Phys.12- Q2W4-Qs. bank-Thermodynamics

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Which of the following is a set of particles or interacting components to which energy is added or from which energy is removed?
a. an ideal gas
b. an engine
c. a system
d. an environment

____ 2. What accounts for an increase in the temperature of a gas that is kept at constant volume?
a. Energy has been removed as heat from the gas.
b. Energy has been added as heat to the gas.
c. Energy has been removed as work done by the gas.
d. Energy has been added as work done on the gas.

____ 3. When an ideal gas does positive work on its surroundings, which of the gas's quantities increases?
a. temperature
b. volume
c. pressure
d. internal energy

____ 4. An ideal gas system is maintained at a constant volume of 4 L. If the pressure is constant, how much work is done by the system?
a. 0 J
b. 5 J
c. 8 J
d. 30 J

____ 5. Air cools as it escapes from a diver's compressed air tank. What kind of process is this?
a. isovolumetric
b. isobaric
c. adiabatic
d. isothermal

____ 6. What thermodynamic process for an ideal gas system has an unchanging internal energy and a heat intake that corresponds to the value of the work done by the system?
a. isovolumetric
b. isobaric
c. adiabatic
d. isothermal

____ 7. Which thermodynamic process takes place when work is done on or by the system but no energy is transferred to or from the system as heat?
a. isovolumetric
b. isobaric
c. adiabatic
d. isothermal

____ 8. Which thermodynamic process takes place at a constant temperature so that the internal energy of a system remains unchanged?
a. isovolumetric
b. isobaric
c. adiabatic
d. isothermal

____ 9. Which thermodynamic process takes place at constant volume so that no work is done on or by the system?
a. isovolumetric
b. isobaric
c. adiabatic
d. isothermal

____ 10. In an isovolumetric process for an ideal gas, the system's change in the energy as heat is equivalent to a change in which of the following?
a. temperature
b. volume
c. pressure
d. internal energy

____ 11. During an isovolumetric process, which of the following does not change?
a. temperature
b. volume
c. pressure
d. internal energy

____ 12. According to the first law of thermodynamics, the difference between energy transferred to or from a system as heat and energy transferred to or from a system by work is equivalent to which of the following?

a. entropy change
b. internal energy change
c. volume change
d. pressure change

____ 13. How is conservation of internal energy expressed for a system during an adiabatic process?
a. $Q = W = 0$, so $\Delta U = 0$ and $U_i = U_f$
b. $Q = 0$, so $\Delta U = -W$
c. $\Delta T = 0$, so $\Delta U = 0$; therefore, $\Delta U = Q - W = 0$, or $Q = W$
d. $\Delta V = 0$, so $P\Delta V = 0$ and $W = 0$; therefore, $\Delta U = Q$

____ 14. How is conservation of internal energy expressed for a system during an isovolumetric process?
a. $Q = W = 0$, so $\Delta U = 0$ and $U_i = U_f$
b. $Q = 0$, so $\Delta U = -W$
c. $\Delta T = 0$, so $\Delta U = 0$; therefore, $\Delta U = Q - W = 0$, or $Q = W$
d. $\Delta V = 0$, so $P\Delta V = 0$ and $W = 0$; therefore, $\Delta U = Q$

____ 15. How is conservation of internal energy expressed for a system during an isothermal process?
a. $Q = W = 0$, so $\Delta U = 0$ and $U_i = U_f$
b. $Q = 0$, so $\Delta U = -W$
c. $\Delta T = 0$, so $\Delta U = 0$; therefore, $\Delta U = Q - W = 0$, or $Q = W$
d. $\Delta V = 0$, so $P\Delta V = 0$ and $W = 0$; therefore, $\Delta U = Q$

____ 16. How is conservation of internal energy expressed for an isolated system?
a. $Q = W = 0$, so $\Delta U = 0$ and $U_i = U_f$
b. $Q = 0$, so $\Delta U = -W$
c. $\Delta T = 0$, so $\Delta U = 0$; therefore, $\Delta U = Q - W = 0$, or $Q = W$
d. $\Delta V = 0$, so $P\Delta V = 0$ and $W = 0$; therefore, $\Delta U = Q$

____ 17. An ideal gas system undergoes an adiabatic process in which it expands and does 20 J of work on its environment. What is the change in the system's internal energy?
a. –20 J
b. –5 J
c. 0 J
d. 20 J

____ 18. An ideal gas system undergoes an adiabatic process in which it expands and does 20 J of work on its environment. How much energy is transferred to the system as heat?
a. –20 J
b. 0 J
c. 5 J
d. 20 J

____ 19. An ideal gas system undergoes an isovolumetric process in which 20 J of energy is added as heat to the gas. What is the change in the system's internal energy?
a. –20 J
b. 0 J
c. 5 J
d. 20 J

____ 20. Which of the following is a thermodynamic process in which a system returns to the same conditions under which it started?
a. an isovolumetric process
b. an isothermal process
c. a cyclic process
d. an adiabatic process

____ 21. Which of the following is *not* a way in which a cyclic process resembles an isothermal process?
a. Energy can be transferred as work.
b. Energy can be transferred as heat.
c. The temperature of the system remains constant throughout the process.
d. There is no net change in the internal energy of the system.

