Find the rms speed in air at 2.50°C and 1.00 atm of the Cl₂ molecules.

\[ \text{(in m/s)} \]

\[ 6A \bigcirc 2.15 \times 10^2 \quad B \bigcirc 3.11 \times 10^2 \quad C \bigcirc 4.51 \times 10^2 \]

\[ D \bigcirc 6.55 \times 10^2 \quad E \bigcirc 9.49 \times 10^2 \]

Find the rms speed in air at 2.50°C and 1.00 atm of the NO₂ molecules.

\[ \text{(in m/s)} \]

\[ 7A \bigcirc 8.74 \times 10^1 \quad B \bigcirc 1.27 \times 10^2 \quad C \bigcirc 1.84 \times 10^2 \]

\[ D \bigcirc 2.67 \times 10^2 \quad E \bigcirc 3.87 \times 10^2 \]

What is the total translational kinetic energy of the gas molecules of 0.420 mol of air at atmospheric pressure that occupies a volume of 3.80 L (0.00380 m³)?

\[ \text{(in J)} \]

\[ 8A \bigcirc 5.11 \times 10^2 \quad B \bigcirc 5.77 \times 10^2 \quad C \bigcirc 6.52 \times 10^2 \]

\[ D \bigcirc 7.37 \times 10^2 \quad E \bigcirc 8.33 \times 10^2 \]

During basketball practice Shane made a jump shot, releasing a 0.690-kg basketball from his hands at a height of 1.81 m above the floor with a speed of 7.18 m/s. The ball swooshes through the net at a height of 3.00 m above the floor and with a speed of 4.64 m/s. How much energy was dissipated by air drag from the time the ball left Shane’s hands until it went through the net?

\[ \text{(in J)} \]

\[ 9A \bigcirc 1.48 \quad B \bigcirc 1.85 \quad C \bigcirc 2.31 \quad D \bigcirc 2.89 \]

\[ E \bigcirc 3.61 \]
1 pt If 4.70 g of steam at 100.0°C condenses to water on a burn victim’s skin and cools to 43.4°C, how much heat is given up by the steam?

\[(\text{in J})\]

\[10. \text{A} \quad 1.17 \times 10^4 \quad \text{B} \quad 1.56 \times 10^4 \quad \text{C} \quad 2.07 \times 10^4\]
\[\text{D} \quad 2.76 \times 10^4 \quad \text{E} \quad 3.67 \times 10^4\]

1 pt If the skin was originally at 37.5°C, how much tissue mass was involved in cooling the steam to water? The specific heat of human tissue is 3.50 kJ/(kg°C).

\[(\text{in g})\]

\[11. \text{A} \quad 1.81 \times 10^2 \quad \text{B} \quad 2.41 \times 10^2 \quad \text{C} \quad 3.21 \times 10^2\]
\[\text{D} \quad 4.27 \times 10^2 \quad \text{E} \quad 5.67 \times 10^2\]

1 pt Many species cool themselves by sweating, because as the sweat evaporates, heat is given up to the surroundings. A human exercising strenuously has an evaporative heat loss rate of about 664 W. If a person exercises strenuously for 47.0 min, how much water must he drink to replenish his fluid loss? The heat of vaporization of water is 2430 J/g at normal skin temperature.

\[(\text{in g})\]

\[12. \text{A} \quad 5.79 \times 10^2 \quad \text{B} \quad 7.71 \times 10^2 \quad \text{C} \quad 1.92 \times 10^3\]
\[\text{D} \quad 1.36 \times 10^3 \quad \text{E} \quad 1.81 \times 10^3\]

1 pt On a very hot summer day Daphne is off to the park for a picnic. She puts 0.120 kg of ice at 0°C in a thermos and then adds a grape-flavored drink, which she has mixed from a powder, using room temperature water (22.5°C). How much grape flavored drink will just melt all the ice?

\[(\text{in kg})\]

\[13. \text{A} \quad 2.61 \times 10^{-1} \quad \text{B} \quad 2.95 \times 10^{-1} \quad \text{C} \quad 3.33 \times 10^{-1}\]
\[\text{D} \quad 3.76 \times 10^{-1} \quad \text{E} \quad 4.25 \times 10^{-1}\]

