into a smaller, more usable area.
C.	Gas molecules break up during combustion, and the resulting thermal energy is distributed in many new, disordered ways.
D.	The process is perfectly reversible, allowing the gas molecules to be readily reassembled.

Critical Thinking Many outdoor amusement parks and zoos have systems that spray a fine mist of water, which evaporates quickly. Explain why this process cools the surrounding air.

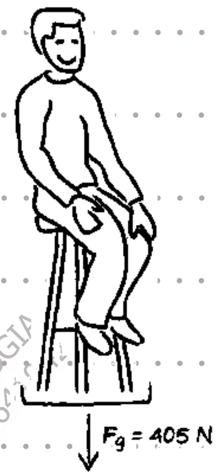
A.	The water mist blocks the sun's rays from reaching the ground.
B.	The water absorbs thermal energy from the air as it evaporates.
C.	Liquid water is naturally colder than the surrounding air.
D.	The mist creates a high-pressure zone that repels heat.

Module 12: States of Matter

MCQ

Properties of Fluids

A child weighs 364 N and sits on a three-legged stool, which weighs 41 N. The bottoms of the stool's legs touch the ground over a total area of 19.3 cm².



a. What is the average pressure that the child and the stool exert on the ground?

A.	3.14×10^2 kPa
B.	4.23×10^2 kPa
C.	1.20×10^2 kPa
D.	2.10×10^2 kPa

b. How does the pressure change when the child leans over so that only two legs of the stool touch the floor?

A.	3.14×10^2 kPa
B.	4.23×10^2 kPa
C.	1.20×10^2 kPa
D.	2.10×10^2 kPa

The atmospheric pressure at sea level is about $1.0 \cdot 10^5$ Pa. What is the force at sea level that air exerts on the top of a desk that is 152 cm long and 76 cm wide?

A.	2.5×10^5 N
B.	1.2×10^5 N
C.	2.3×10^5 N
D.	3.6×10^5 N

A car tire makes contact with the ground on a rectangular area of 12 cm by 18 cm. If the car's mass is 925 kg, what pressure does the car exert on the ground as it rests on all four tires?

A.	3.0×10^2 kPa
B.	4. 3×10^2 kPa
C.	1. 0×10^2 kPa
D.	2. 0×10^2 kPa

A lead brick, 5.0 cm × 10.0 cm × 20.0 cm, rests on the ground on its smallest face. Lead has a density of 11.8 g/cm^3. What pressure does the brick exert on the ground?

A.	23.0 kPa
B.	24. 0 kPa
C.	21. 0 kPa
D.	42. 0 kPa

Suppose that during a storm, the atmospheric pressure suddenly drops by 15 percent outside. What net force would be exerted on a front door to a house that is 195 cm high and 91 cm wide? In what direction would this force be exerted?

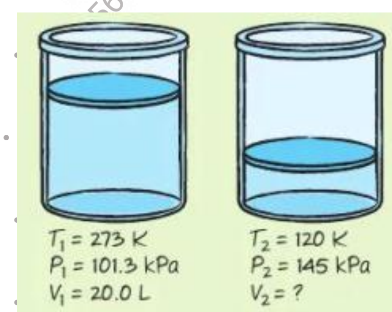
A.	2.7×10^4 N
B.	5.2×10^4 N
C.	1.3×10^4 N
D.	3.6×10^4 N

Challenge Large pieces of industrial equipment are placed on wide steel plates that spread the weight of the equipment over larger areas. If an engineer plans to install a 454-kg device on a floor that is rated to withstand additional pressure of 5.0×10^4 Pa, how large should the steel support plate be?

A. 9.8×10^{-2} m^2
B. 5.2×10^{-2} m^2
C. 8.9×10^{-2} m^2
D. 7.3×10^{-2} m^2

A 20.0–L sample of argon gas at 273 K is at atmospheric pressure (101.3 kPa). The temperature is lowered to 120 K, and the pressure is increased to 145 kPa.

a. What is the new volume of the argon sample?



A. 5.5 L
B. 6.1 L
C. 2.3 L
D. 3.6 L

b. Find the number of moles of argon atoms in the argon sample.