____ 22. Which equation describes the net work done for a complete cycle of a heat engine?
a. $W_{net} = Q - \Delta U$
b. $W_{net} = Q_h - Q_c$
c. $W_{net} = Q_c - Q_h$
d. $W_{net} = P\Delta V$

____ 23. How does a real heat engine differ from an ideal cyclic heat engine?
a. A real heat engine is not cyclic.
b. An ideal heat engine converts all energy from heat to work.
c. A real heat engine is not isolated, so matter enters and leaves the engine.
d. An ideal heat engine is not isolated, so matter enters and leaves the engine.

____ 24. The requirement that a heat engine must give up some energy at a lower temperature in order to do work corresponds to which law of thermodynamics?
a. first
b. second
c. third
d. No law of thermodynamics applies.

____ 25. According to the second law of thermodynamics, which of the following statements about a heat engine operating in a complete cycle must be true?
a. Heat from a high-temperature reservoir must be completely converted to work.
b. Heat from a high-temperature reservoir equals the entropy increase.
c. Heat from a high-temperature reservoir must be completely converted to internal energy.
d. Heat from a high-temperature reservoir cannot be completely converted to work.

____ 26. A heat engine has taken in energy as heat and used a portion of it to do work. What must happen next for the engine to complete the cycle and return to its initial conditions?
a. It must give up energy as heat to a lower temperature so work can be done on it.
b. It must give up energy as heat to a higher temperature so work can be done on it.
c. It must do work to transfer the remaining energy as heat to a lower temperature.
d. It must do work to transfer the remaining energy as heat to a higher temperature.

____ 27. Which of the following is a way to improve the efficiency of a heat engine?
a. increase Q_h
b. reduce Q_h
c. reduce W_{net}
d. increase Q_c

____ 28. An electrical power plant manages to transfer 88 percent of the heat produced in the burning of fossil fuel to convert water to steam. Of the heat carried by the steam, 40 percent is converted to the mechanical energy of the spinning turbine. Which best describes the overall efficiency of the heat-to-work conversion in the plant?
a. greater than 88 percent
b. 88 percent
c. 40 percent
d. less than 40 percent

____ 29. An ideal heat engine has an efficiency of 50 percent. Which of the following statements is *not* true?
a. The amount of energy exhausted as heat equals the energy added to the engine as heat.
b. The amount of work done is half the energy added to the engine as heat.
c. The amount of energy exhausted as heat is half the energy added to the engine as heat.
d. The amount of energy exhausted as heat equals the work done.

____ 30. What occurs when a system's disorder is increased?
a. No work is done.
b. No energy is available to do work.
c. Less energy is available to do work.
d. More energy is available to do work.

____ 31. Imagine you could observe the individual atoms that make up a piece of matter and that you observe the motion of the atoms becoming more orderly. What can you assume about the system?
a. It is gaining thermal energy.
b. Its entropy is increasing.
c. Its entropy is decreasing.
d. Positive work is being done on the system.

____ 32. A chunk of ice with a mass of 1 kg at 0°C melts and absorbs 3.33×10^5 J of heat in the process. Which best describes what happened to this system?
a. Its entropy increased.
b. Its entropy decreased.
c. Its entropy remained constant.
d. Work was converted to energy.

____ 33. When a drop of ink mixes with water, what happens to the entropy of the system?

a. The system’s entropy increases, and the total entropy of the universe increases.
b. The system’s entropy decreases, and the total entropy of the universe increases.
c. The system’s entropy increases, and the total entropy of the universe decreases.
d. The system’s entropy decreases, and the total entropy of the universe decreases.

____ 34. Which statement applies when all of the entropy changes in a process are taken into account?
a. The increases in entropy are always less than the decreases.
b. The increases in entropy are always equal to the decreases.
c. The increases in entropy are always greater than the decreases.
d. The increases in entropy can be greater or less than the decreases.

____ 35. A thermodynamic process occurs, and the entropy of a system decreases. What can be concluded about the entropy change of the environment?
a. It decreases.
b. It increases.
c. It stays the same.
d. It could increase or decrease, depending on the process.