1 pt You are given 231 g of coffee (same specific heat as water) at 83.8°C (too hot to drink). In order to cool this to 60.0°C, how much ice (at 0.0°C) must be added? Neglect heat content of the cup and heat exchanges with the surroundings.

\[(\text{in kg})\]

\[14. \text{A} \quad 3.08 \times 10^{-2} \quad \text{B} \quad 3.48 \times 10^{-2} \quad \text{C} \quad 3.93 \times 10^{-2}\]
\[\text{D} \quad 4.45 \times 10^{-2} \quad \text{E} \quad 5.02 \times 10^{-2}\]

1 pt A dog loses a lot of heat through panting. The air rushing over the upper respiratory tract causes evaporation and thus heat loss. A dog typically pants at a rate of 662 pants per minute. As a rough calculation, assume that one pant causes 0.0167 g of water to be evaporated from the respiratory tract. What is the rate of heat loss for the dog through panting?

\[(\text{in W})\]

\[15. \text{A} \quad 2.66 \times 10^2 \quad \text{B} \quad 3.33 \times 10^2 \quad \text{C} \quad 4.16 \times 10^2\]
\[\text{D} \quad 5.20 \times 10^2 \quad \text{E} \quad 6.50 \times 10^2\]

1 pt A lizard of mass 2.93 g is warming itself in the bright sunlight. It casts a shadow of 1.67 cm² on a piece of paper held perpendicularly to the Sun’s rays. The intensity of sunlight at the Earth is 1.40 \times 10^3 W/m² but only half of this energy penetrates the atmosphere and is absorbed by the lizard. If the lizard has a specific heat of 4.20 J/(g°C), what is the rate of increase of the lizard’s temperature? Do not enter unit (°C/s).

\[16. \text{A} \quad 5.83 \times 10^{-3} \quad \text{B} \quad 6.58 \times 10^{-3} \quad \text{C} \quad 7.44 \times 10^{-3}\]
\[\text{D} \quad 8.41 \times 10^{-3} \quad \text{E} \quad 9.50 \times 10^{-3}\]
1 pt Assuming that there is no heat loss by the lizard (to simplify), how long must the lizard lie in the Sun in order to raise its temperature by 3.25°C?

\[ \text{(in s)} \]

18. A \( 2.68 \times 10^2 \)  B \( 3.03 \times 10^2 \)  C \( 3.42 \times 10^2 \)  D \( 3.87 \times 10^2 \)  E \( 4.37 \times 10^2 \)

1 pt The inner vessel of a calorimeter contains 44.8 g of ammonia, \( \text{NH}_3 \), at 40.0°C. The vessel is surrounded by 2.00 kg of water at 18.02°C. After a time, the \( \text{NH}_3 \) and the water reach the equilibrium temperature of 18.56°C. What is the specific heat of \( \text{NH}_3 \)? Do not enter unit (kJ/(kg°C)).

\[ \text{(in J)} \]

19. A \( 3.76 \)  B \( 4.70 \)  C \( 5.88 \)  D \( 7.34 \)  E \( 9.18 \)

1 pt The United States generates about \( 5.35 \times 10^{16} \) J of electric energy a day. This energy is equivalent to work, since it can be converted into work with almost 100% efficiency by an electric motor. If this energy is generated by power plants with an average efficiency of 0.302, how much heat is dumped into the environment each day?

\[ \text{(in J)} \]

20. A \( 1.24 \times 10^{17} \)  B \( 1.79 \times 10^{17} \)  C \( 2.60 \times 10^{17} \)  D \( 3.77 \times 10^{17} \)  E \( 5.47 \times 10^{17} \)

1 pt How much water would be required to absorb this heat if the water temperature is not to increase more than 2.09°C?

\[ \text{(in kg)} \]

21. A \( 1.13 \times 10^{13} \)  B \( 1.41 \times 10^{13} \)  C \( 1.77 \times 10^{13} \)  D \( 2.21 \times 10^{13} \)  E \( 2.76 \times 10^{13} \)

1 pt Suppose 1.87 mol of oxygen is heated at constant pressure of 1.00 atm from 13.1°C to 23.3°C. How much heat is absorbed by the gas?

\[ \text{(in J)} \]

22. A \( 5.55 \times 10^2 \)  B \( 6.94 \times 10^2 \)  C \( 8.67 \times 10^2 \)  D \( 1.08 \times 10^3 \)  E \( 1.36 \times 10^3 \)

