



PHYSICS

BOOKS - PRINCETON PHYSICS (ENGLISH)

HEAT AND THERMODYNAMICS

Example

1. Room temperature is $20^{\circ}C$. What is this temperature in Kelvins?



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2. Gold has a specific heat of $130 \text{ J/kg} \cdot ^\circ \text{C}$ and wood has a specific heat of $1,800 \text{ J/kg} \cdot ^\circ \text{C}$. If a piece of gold and a piece of wood, each of mass 0.1 kg , both absorb 2.340 J of heat, by how much will their temperatures rise?



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3. The heat of fusion for water is 334 kJ/kg .
how much thermal energy is required to
completely melt a 100-gram ice cube?



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4. A beaker contains 0.1 kg of water, initially at
room temperature (20°C). If the specific heat
of water is $4.2 \text{ kJ/kg} \cdot ^\circ \text{C}$ and the latent heat
of vaporization is $2,300 \text{ kJ/kg}$, how much

thermal energy would the water need to absorb to turn completely to steam?



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5. A steel beam used in the construction of a bridge has a length of 30.0 m when the temperature is $15^{\circ}C$. On a very hot day, when the temperature is $35^{\circ}C$, what will the beam's change in length be? (The coefficient of linear expansion for structural steel is $+1.2 \times 10^{-5} / ^{\circ}C$.)



6. The mercury in a household glass-tube thermometer has a volume of 500mm^3 ($= 5.0 \times 10^{-7}\text{m}^3$) at $T = 19^\circ\text{C}$.

The hollow column within which the mercury can rise or fall has a cross-sectional area of 0.1mm^2 ($= 1.0 \times 10^{-7}\text{m}^2$). Ignoring the volume expansion of the glass, how much will the mercury rise in the thermometer when its temperature is 39°C ? (The coefficient of

volume expansion of mercury is

$$1.8 \times 10^{-4} / ^\circ C.)$$



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7. What happens to the rms speed of the molecules in a sample of helium gas if the temperature is increased from $-73^\circ C$ to $527^\circ C$?



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8. What happens to the pressure of a sample of helium gas if the temperature is increased from 200 K to 800 K, with no change in volume?



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9. What happens to the pressure of a sample of helium gas if the volume is reduced from 6 liters to 3 liters, with no change in temperature?





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10. What's the value of W for the process ab following path 1 (a to b) and for the same process following path 2 (a to d, d to b), shown in the P-V diagram below?



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11. 

Q. Find the work done by the system for the

path abda.



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12. 

Q. Find the heat absorbed by the system along this same path.



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13. A heat engine draws, 800 J of heat from its high temperature source and discards 600 J of

exhaust heat into its cold-temperature reservoir each cycle. How much work does this engine perform per cycle, and what is its thermal efficiency?



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Comprehensive Drill

1. How much heat is required to raise the temperature of a 0.04 kg stainless steel spoon

from $20^{\circ}C$ to $50^{\circ}C$ if the specific heat of stainless steel is $0.50kJ/kg \cdot ^{\circ}C$?

A. 200J

B. 400J

C. 600J

D. 800J

Answer: C



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2. The melting point of copper is $1,080^{\circ}C$ and its heat of fusion is 200kJ/kg . If a copper coin at this temperature is completely melted by the absorption of $2,000\text{ J}$ of heat, what is the mass of the coin?

A. $\frac{1}{1,080\text{kg}}$

B. $\frac{1}{540\text{kg}}$

C. $\frac{1}{108\text{kg}}$

D. $\frac{1}{100\text{kg}}$

Answer: D



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3. Water has the specific heat $4,186\text{kJ/kg} \cdot ^\circ\text{C}$, a boiling point of 100°C , and a heat of vaporisation of $2,260\text{kJ/kg}$. a sealed beaker contains 100g of water that's initially at 20°C . If the water absorbs 100 kJ of heat, what will its final temperature be?

A. 100°C

B. 119°C

C. 143°C

D. $183^{\circ}C$

Answer: A



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4. On a cold winter day ($5^{\circ}C$), the foundation block or a statue is filled with $2.0m^3$ of concrete. By how much will the concrete's volume increase on a very warm summer day (35°) if its coefficient of volume expansion is $4.0 \times 10^{-5} / ^{\circ}C$?

A. 160cm^3

B. $1,200\text{cm}^3$

C. $1,600\text{cm}^3$

D. $2,400\text{cm}^3$

Answer: D



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5. An ideal gas is confined to a container whose volume is fixed. If the container holds n moles of gas, by what factor will the pressure

increase if the absolute temperature is increased by a factor of 2?

A. $\frac{2}{(nR)}$

B. 2

C. $2nR$

D. $\frac{2}{n}$

Answer: B



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6. Two large glass containers of equal volume each hold 1 mole of gas. Container 1 is filled with hydrogen gas (2g/mol), and container 2 holds helium (4g/mol). If the pressure of the gas in container 1 equals the pressure of the gas in container 2, which of the following is true?

A. The temperature of the gas in container 1 is lower than the temperature of the gas in container 2.

B. The temperature of the gas in container 1 is greater than the temperature of the gas in container 2.

C. The value of R for the gas in container 1 is $\frac{1}{2}$ the value of R for the gas in container 2.

D. The rms speed of the gas molecules in container 1 is greater than the rms speed of the gas molecules in container 2.

Answer: D



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7. Through a series of thermodynamic processes, the internal energy of a sample of confined gas is increased by 560 J. if the net amount of work done on the sample by its surroundings is 320 J, how much heat was transferred between the gas and its environment?

A. 240 J absorbed

B. 240J dissipated

C. 880 J absorbed

D. 880 J dissipated

Answer: A



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8. What's the total work performed on the gas as it's transformed from state a to state c,

along the path indicated?



A. 1,500 J

B. 3,000J

C. 4,500 J

D. 5,000J

Answer: C



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9. During each cycle, a heat engine absorbs 400J of heat from its high-temperature source and discards 300J of heat into its low-temperature sink. What is the efficiency of this engine?

A. $\frac{1}{7}$

B. $\frac{1}{4}$

C. $\frac{3}{7}$

D. $\frac{4}{7}$

Answer: B



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10. Of the following, which is the best description of the second law of thermodynamics?

A. The total energy of the universe is a constant.

B. The efficiency of a heat engine can never be greater than 50 percent.

C. The amount of heat required to vaporise a liquid is greater than the amount of heat required to melt a solid of the same substance.

D. The entropy of the universe is always increasing.

Answer: D



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