Short Answer

1. What indicates that energy has been added to or removed as heat or work from a system?
2. How are heat and work similar?
3. A match is struck on a matchbook cover. How is energy transferred so that the match can ignite and produce a flame?
4. A physics textbook is balanced on top of an inflated balloon on a cold morning. As the day passes, the temperature increases, the balloon expands, and the textbook rises. Is there a transfer of energy as heat? If so, what is it? Has any work been done? If so, on what?
5. A gas is confined in a cylinder with a piston. What happens when work is done on the gas?
6. A rubber raft loaded with cargo is set on the bank of a river. During the day, the temperature of the air outside the raft increases. The volume of the raft increases, causing the cargo to be lifted a few centimeters. What type of thermodynamic process has taken place, and what is the net change in the internal energy of the air within the raft?
7. How does an adiabatic process compare to an isovolumetric process?
8. A mechanic pushes down very quickly on the plunger of an insulated pump. The air hose is plugged so that no air escapes. What type of thermodynamic process takes place? What type of energy transfer and change occurs?
9. What is true of the internal energy of an isolated system?
10. How is the conservation of a system’s internal energy mathematically expressed for an adiabatic process? Explain your answer.
11. How is the conservation of a system’s internal energy mathematically expressed for an isothermal process? Explain your answer.
12. How is the conservation of a system’s internal energy mathematically expressed for an isovolumetric process? Explain your answer.
13. What is a cyclic process?
14. According to the conservation of energy, what is true about the net work and net heat in a cyclic process?

15. What changes can be made to the transfer of energy as heat to a heat engine in order to increase the amount of work done by the engine?
16. Energy is transferred as heat and work to and from a heat engine in separate steps so that the internal energy of the engine must change during those steps. Explain why this does not contradict the condition for a cyclic process that a system's internal energy remain unchanged.
17. State the second law of thermodynamics.
18. How does $Q_c > 0$ relate to the second law of thermodynamics?
19. Describe how energy is transferred as heat during the part of an engine cycle where the engine does work on the environment and during the part of the cycle when work is done on the engine.
20. What term is used to describe the measure of useful energy taken out of a process relative to the total energy put into the process?
21. Use the second law of thermodynamics and the equation for heat engine efficiency to show why efficiency must always be less than 1.
22. Explain why the efficiencies of real heat engines are always much less than the calculated maximum efficiencies of ideal heat engines.
23. What is entropy?
24. Why must work be done to reduce entropy in most systems?
25. Ice cubes are formed in the freezer compartment of a refrigerator. Explain the change in entropy of the water freezing, as well as the change in entropy of the environment outside the refrigerator. Does the water freezes spontaneously, and if not, why not?

Problem

1. A container of gas is at a pressure of 3.8×10^5 Pa. How much work is done by the gas if its volume expands by 1.8 m^3?
2. A container of gas is at a pressure of 1.7×10^5 Pa and a volume of 4.9 m^3. How much work is done by the gas if it expands at constant pressure to twice its initial volume?
3. An ideal gas is maintained at a constant pressure of 9.8×10^4 N/m^2 while its volume decreases by 0.38 m^3. What work is done by the system on its environment?
4. A cylinder has a radius of 0.082 m. How much work is done by a gas in the cylinder if the gas exerts a constant pressure of 7.5×10^5 Pa on the piston, moving it a distance of 0.026 m?
5. Gas within a cylinder expands outward against a piston with a radius of 0.15 m so that 6680 J of work is to be done by the gas. If the net pressure exerted on the gas is 3.8×10^5 Pa, how far is the piston displaced?
6. A gas compressed within a cylinder with a piston with a radius of 5.5 cm is displaced 8.6 cm. What is the net pressure on the gas if the work done on the gas equals –380 J?
7. A total of 198 J of work is done on a gaseous refrigerant as it undergoes compression. If the internal energy of the gas increases by 121 J during the process, what is the total amount of energy transferred as heat?
8. The internal energy of a system is initially 57 J. A total of 84 J of energy is added to the system as heat while the system does 62 J of work. What is the system's final internal energy?

9. An engine with a mass of 324 kg and an initial temperature of 21.6°C takes in 8.8×10^5 J of energy as heat and does 3.9×10^5 J of work. If the rest of the energy is retained by the engine, which has a specific heat capacity of 533 J/kg•°C, what is the engine's final temperature?