1 pt Using the ideal gas law, calculate the change of volume of the gas in this process.

\[ \text{(in dm}^3 \text{)} \]

23. A \( 7.45 \times 10^{-1} \)  B \( 1.08 \)  C \( 1.57 \)  D \( 2.27 \)  E \( 3.29 \)

1 pt What is the work done by the gas during this expansion?

\[ \text{(in J)} \]

24. A \( 6.74 \times 10^1 \)  B \( 8.96 \times 10^1 \)  C \( 1.19 \times 10^2 \)  D \( 1.59 \times 10^2 \)  E \( 2.11 \times 10^2 \)

1 pt From the first law, calculate the change of internal energy of the gas in this process.

\[ \text{(in J)} \]

25. A \( 3.51 \times 10^2 \)  B \( 3.96 \times 10^2 \)  C \( 4.48 \times 10^2 \)  D \( 5.06 \times 10^2 \)  E \( 5.72 \times 10^2 \)

1 pt Calculate the efficiency of a reversible engine that operates between the temperatures 603°C and 325°C.

\[ \text{26. A} \]

\( 1.62 \times 10^{-1} \)  B \( 2.03 \times 10^{-1} \)  C \( 2.54 \times 10^{-1} \)  D \( 3.17 \times 10^{-1} \)  E \( 3.97 \times 10^{-1} \)
1 pt If the engine absorbs 450 kJ of heat from the hot reservoir, how much does it exhaust to the cold reservoir? (in kJ)

27 A $3.07 \times 10^2$ B $3.47 \times 10^2$ C $3.92 \times 10^2$
D $4.43 \times 10^2$ E $5.01 \times 10^2$

1 pt
In a certain steam engine, the boiler temperature is 110°C and the cold reservoir temperature is 25.0°C. While this engine does 8.34 kJ of work, what minimum amount of heat must be discharged into the cold reservoir? (in kJ)

28 A $1.65 \times 10^1$ B $2.20 \times 10^1$ C $2.93 \times 10^1$
D $3.89 \times 10^1$ E $5.17 \times 10^1$

1 pt
An oil-burning electric power plant uses steam at 830 K to drive a turbine, after which the steam is expelled at 422 K. The engine has an efficiency of 0.423. What is the theoretical maximum efficiency possible at those temperatures?

29 A $2.78 \times 10^{-1}$ B $3.70 \times 10^{-1}$ C $4.92 \times 10^{-1}$
D $6.54 \times 10^{-1}$ E $8.70 \times 10^{-1}$

1 pt
A reversible refrigerator has a coefficient of performance of 3.04. How much work must be done to freeze 1.05 kg of liquid water initially at 0°C?

30 A $7.95 \times 10^1$ B $1.15 \times 10^2$ C $1.67 \times 10^2$
D $2.42 \times 10^2$ E $3.51 \times 10^2$

1 pt The efficiency of a muscle during weight lifting is equal to the work done in lifting the weight divided by the total energy output of the muscle (work done plus internal energy dissipated in the muscle). Determine the efficiency of a muscle that lifts a 154-N weight through a vertical displacement of 0.571 m and dissipates 140 J in the process. Give answer in %. Do not enter unit.

31 A $3.86 \times 10^1$ B $4.51 \times 10^1$ C $5.28 \times 10^1$
D $6.18 \times 10^1$ E $7.23 \times 10^1$

1 pt A heat engine uses the warm air at the ground as the hot reservoir and the cooler air at an altitude of several thousand meters as the cold reservoir. If the warm air is at 35.5°C and the cold air is at 25.7°C, what is the maximum possible efficiency for the engine?

32 A $2.20 \times 10^{-2}$ B $2.49 \times 10^{-2}$ C $2.81 \times 10^{-2}$
D $3.18 \times 10^{-2}$ E $3.59 \times 10^{-2}$

1 pt
An ideal refrigerator removes heat at a rate of 0.161 kW from its interior (+2.46°C) and exhausts heat at 41.4°C. How much electrical power is used?

33 A $1.16 \times 10^1$ B $1.46 \times 10^1$ C $1.82 \times 10^1$
D $2.27 \times 10^1$ E $2.84 \times 10^1$