Thermodynamics

Use this key to check answers and read the explanations.

1. Two blocks have the same temperature and can exchange energy with each other. What is their net heat transfer at thermal equilibrium?

A. Zero
B. Always from the larger block to the smaller one
C. Always from the smaller block to the larger one
D. Equal to the sum of their masses

Correct answer: A. Zero

At thermal equilibrium the blocks have the same temperature and no net transfer of heat occurs between them.

2. A warm cup touches a colder tabletop. In which direction does heat flow spontaneously at first?

A. In whichever direction has the larger mass
B. From the tabletop to the cup
C. From the cup to the tabletop
D. There is no heat transfer because both objects are solid

Correct answer: C. From the cup to the tabletop

Heat flows spontaneously from a higher temperature toward a lower temperature.

3. What is the heat transfer Q across a perfectly insulated system boundary?

A. Equal to the work done by the system
B. Zero
C. Always positive
D. Always negative

Correct answer: B. Zero

A perfectly insulated boundary prevents heat transfer. Mechanical work can still cross some insulated boundaries.

4. Use the convention $\Delta U = Q - W$, with W the work done by a gas. What sign does W have when the gas expands and pushes a piston outward?

A. The sign is undefined
B. Negative
C. Zero for every expansion
D. Positive

Correct answer: D. Positive

The gas does work on the piston, so the convention assigns W a positive value.

5. What name describes a process in which the system’s temperature is held constant?

A. Isobaric
B. Isothermal
C. Isochoric
D. Adiabatic

Correct answer: B. Isothermal
An isothermal process stays at one temperature. The other terms describe other constraints.

6. A closed gas system absorbs 120 joules of heat and does 35 joules of work. What is the change in internal energy?

A. An increase of 85 joules
B. An increase of 155 joules
C. A decrease of 85 joules
D. An increase of 35 joules

Correct answer: A. An increase of 85 joules
Use heat in minus work out. The change is 120 − 35 = 85 joules.

7. A piston does 55 joules of work on a closed gas while 15 joules of heat leave it. How does the gas’s internal energy change?

A. It falls by 70 joules.
B. It rises by 70 joules.
C. It falls by 40 joules.
D. It rises by 40 joules.

Correct answer: D. It rises by 40 joules.
Work done on the gas adds energy, and heat leaving removes energy. The net change is 55 − 15 = 40 joules.

8. At a constant pressure of 200,000 pascals, a gas expands by 0.003 cubic meter. How much pressure-volume work does it do?

A. 6 joules
B. 60 joules
C. 600 joules
D. 6,000 joules

Correct answer: C. 600 joules
At constant pressure, multiply pressure by the volume change. The product 200,000 × 0.003 is 600 joules.

9. During a complete cycle, a system absorbs 200 joules of heat and releases 140 joules of heat. What is the net work done by the system?

A. 60 joules
B. 340 joules
C. 140 joules
D. Zero joules

Correct answer: A. 60 joules
The internal energy returns to its initial value. Net work out therefore equals the net heat input of 60 joules.

10. A fixed amount of ideal gas expands while its temperature stays constant. If it does positive work, what is true of the heat transfer?

A. The gas’s temperature must rise to balance the work.
B. The gas releases heat equal to the work it does.
C. No heat can be transferred at constant temperature.
D. The gas absorbs heat equal to the work it does.

Correct answer: D. The gas absorbs heat equal to the work it does.
An ideal gas’s internal energy depends on temperature. With no internal energy change, the heat input equals the work output.

11. In one cycle, an engine absorbs 240 joules from a hot reservoir and releases 160 joules to a cold reservoir. What is its efficiency?

A. One half
B. Two thirds
C. One third
D. Two fifths

Correct answer: C. One third
The engine delivers 80 joules of work. Divide 80 by the 240 joules drawn from the hot reservoir.

12. A reversible heat engine works between reservoirs at 500 kelvins and 300 kelvins. What is its maximum efficiency?

A. 60 percent
B. 40 percent
C. 20 percent
D. 80 percent

Correct answer: B. 40 percent
Carnot efficiency is 1 minus the cold absolute temperature divided by the hot one. The result is 1 − 300/500 = 0.40.

13. A refrigerator removes 220 joules from its cold space while using 55 joules of work. What is its refrigeration coefficient of performance?

A. 5
B. 0.25
C. 3
D. 4

Correct answer: D. 4
For a refrigerator, divide heat removed from the cold space by work input. Here 220/55 = 4.

14. Two regions inside an isolated container start at different temperatures and are allowed to reach equilibrium. What happens to the total entropy of the contents?

A. It increases.
B. It decreases.
C. It stays the same because energy is conserved.
D. It must become zero.

Correct answer: A. It increases.
Spontaneous heat flow across a finite temperature difference is irreversible. The entropy of the isolated contents increases.

15. A 480-kelvin reservoir transfers 480 joules of heat to a 240-kelvin reservoir. Treat both temperatures as constant. What total entropy change do the two reservoirs undergo?

A. An increase of 3 joules per kelvin
B. A decrease of 1 joule per kelvin
C. An increase of 1 joule per kelvin
D. Zero change

Correct answer: C. An increase of 1 joule per kelvin
The hot reservoir loses 480/480 = 1 joule per kelvin, and the cold one gains 480/240 = 2. The net change is +1 joule per kelvin.