10. Over several cycles, a refrigerator compressor does work on the refrigerant. This work is equivalent to a constant pressure of 4.73×10^5 Pa compressing a circular piston with a radius of 0.022 m a distance of 27.6 m. If the change in the refrigerant's internal energy is 0 J after each cycle, how much heat will the refrigerant remove from within the refrigerator?

11. The piston and flywheel part of a steam engine takes in 993 J of energy as heat and expels 514 J of energy as heat. The internal energy of the system increases by 372 J during the process. Work is done by steam at a pressure of 2.21×10^5 Pa. If the radius of the piston is 4.14×10^{-2} m, how far is the piston displaced?

12. Over several cycles, a refrigerator compressor does work on the refrigerant by causing a net change in volume of -0.164 m^3 under a constant pressure of 3.31×10^5 Pa. This causes the refrigerant to remove 6.37×10^4 J of energy as heat from the interior of the refrigerator. Because the compartment is not perfectly insulated, 1.1×10^3 J of energy leaks into the compartment from outside the refrigerator. Treating the compressor, refrigerant, and refrigerator compartment as a single system, and assuming that the refrigerator requires 355 J of energy to change its interior temperature by 1.00°C, what is the final temperature of the refrigerator? Assume that its temperature at the start of the process is 27.2°C.

13. An internal combustion engine with an initial temperature of 36.2°C is started. The combustion reactions add 8.66×10^6 J of energy as heat to the engine after several cycles. During this time, the coolant that flows through the block of the engine removes 3.63×10^6 J of energy as heat. At the same time, 2.60×10^5 J of energy is removed as heat by the exhaust gases. The engine does work, which can be described as being equivalent to one large piston with an area of 3.41×10^{-4} m^2 being pushed a total distance of 3.35×10^3 m by gas at a constant pressure of 7.63×10^5 Pa. If 2.97×10^5 J must be added or removed from the engine to change its temperature by 1.00°C, what is the final temperature of the engine?

14. An engine absorbs 2310 J as heat from a hot reservoir and gives off 830 J as heat to a cold reservoir during each cycle. What is the efficiency of the engine?

15. An engine adds 62 000 J of energy as heat and removes 17 000 J of energy as heat. What is the engine's efficiency?

16. A steam engine takes in 2.54×10^5 J of energy added as heat and exhausts 1.75×10^5 J of energy removed as heat per cycle. What is its efficiency?

17. A turbine exhausts 62 500 J of energy as heat when it puts out 22 100 J of net work. What is the efficiency of the turbine?

18. A heat engine performs 2300.0 J of net work while adding 7100.0 J of heat to the low-temperature reservoir. What is the efficiency of the engine?

19. The gas within a cylinder of an engine undergoes a net change in volume of 1.40×10^{-3} m^3 when it does work at a constant pressure of 3.56×10^5 Pa. If the efficiency of the engine is 0.278, how much work must the engine give up as heat to the low-temperature reservoir?

20. The piston of an engine has a radius of 5.5×10^{-2} m and is displaced a distance of 0.28 m when the pressure within the cylinder is 3.5×10^5 Pa. If the efficiency of the engine is 0.44, how much work must the engine give up as heat to the low-temperature reservoir?