A. 0.983 mol
B. 0.398 mol
C. 0.789 mol
D. 0.893 mol

c. Find the mass of the argon sample. The molar mass (M*M*) of argon is 39.9 g/mol.

A. 55.5 g
B. 35.6 g
C. 25.3 g
D. 65.1 g

A tank of helium gas used to inflate toy balloons is at a pressure of 15.5×10^6 Pa and a temperature of 293 K. The tank's volume is 0.020 m^3. How large a balloon would it fill at 1.00 atmosphere and 323 K?

A.	1.3 m^3
B.	6.8 m^3
C.	3.4 m^3
D.	7.2 m^3

What is the mass of the helium gas in the previous problem? The molar mass of helium gas is 4.00 g/mol.

A.	5.1×10^2 g
B.	3.6×10^2 g
C.	2.3×10^2 g
D.	6.1×10^2 g

A tank containing 200.0 L of hydrogen gas at 0.0°C is kept at 156 kPa. The temperature is raised to 95°C, and the volume is decreased to 175 L. What is the new pressure of the gas?

A.	3.0×10^2 kPa
B.	4.3×10^2 kPa
C.	2.4×10^2 kPa
D.	2.8×10^2 kPa

Challenge The average molar mass of the components of air (mainly diatomic nitrogen gas and diatomic oxygen gas) is about 29 g/mol. What is the volume of 1.0 kg of air at atmospheric pressure and 20.0°C?

A.	1.3 m^3
B.	0.83 m^3
C.	0.43 m^3
D.	2.2 m^3

Compare and contrast liquids, gases, and plasmas.

A. All three have a definite shape but vary in their ability to flow under pressure.
B. They are all fluids that lack a definite shape, but plasma is uniquely composed of charged ions and electrons.
C. Only gases and plasmas follow the combined gas law, while liquids remain unaffected by temperature.
D. Liquids and gases are considered fluids, whereas plasma is a solid-like state that does not flow.

Pressure and Force Two boxes are each suspended by thin strings in midair. One is 20 cm × 20 cm × 20 cm. The other is 20 cm × 20 cm × 40 cm.

a. How does the pressure of the air on the outside of the two boxes compare?

A. The larger box experiences higher air pressure and a greater total force.
B. The air pressure is the same on both, but the larger box experiences four times the total force.
C. Both boxes experience the same air pressure and the same total force because they are at the same altitude.
D. The air pressure is the same on both, but the larger box experiences twice the total force due to having twice the surface area.

b. How does the magnitude of the total force of the air on the two boxes compare?

A. Box B experiences higher air pressure and a greater total force due to its larger volume.
B. Both boxes experience the same air pressure and identical total force because they are in the same environment.
C. The air pressure is the same on both boxes, but Box B experiences twice the total force because it has twice the surface area.
D. Box A experiences higher air pressure because it is smaller, while Box B experiences more total force.

Meteorology A weather balloon used by meteorologists is made of a flexible bag that allows the gas inside to freely expand. If a weather balloon containing 25.0 m^3 of helium gas is released from sea level, what is the volume of gas when the balloon reaches a height of 2100 m, where the pressure is 0.82×10^5 Pa? Assume the temperature is unchanged.

A. $1.3\times10^1\ m^3$
B. $4.8\times10^1\ m^3$
C. $3.1\times10^1\ m^3$
D. $7.2\times10^1\ m^3$

Density and Temperature Starting at 0°C, how will the density of water change as it is heated to 4°C? To 8°C?

A. It decreases steadily from 0°C to 8°C.
B. It increases steadily from 0°C to 8°C.
C. It increases until 4°C, then decreases from 4°C to 8°C.
D. It decreases until 4°C, then increases from 4°C to 8°C.

Gas Compression In a certain internal-combustion engine, 0.0021 m^3 of air at atmospheric pressure and 303 K is rapidly compressed to a pressure of 20.1×10^5 Pa and a volume of 0.0003 m^3. What is the final temperature of the compressed gas?

