Linear Expansion-1

Sunday, 17 October, 2021 21:10

Lecturer: Mustafa Al-Zyout, Philadelphia University, Jordan.

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The roadbed of the Golden gate bridge is $1280m$ long. During a certain year the temperature varies from $-12\,℃$ to $38\,℃$. What is the difference In the lengths at girders? ($\alpha_{steel} = 1.27 \times 10^{-5}\ \mathrm{K}^{-1}$)

Linear Expansion-2

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A steel rod has a length $L = 8m$ and radius $r = 1.5\,cm$ when the temperature is $20\,℃$. Take $(\alpha_{steel} = 11 \times 10^{-6}\,\mathrm{K}^{-1})$ and Young's modulus of the rod to be $(Y = 2 \times 10^{11}\ N/m^2)$.

- What is its length on a hot day when the temperature is $50\,℃$?
- If the rod's ends were originally fixed, then find the compression force on the rod?

Linear Expansion-3

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- A segment of steel railroad track has a length of $30\ m$ when the temperature is $0\ ℃$. What is its length when the temperature is $40\ ℃$?
- Suppose the ends of the rail are rigidly clamped at $0\ ℃$ so that expansion is prevented. What is the thermal stress set up in the rail if its temperature is raised to $40\ ℃$?

Area Expansion-1

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A circular steel disk ($\alpha_{steel} = 1.27 \times 10^{-5}\mathrm{K}^{-1}$) has a circular hole through its center. If the disk is heated from $10\,℃$ to $100\,℃$, what is the fractional increase in the area of the hole ($\Delta A/A$)?

Volume Expansion-1

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On a hot day, an oil trucker loaded $37000\ L$ of diesel fuel from an oil station. He encountered cold weather on the way to delivery city, where the temperature was $23\ \mathrm{K}$ lower than in the station. How many liters did he deliver? The coefficient of volume expansion for diesel fuel is $(9.5 \times 10^{-4}\ \mathrm{K}^{-1})$ and the coefficient of linear expansion for his steel truck tank is $(11 \times 10^{-6}\ \mathrm{K}^{-1})$

Volume Expansion-2

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- A spray can containing a propellant gas at twice atmospheric pressure $(202\ kPa)$ and having a volume of $125\ cm^3$ is at $22\ ℃$. It is then tossed into an open fire. When the temperature of the gas in the can reaches $195\ ℃$. What is the pressure inside the can? Assume any change in the volume of the can is negligible.
- Suppose we include a volume change due to thermal expansion of the steel can as the temperature increases. Does that alter our answer for the final pressure significantly?

Heat Capacity and Specific Heat-1

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A $0.05\,kg$ ingot of metal is heated to $200\,℃$ and then dropped into a calorimeter containing $0.4\,kg$ of water initially at $20\,℃$. The final equilibrium temperature of the mixed system is $22.4\,℃$. Find the specific heat of the metal.

Heat Capacity and Specific Heat-2

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There are $0.1\ kg$ of carbon in a calorimeter at $15\ ℃$. The container has mass $0.02\ kg$ and is made of aluminum. The addition of $0.892\ kJ$ of heat energy brings that temperature to $28\ ℃$. What is the specific heat capacity of carbon? Assume the specific heat capacity of aluminum in this temperature range is $0.9\ kJ/kg.\mathrm{K}$.

Heat Capacity and Specific Heat-3

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A copper pipe of mass $0.5\,kg$ is originally at $20\,℃$. If its ends are capped after $0.6\,kg$ of water at $98\,℃$ is poured into it, what is the final temperature of the pipe? (Assume the pipe is insulated so no heat is lost to the surroundings).

Heat Capacity and Specific Heat-4

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A cowboy fires a silver bullet with a muzzle speed of $200\ m/s$ into the pine wall of a saloon. Assume all the internal energy generated by the impact remains with the bullet. What is the temperature change of the bullet?

Latent Heat and Phase Changes-1

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How much energy is required to convert a $1.0\ g$ cube of ice at $-30\ ℃$ to steam at $120\ ℃$.

Latent Heat and Phase Changes-2

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A $0.6\,kg$ pitcher of tea at $50\,℃$ is cooled with $0.4\,kg$ of ice cubes at $0\,℃$. What is the equilibrium condition if no heat is lost to the surroundings?

Latent Heat and Phase Changes-3

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- How much heat is required to melt $5\,kg$ of ice at $0\,℃$?
- If $20\,kg$ of water at $95\,℃$ is mixed with $5\,kg$ of ice at $0\,℃$, what is the final temperature of the mixture?

Latent Heat and Phase Changes-4

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If we supply a $720\ g$ of ice at $-10\ ℃$ with a total energy of only $210\ kJ$ (as heat), what are the final state and temperature of the water?

Latent Heat and Phase Changes-5

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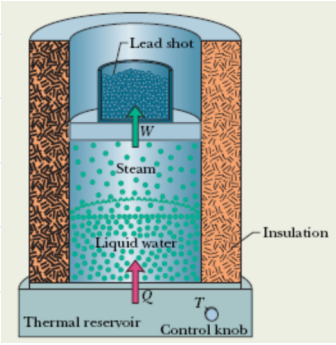
Let $1.0\ kg$ of liquid water at $100\ ℃$ be converted to steam at $100\ ℃$ by boiling at standard atmospheric pressure (which is $1.00\ atm$ or $101\ kPa$) in the arrangement of the figure shown. The volume of that water changes from an initial value of $1 \times 10^{-3}\ m^3$ as a liquid to $1.671\ m^3$ as steam.

- How much work is done by the system during this process?
- How much energy is transferred as heat during the process?
- What is the change in the system's internal energy during the process?



Latent Heat and Phase Changes-6

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What mass of steam initially at $130\,℃$ is needed to warm $200\,g$ of water in a $100\,g$ glass container from $20\,℃$ to $50\,℃$?