Phys.12- Q2W4-Qs. bank-Thermodynamics
Answer Section

MULTIPLE CHOICE

1.	ANS: C	PTS: 1	DIF: I	OBJ: 10-1.1
2.	ANS: B	PTS: 1	DIF: I	OBJ: 10-1.1
3.	ANS: B	PTS: 1	DIF: I	OBJ: 10-1.1
4.	ANS: A	PTS: 1	DIF: II	OBJ: 10-1.2
5.	ANS: C	PTS: 1	DIF: I	OBJ: 10-1.3
6.	ANS: D	PTS: 1	DIF: I	OBJ: 10-1.3
7.	ANS: C	PTS: 1	DIF: I	OBJ: 10-1.3
8.	ANS: D	PTS: 1	DIF: I	OBJ: 10-1.3
9.	ANS: A	PTS: 1	DIF: I	OBJ: 10-1.3
10.	ANS: D	PTS: 1	DIF: I	OBJ: 10-1.3
11.	ANS: B	PTS: 1	DIF: I	OBJ: 10-1.3
12.	ANS: B	PTS: 1	DIF: I	OBJ: 10-2.1
13.	ANS: B	PTS: 1	DIF: I	OBJ: 10-2.1
14.	ANS: D	PTS: 1	DIF: I	OBJ: 10-2.1
15.	ANS: C	PTS: 1	DIF: I	OBJ: 10-2.1
16.	ANS: A	PTS: 1	DIF: I	OBJ: 10-2.1
17.	ANS: A	PTS: 1	DIF: II	OBJ: 10-2.2
18.	ANS: B	PTS: 1	DIF: II	OBJ: 10-2.2
19.	ANS: D	PTS: 1	DIF: II	OBJ: 10-2.2
20.	ANS: C	PTS: 1	DIF: I	OBJ: 10-2.3
21.	ANS: C	PTS: 1	DIF: I	OBJ: 10-2.3
22.	ANS: B	PTS: 1	DIF: I	OBJ: 10-2.3
23.	ANS: C	PTS: 1	DIF: I	OBJ: 10-2.3
24.	ANS: B	PTS: 1	DIF: I	OBJ: 10-3.1
25.	ANS: D	PTS: 1	DIF: I	OBJ: 10-3.1
26.	ANS: A	PTS: 1	DIF: II	OBJ: 10-3.1
27.	ANS: A	PTS: 1	DIF: I	OBJ: 10-3.2
28.	ANS: D	PTS: 1	DIF: II	OBJ: 10-3.2
29.	ANS: A	PTS: 1	DIF: II	OBJ: 10-3.2
30.	ANS: C	PTS: 1	DIF: I	OBJ: 10-3.3
31.	ANS: C	PTS: 1	DIF: I	OBJ: 10-3.3
32.	ANS: A	PTS: 1	DIF: I	OBJ: 10-3.3
33.	ANS: A	PTS: 1	DIF: II	OBJ: 10-3.3
34.	ANS: C	PTS: 1	DIF: II	OBJ: 10-3.3
35.	ANS: B	PTS: 1	DIF: II	OBJ: 10-3.3

SHORT ANSWER

1. ANS:
   The internal energy of the system changes, as indicated by a change in the system’s temperature.

PTS: 1 DIF: I OBJ: 10-1.1

2. ANS:
Heat and work are both ways in which energy can be transferred to or from a substance.

PTS: 1 DIF: I OBJ: 10-1.1

3. ANS:
Work is being done on the system (the match and matchbook) to increase the internal energy of the match. When the internal energy (temperature) of the match is high enough for combustion to occur, the chemicals in the match ignite.

PTS: 1 DIF: II OBJ: 10-1.1

4. ANS:
Energy from the air was transferred as heat into the balloon. The balloon did work on the book.

PTS: 1 DIF: II OBJ: 10-1.1

5. ANS:
The volume of the gas decreases.

PTS: 1 DIF: I OBJ: 10-1.2

6. ANS:
The process is isothermal. The internal energy of the air in the raft increases as energy is added as heat and decreases as work is done on the cargo, so the overall internal energy in the raft remains unchanged.

PTS: 1 DIF: II OBJ: 10-1.3

7. ANS:
The internal energy of a system changes during both processes. In an adiabatic process, no energy is transferred as heat, but work is done on or by the system. In an isovolumetric process, no work is done, but energy is transferred as heat to or from the system.

PTS: 1 DIF: II OBJ: 10-1.3

8. ANS:
The process is adiabatic, because no energy is transferred into or out of the system as heat. Work is done on the air in the system, which causes the internal energy of the air to increase.

PTS: 1 DIF: II OBJ: 10-1.3

9. ANS:
No energy is transferred to or from an isolated system. Therefore, the internal energy of an isolated system remains unchanged.

PTS: 1 DIF: I OBJ: 10-2.1

10. ANS:
$Q = 0$ for an adiabatic process, so $\Delta U = -W$.

PTS: 1 DIF: II OBJ: 10-2.1

11. ANS:
$\Delta U = 0$ for an isothermal process, so $Q - W = 0$, or $Q = W$.

PTS: 1 DIF: II OBJ: 10-2.1

12. ANS:

$W = 0$ for an isovolumetric process, so $\Delta U = Q$.

PTS: 1 DIF: II OBJ: 10-2.1

13. ANS:
A cyclic process is a thermodynamic process in which a system returns to the same conditions under which it started, so that there is no change in the system's internal energy.

PTS: 1 DIF: I OBJ: 10-2.3

14. ANS:
In a cyclic process, the net work equals the net heat.

PTS: 1 DIF: I OBJ: 10-2.3

15. ANS:
Increasing the net amount of energy transferred as heat from a high-temperature substance to the engine, or decreasing the net amount of energy transferred as heat from the engine to a low-temperature substance, or both of these conditions together will increase the net amount of work done by the engine.

PTS: 1 DIF: II OBJ: 10-2.3

16. ANS:
The internal energy of the system can change during individual steps of a cycle. However, by the time the cycle is completed, the final internal energy of the system is the same as the initial internal energy when the cycle began, so the net change in the internal energy remains unchanged with the completion of the cycle.