A.	9×10^2 K
B.	8×10^2 K
C.	6×10^2 K
D.	2×10^2 K

The Standard Molar Volume What is the volume of 1.00 mol of a gas at atmospheric pressure and a temperature of 273 K?

A.	0.0288 m^3
B.	0.0128 m^3
C.	0.0224 m^3
D.	0.0928 m^3

The Air in a Refrigerator How many moles of air are in a refrigerator with a volume of 0.635 m^3 at a temperature of 2.00°C? If the average molar mass of air is 29 g/mol, what is the mass of the air in the refrigerator?

A.	0.81 kg
B.	0.36 kg
C.	0.93 kg
D.	0.66 kg

Critical Thinking Compared to the particles that make up carbon dioxide gas, the particles that make up helium gas are very small. What can you conclude about the number of particles in a 2.0-L sample of carbon dioxide gas compared to the number of particles in a 2.0-L sample of helium gas if both samples are at the same temperature and pressure?

A. The helium sample contains more particles because its atoms are smaller.
B. The carbon dioxide sample contains more particles because its molecules are larger.
C. Both samples contain an equal number of particles.
D. The number of particles depends on the mass of the gases, not the volume.

Forces Within Liquids

How do the adhesive forces between water and glass compare with the cohesive forces between water molecules when water rises in a tube?

A. The cohesive forces are stronger than the adhesive forces.
B. The adhesive forces are stronger than the cohesive forces.
C. The forces are equal, causing the water to remain level.
D. There are no cohesive forces acting between water molecules.

Why does evaporation result in a cooling effect on the remaining liquid?

A. The liquid absorbs cold air from the surrounding environment.
B. Fast-moving particles collide with the surface and create wind.
C. The most energetic particles escape, lowering the average kinetic energy of the remaining liquid.
D. Evaporation increases the pressure on the liquid, which lowers its temperature.

what happens to gas particles during the process of condensation?

A. They gain kinetic energy and move faster.
B. They lose energy, allowing cohesive forces to pull them into a liquid phase.
C. They escape into the surrounding air as humidity.
D. Their temperature increases until they strike a cold surface.

The English language includes the term *adhesive tape* and the phrase *working as a cohesive group*. In these examples, are *adhesive* and *cohesive* being used in the same context as their meanings in physics? Explain your answer.

A. No, because physics terms only apply to subatomic particles, not everyday objects like tape or people.
B. Yes, because "adhesive" refers to sticking to something different (like tape to a surface), and "cohesive" refers to a similar group sticking together (like people in a group).
C. Partially, but "adhesive tape" is actually a cohesive force because the glue is part of the tape itself.
D. No, because "cohesive" in physics only refers to the surface tension of liquids, not the behavior of people.

Surface Tension A paper clip, which has a density greater than that of water, can be made to stay on the surface of water. What procedures must you follow for this to happen? Explain.

A. By dropping it vertically to increase its momentum.
B. By heating the water to increase the surface tension.
C. By placing it carefully and flatly to reduce the weight per unit area.
D. By coating the paper clip in a substance that increases its density.

Floating How can you tell that the paper clip in previous problem was not floating?

A.	Floating objects always remain completely submerged.
B.	If the paper clip breaks the surface, it will sink; a floating object would bob back up.
C.	The paper clip will eventually dissolve if it is floating.
D.	Floating only occurs in liquids with a higher density than metal.

Adhesion and Cohesion In terms of adhesion and cohesion, explain why alcohol clings to the surface of a glass rod but mercury does not.

A.	Mercury is too dense to be affected by adhesive forces.
B.	Alcohol has a stronger adhesive attraction to glass, while mercury's cohesive forces are stronger than its attraction to glass.
C.	Glass is naturally repellent to metallic liquids like mercury.
D.	Alcohol creates a vacuum between itself and the glass surface.

Evaporation and Cooling In the past when a baby had a high fever, the doctor might have suggested gently sponging off the baby with a liquid that evaporates easily. Why would this help?

