Thermodynamics
Kraemer 11/4
Key

Answer Sheet:

Multiple Choice:

1. _C___
2. _C___
3. _D___
4. _D___
5. _C___
6. _C___
7. _D___
8. _D___
9. _B___
10. _D___
11. _C___
12. _A___
13. _A__
14. _A__
15. _A___
16. __B__

Key

17-18.

What is the average kinetic energy of a gas molecule at 20.0 C (room temperature)?

The known in the equation for the average kinetic energy is the temperature.

(13.57) Before substituting values into this equation, we must convert the given temperature to kelvins. This conversion gives

$\overline{KE} = \frac{1}{2}m\overline{v^2} = \frac{3}{2}kT$ The temperature alone is sufficient to find the average translational kinetic energy. Substituting the temperature into the

$T = (20.0 + 273)\text{ K} = 293\text{ K}.$

Solution for (a)

translational kinetic energy equation gives

$\overline{KE} = \frac{3}{2}kT = \frac{3}{2}\left(1.38\times10^{-23}\text{ J/K}\right)(293\text{ K}) = \mathbf{6.07\times10^{-21}\text{ J}}.$

19-20. **"Room temperature" is generally defined to be 25 degrees C . (a) What is room temperature in F ? (b) What is it in K?**

1. Choose the right equation. To convert from oC to oF , use the equation $T_{oF} = \frac{9}{5}T_{oC} + 32.$ (13.1)

2. Plug the known value into the equation and solve:

$T_{oF} = \frac{9}{5}25\text{C} + 32 = \mathbf{77F.}$

Solution for (b)

1. Choose the right equation. To convert from oC to K, use the equation $T_K = T_{oC} + 273.15.$

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2. Plug the known value into the equation and solve:

$T_K = 25C + 273.15 =$ **298 K.**

21-23.

A 0.500 kg aluminum pan on a stove is used to heat 0.250 liters of water from 20.0 degrees C to 80.0 degrees C . (a) How much heat is required?

1.Calculate the temperature difference: $\Delta T = T_f - T_i = 60.0$oC. (14.3)

2.Calculate the mass of water. Because the density of water is 1000 kg/m^3 , one liter of water has a mass of 1 kg, and

the mass of 0.250 liters of water is $m_w = 0.250$ kg .

3.Calculate the heat transferred to the water. Use the specific heat of water in Table 14.1: $Q_w = m_w c_w \Delta T = (0.250 \text{ kg})(4186 \text{ J/kgoC})(60.0\text{oC}) = 62.8$ kJ.

4.Calculate the heat transferred to the aluminum. Use the specific heat for aluminum in Table 14.1: $Q_{Al} = m_{Al} c_{Al} \Delta T = (0.500 \text{ kg})(900 \text{ J/kgoC})(60.0\text{oC}) = 27.0 \times 10^{3}$ = 27kJ

=62.8+27.0 =89.8 kJ

24-25.

(a) Suppose there is heat transfer of 40.00 J to a system, while the system does 10.00 J of work. Later, there is heat transfer of 25.00 J out of the system while 4.00 J of work is done on the system. What is the net change in internal energy of the system?

(b) What is the change in internal energy of a system when a total of 150.00 J of heat transfer occurs out of (from) the system and 159.00 J of work is done on the system?

Key

Solution for (a)

The net heat transfer is the heat transfer into the system minus the heat transfer out of the system, or

$Q = 40.00\ \text{J} - 25.00\ \text{J} = 15.00\ \text{J}$.

Similarly, the total work is the work done by the system minus the work done on the system, or

$W = 10.00\ \text{J} - 4.00\ \text{J} = 6.00\ \text{J}$. Thus the change in internal energy is given by the first law of thermodynamics:

$\Delta U = Q - W = 15.00\ \text{J} - 6.00\ \text{J} = 9.00\ \text{J}$. We can also find the change in internal energy for each of the two steps. First, consider 40.00 J of heat transfer in and 10.00

J of work out, orNow consider 25.00 J of heat transfer out and 4.00 J of work in, or

$\Delta U_1 = Q_1 - W_1 = 40.00\ \text{J} - 10.00\ \text{J} = 30.00\ \text{J}$. $\Delta U_2 = Q_2 - W_2 = -25.00\ \text{J} - (-4.00\ \text{J}) = -21.00\ \text{J}$.

The total change is the sum of these two steps, or

$\Delta U = \Delta U_1 + \Delta U_2 = 30.00\ \text{J} + (-21.00\ \text{J}) = \mathbf{9.00\ J.}$

Discussion on (a)

No matter whether you look at the overall process or break it into steps, the change in internal energy is the same.

Solution for (b)

Here the net heat transfer and total work are given directly to be $Q = -150.00\ \text{J}$ and $W = -159.00\ \text{J}$, so that $\Delta U = Q - W = -150.00\ \text{J} - (-159.00\ \text{J}) = \mathbf{9.00\ J.}$

Key