PTS: 1 DIF: II OBJ: 10-2.3

17. ANS:
No machine can be made that converts heat entirely to work. (Alternately, in terms of entropy change: the entropy of the universe increases in all natural processes.)

PTS: 1 DIF: I OBJ: 10-3.1

18. ANS:
The requirement that $Q_c > 0$ means that some energy must be transferred as heat to the system's surroundings, and therefore this energy cannot be used by the engine to do work.

PTS: 1 DIF: I OBJ: 10-3.1

19. ANS:
Energy is transferred as heat from a high-temperature substance to the lower-temperature engine, and some of the energy is used by the engine to do work on the environment. The remaining energy in the system is transferred as heat from the engine to a lower-temperature substance. This allows work to be done on the engine, thus returning the engine to its initial condition and completing the cycle.

PTS: 1 DIF: II OBJ: 10-3.1

20. ANS:
efficiency

PTS: 1 DIF: I OBJ: 10-3.2

21. ANS:

According to the second law of thermodynamics, some of the energy added as heat to an engine (Q_h) must be removed from the engine as heat to a substance at a lower temperature (Q_c). Q_c is therefore greater than 0. Efficiency is equal to $1–(Q_c/Q_h)$, and because Q_c/Q_h must be greater than 0, the efficiency must be less than 1.

PTS: 1 DIF: II OBJ: 10-3.2

22. ANS:
Calculated efficiencies are based only on the amounts of energy transferred as heat to and from the engine. They do not take into account friction or thermal conduction within the engine, which cause energy to be dissipated by the engine. This makes real engines less efficient than their ideal counterparts.

PTS: 1 DIF: II OBJ: 10-3.2

23. ANS:
Entropy is a measure of the disorder of a system.

PTS: 1 DIF: I OBJ: 10-3.3

24. ANS:
In most systems, entropy increases with the spontaneous transfer of energy as heat, causing the systems to become more disordered. This process can be reversed, and the system’s entropy can be decreased, only by transferring energy as heat from a lower temperature to a higher temperature. This requires work to be done on the system.

PTS: 1 DIF: II OBJ: 10-3.3

25. ANS:
The entropy of the water decreases, because it goes from a less-ordered liquid state to a more-ordered solid state. This does not occur spontaneously, but by the refrigerator doing work to remove energy as heat from the freezer. This energy is added to the air outside the refrigerator, so the entropy of the outside air (the environment) increases by more than the entropy of the freezing water decreases.

PTS: 1 DIF: II OBJ: 10-3.3

PROBLEM

1. ANS:
6.8×10^5 J

Given
$P = 3.8 \times 10^5$ Pa
$\Delta V = 1.8$ m^3

Solution
$W = P\Delta V = (3.8 \times 10^5 \text{ Pa})(1.8 \text{ m}^3) = 6.8 \times 10^5 \text{ J}$

PTS: 1 DIF: IIIA OBJ: 10-1.2

2. ANS:
8.3×10^5 J

Given

$P = 1.7 \times 10^5$ Pa
$V_i = 4.9$ m^3
$V_f = 2V_i$

Solution
$W = P\Delta V$

$\Delta V = V_f - V_i = 2V_i - V_i = V_i$

$W = (1.7 \times 10^5 \text{ Pa})(4.9 \text{ m}^3) = 8.3 \times 10^5 \text{ J}$

PTS: 1 DIF: IIIA OBJ: 10-1.2

3. ANS:
-3.7×10^4 J

Given
$P = 9.8 \times 10^4 \text{ N/m}^2$
$\Delta V = -0.38 \text{ m}^3$

Solution
The volume decreases, so ΔV, and thus W, are negative.
$W = P\Delta V = (9.8 \times 10^4 \text{ N/m}^2)(-0.38 \text{ m}^3) = -3.7 \times 10^4 \text{ J}$

PTS: 1 DIF: IIIA OBJ: 10-1.2

4. ANS:
4.1×10^2 J

Given
$r = 0.082$ m
$P = 7.5 \times 10^5$ Pa
$d = 0.026$ m

Solution
Work is done by the gas, so W is positive.
$W = P\Delta V = PAd$

$A = \pi r^2$

$W = PAd = P\pi r^2 d = (7.5 \times 10^5 \text{ Pa})(\pi)(0.082 \text{ m})^2(0.026 \text{ m})$