A.	The liquid is naturally colder than the baby's body temperature, causing a direct transfer of cold.
B.	The liquid acts as an insulator, preventing more heat from entering the baby's body from the environment.
C.	The liquid seeps into the skin and chemically reacts with the blood to lower the internal temperature.
D.	The liquid absorbs heat from the baby's skin to overcome molecular attraction and turn into a gas, creating a cooling effect.

Critical Thinking On a hot, humid day, Beth sat outside with a glass of cold water. The outside of the glass was coated with water. Her friend, Sally, suggested that the water had leaked through the glass from the inside to the outside. Design an experiment for Beth to show Sally where the water came from.

A.	Use a magnifying glass to look for tiny cracks in the glass where water might be escaping.
B.	Wipe the outside of the glass dry and see if the water returns immediately.
C.	Weigh the cold glass before moisture forms, then weigh it again after the "sweat" appears to see if the total mass has increased.
D.	Pour the water into a different type of container, like plastic, to see if the same thing happens.

Solids

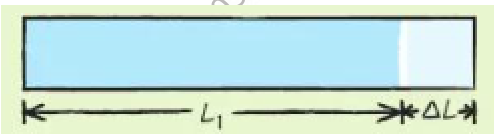
For most substances (excluding water), how do the densities of the solid and liquid states typically compare?

A. The solid state is less dense because the particles spread out to form a crystal lattice.
B. The liquid state is more dense because the particles are moving faster and colliding more often.
C. The densities are exactly the same because the mass of the particles does not change during a phase shift.
D. The solid state is more dense because the particles usually fit more closely together than they do in the liquid state.

Which pair of items correctly identifies a product of malleability and a product of ductility?

A. Aluminum foil (malleability) and Copper wiring (ductility)
B. Steel beams (malleability) and Glass bottles (ductility)
C. Rubber bands (malleability) and Plastic pipes (ductility)
D. Gold coins (malleability) and Ceramic tiles (ductility)

A metal bar is 1.60 m long at room temperature (21°C). The bar is put into an oven and heated to a temperature of 84°C. It is then measured and found to be 1.7 mm longer. What is the coefficient of linear expansion of this material?



A.	1.7×10^{-5} °C^{-1}
B.	1.2×10^{-5} °C^{-1}
C.	2.4×10^{-5} °C^{-1}
D.	3.1×10^{-5} °C^{-1}

A piece of aluminum house siding is 3.66 m long on a cold winter day of –28°C. How much longer is it on the hot summer day shown in **Figure 22**?

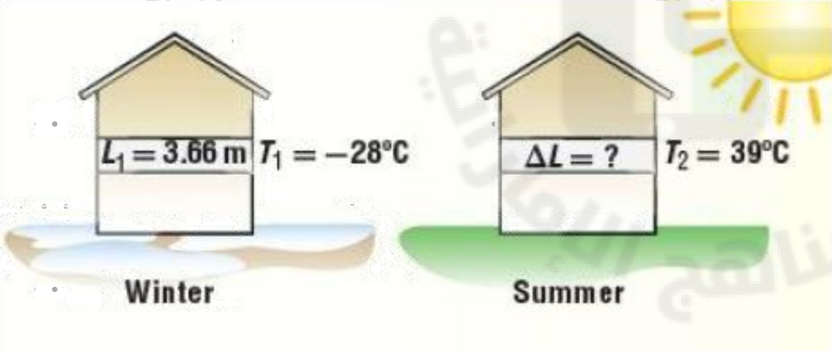


Figure 22

A.	6.8 mm
B.	2.6 mm
C.	6.1 mm
D.	5.8 mm

A piece of steel is 11.5 cm long at 22°C. It is heated to 1221°C, close to its melting temperature. How long is it?

A.	12 cm
B.	9 cm
C.	6 cm
D.	3 cm

A 400-mL glass beaker at room temperature is filled to the brim with cold water at 4.4°C. When the water warms up to 30.0°C, how much water will spill from the beaker?

A.	8 mL
B.	4 mL
C.	1 mL
D.	2 mL

A tank truck takes on a load of 45,725 L of gasoline in Houston, where the temperature is 28.0°C. The truck delivers its load in Minneapolis, where the temperature is −12.0°C.

a. How many liters of gasoline does the truck deliver?
b. What happened to the gasoline?