$P = 4.1 \times 10^2 \text{ J}$

PTS: 1 DIF: IIIB OBJ: 10-1.2

5. ANS:
0.25 m = 25 cm

Given
$r = 0.15$ m
$W = 6680$ J

$P = 3.8 \times 10^5$ Pa

Solution
Work is done by the gas, so W is positive.
$$W = P\Delta V = PAd$$

$$A = \pi r^2$$

$$d = \frac{W}{PA} = \frac{W}{P\pi r^2} = \frac{6680 \text{ J}}{(3.8 \times 10^5 \text{ Pa})(\pi)(0.15 \text{ m})^2}$$

$$P = 0.25 \text{ m} = 25 \text{ cm}$$

PTS: 1 DIF: IIIB OBJ: 10-1.2

6. ANS:
4.6×10^5 Pa

Given
$r = 5.5$ cm
$d = 8.6$ cm
$W = –380$ J

Solution
Work is done on the gas, so W is negative.
$$W = P\Delta V = -PAd$$

$$A = \pi r^2$$

$$P = -\frac{W}{Ad} = -\frac{W}{\pi r^2 d} = \frac{-(-380 \text{ J})}{\pi(5.5 \text{ cm})^2(8.6 \text{ cm})} \times \left(\frac{100 \text{ cm}}{1 \text{ m}}\right)^3$$

$$P = 4.6 \times 10^5 \text{ Pa}$$

PTS: 1 DIF: IIIB OBJ: 10-1.2

7. ANS:
–77 J, or 77 J transferred from the system as heat

Given
$W = –198$ J
$\Delta U = 121$ J

Solution
Work is done on the system, so W is negative.
$$\Delta U = Q - W$$

$$Q = \Delta U + W = 121 \text{ J} + (-198 \text{ J}) = -77 \text{ J, or 77 J transferred from the system as heat}$$

PTS: 1 DIF: IIIA OBJ: 10-2.2

8. ANS:
79 J

Given
U_i = 57 J
Q = 84 J
W = 62 J

Solution
Work is done by the system, so W is positive. Energy is added as heat to the system, so Q is positive.

$$\Delta U = U_f - U_i = Q - W$$

$$U_f = U_i + Q - W = 57\text{ J} + 84\text{ J} - 62\text{ J} = 79\text{ J}$$

PTS: 1 DIF: IIIA OBJ: 10-2.2

9. ANS:
24.4°C

Given
m = 324 kg
T_i = 21.6°C
$Q = 8.8 \times 10^5$ J
$W = 3.9 \times 10^5$ J
c_p = 533 J/kg•°C

Solution
Work is done by the system, so W is positive. Energy is added as heat to the system, so Q is positive.

$$\Delta U = Q - W$$

$$\Delta U = mc_p\Delta T = mc_p(T_f - T_i)$$

$$mc_p(T_f - T_i) = Q - W$$

$$T_f = \frac{Q - W}{mc_p} + T_i$$

$$T_f = \frac{8.8 \times 10^5\text{ J} - 3.9 \times 10^5\text{ J}}{(324\text{ kg})(533\text{ J/kg°C})} + 21.6\text{°C} = \frac{4.9 \times 10^5\text{ J}}{(324\text{ kg})(533\text{ J/kg°C})} + 21.6\text{°C}$$

$$T_f = 2.8\text{°C} + 21.6\text{°C} = 24.4\text{°C}$$

PTS: 1 DIF: IIIB OBJ: 10-2.2

10. ANS:
-2.0×10^4 J

Given
$P = 4.73 \times 10^5$ Pa
r = 0.022 m
d = 27.6 m
ΔU = 0 J

Solution

$\Delta U = Q - W = 0$

Work is done on the system, so W is negative.

$W = P\Delta V = -PAd$

$A = \pi r^2$

$Q = W = -P\pi r^2 d$

$Q = -(4.73 \times 10^5 \text{ Pa})(\pi)(0.022 \text{ m})^2(27.6 \text{ m}) = -2.0 \times 10^4 \text{ J}$

PTS: 1 DIF: IIIB OBJ: 10-2.2

11. ANS:
8.99×10^{-2} m = 8.99 cm

Given
Q_{added} = 993 J
$Q_{removed}$ = 514 J
ΔU = 372 J
$P = 2.21 \times 10^5$ Pa
$r = 4.14 \times 10^{-2}$ m

Solution
$\Delta U = Q - W$

$W = Q - \Delta U$

$W = P\Delta V = PAd$

$A = \pi r^2$

$Q = Q_{added} - Q_{removed}$

$$d = \frac{W}{PA} = \frac{Q - \Delta U}{PA} = \frac{Q_{added} - Q_{removed} - \Delta U}{P\pi r^2} = \frac{993 \text{ J} - 514 \text{ J} - 372 \text{ J}}{(2.21 \times 10^5 \text{ Pa})(\pi)(4.14 \times 10^{-2} \text{ m})^2}$$

$$d = \frac{107 \text{ J}}{(2.21 \times 10^5 \text{ Pa})(\pi)(4.14 \times 10^{-2} \text{ m})^2} = 8.99 \times 10^{-2} \text{ m} = 8.99 \text{ cm}$$