:a

A.	8.8×10^4 L
B.	4.4×10^4 L
C.	1.6×10^4 L
D.	2.5×10^4 L

:b

A.	The volume increased and the mass decreased due to the cold.
B.	Both the volume and the mass decreased as the temperature dropped.
C.	The volume decreased because of the temperature drop, but the mass remained the same.
D.	The volume remained the same, but the mass increased due to higher density.

A hole with a diameter of 0.85 cm is drilled into a steel plate. At 30.0°C, the hole exactly accommodates an aluminum rod of the same diameter. What is the spacing between the plate and the rod when they are cooled to 0.0°C?

A.	4.1 cm
B.	3.3 cm
C.	1.7 cm
D.	0.7 cm

Challenge A steel ruler is marked in millimeters so that the ruler is absolutely correct at 30.0°C. By what percentage would the ruler be incorrect at −30.0°C?

A.-0.072%
B.0.072%
C.2. 2%
D.-2. 2%

On a hot day, you are installing an aluminum screen door in a concrete door frame. You want the door to fit well on a cold winter day. Should you make the door fit tightly in the frame or leave extra room?

A.Leave extra room in the frame.
B.Fit the door tightly in the frame.
C.Ensure there is a large gap at the bottom.
D.The fit does not matter as materials don't change size.

Types of Solids What is the difference between the structure of candle wax and that of ice?

A. Candle wax is a crystalline solid, while ice is an amorphous solid.
B. Candle wax is an amorphous solid, while ice is a crystalline solid.
C. Both are crystalline solids, but they have different melting points.
D. Both are amorphous solids with disordered molecular patterns.

Thermal Expansion Can you heat a piece of copper enough to double its length?

A. Yes, copper is highly ductile and will double in length at approximately 1,085°C.
B. Yes, but only if the copper is heated in a vacuum to prevent oxidation.
C. No, the required temperature change ($\Delta T \approx 63{,}000°C$) would vaporize the copper before it could double in length.
D. No, because the thermal expansion coefficient of copper is zero at high temperatures.

States of Matter Does **Table 2** provide a way to distinguish between solids and liquids?

Table 2 Coefficients of Thermal Expansion at 20°C

Material	Coefficient of Linear Expansion, α (°C^{-1})	Coefficient of Volume Expansion, β (°C^{-1})
Solids		
Aluminum	23×10^{-6}	69×10^{-6}
Glass (soft)	9×10^{-6}	27×10^{-6}
Glass (ovenproof)	3×10^{-6}	9×10^{-6}
Concrete	12×10^{-6}	36×10^{-6}
Copper	17×10^{-6}	51×10^{-6}
Liquids		
Methanol	Not Applicable	1200×10^{-6}
Gasoline	Not Applicable	950×10^{-6}
Water	Not Applicable	210×10^{-6}

A.	Liquids have a coefficient of linear expansion, while solids do not.
B.	Solids have much higher coefficients of volume expansion than liquids.
C.	The coefficients of volume expansio are significantly greater for liquids than for solids.
D.	Liquids do not experience volume expansion at 20°C.

Solids and Liquids A solid can be defined as a material that can be bent and will resist bending. Explain how these properties relate to the binding of atoms in a solid but do not apply to a liquid.

A. Particles in a liquid are more tightly bound and closer together than in a solid.
B. Solids have particles that flow past one another, preventing them from resisting force.
C. Particles in a solid are tightly bound in fixed positions, allowing them to resist bending, whereas liquid particles flow freely past each other.
D. Liquids possess a fixed position for their particles, which allows them to maintain a specific shape.

Critical Thinking The iron ring in **Figure 23** was made by cutting a small piece from a solid ring. If the ring in the figure is heated, will the gap become wider or narrower? Explain your answer.

Figure 23

A. The gap will become narrower because the metal expands inward.
B. The gap will become wider because all measurements of the ring increase when heated.
C. The gap will remain the same size while the thickness of the ring increases.
D. The gap will close completely as the two ends of the ring expand toward each other.

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