PTS: 1 DIF: IIIB OBJ: 10-2.2

12. ANS:
3.8°C

Given
$\Delta V = -0.164 \text{ m}^3$
$P = 3.31 \times 10^5$ Pa
$Q_{removed} = 6.37 \times 10^4$ J
$Q_{added} = 1.1 \times 10^3$ J
$\Delta U/\Delta T$ = 355 J/1.00°C
$T_{initial}$ = 27.2°C

Solution

$\Delta U = Q - W$

$W = P\Delta V$

$Q = -Q_{removed} + Q_{added}$

$\Delta U = -Q_{removed} + Q_{added} - P\Delta V$

$\Delta U = -6.37 \times 10^4 \text{ J} + 1.1 \times 10^3 \text{ J} - (3.31 \times 10^5 \text{ Pa})(-0.164 \text{ m}^3)$

$\Delta U = -6.37 \times 10^4 \text{ J} + 1.1 \times 10^3 \text{ J} + 5.43 \times 10^4 \text{ J} = -8.3 \times 10^3 \text{ J}$

$$\Delta T = T_{final} - T_{initial} = \frac{\Delta U}{\left(\frac{355 \text{ J}}{1.00°\text{C}}\right)}$$

$$T_{final} = \frac{\Delta U}{\left(\frac{355 \text{ J}}{1.00°\text{C}}\right)} + T_{initial} = \frac{-8.3 \times 10^3 \text{ J}}{\left(\frac{355 \text{ J}}{1.00°\text{C}}\right)} + 27.2°\text{C} = -23.4°\text{C} + 27.2°\text{C} = 3.8°\text{C}$$

PTS: 1 DIF: IIIC OBJ: 10-2.2

13. ANS:
49.3°C

Given
$T_{initial}$ = 36.2°C
Q_{added} = 8.66 × 10^6 J
$Q_{removed,coolant}$ = 3.63 × 10^6 J
$Q_{removed,exhaust}$ = 2.60 × 10^5 J
A = 3.41 × 10^{-4} m^2
d = 3.35 × 10^{-3} m
P = 7.63 × 10^5 Pa
$\Delta U/\Delta T$ = 2.97 × 10^5 J/1.00°C

Solution

$\Delta U = Q - W$

$W = P\Delta V = PAd$

$Q = Q_{added} - Q_{removed,coolant} - Q_{removed,exhaust}$

$\Delta U = Q_{added} - Q_{removed,coolant} - Q_{removed,exhaust} - PAd$

$\Delta U = 8.66 \times 10^6 \text{ J} - 3.63 \times 10^6 \text{ J} - 2.60 \times 10^5 \text{ J} - (7.63 \times 10^5 \text{ Pa})(3.41 \times 10^{-4} \text{ m}^2)(3.35 \times 10^3 \text{ m})$

$\Delta U = 4.77 \times 10^6 \text{ J} - 8.72 \times 10^5 \text{ J} = 3.90 \times 10^6 \text{ J}$

$$\Delta T = T_{final} - T_{initial} = \frac{\Delta U}{\left(\dfrac{2.97 \times 10^5 \text{ J}}{1.00°\text{C}}\right)}$$

$$T_{final} = \frac{\Delta U}{\left(\dfrac{2.97 \times 10^5 \text{ J}}{1.00°\text{C}}\right)} + T_{initial} = \frac{3.90 \times 10^6 \text{ J}}{\left(\dfrac{2.97 \times 10^5 \text{ J}}{1.00°\text{C}}\right)} + 36.2°\text{C} = 13.1°\text{C} + 36.2°\text{C} = 49.3°\text{C}$$

PTS: 1 DIF: IIIC OBJ: 10-2.2

14. ANS:
0.64

Given
Q_h = 2310 J
Q_c = 830 J

Solution

$$eff = 1 - \frac{Q_c}{Q_h}$$

$$eff = 1 - \frac{830 \text{ J}}{2310 \text{ J}} = 1 - 0.36 = 0.64$$

PTS: 1 DIF: IIIA OBJ: 10-3.2

15. ANS:
0.73

Given
Q_h = 62 000 J
Q_c = 17 000 J

Solution

$$eff = 1 - \frac{Q_c}{Q_h}$$

$$eff = 1 - \frac{17\,000 \text{ J}}{62\,000 \text{ J}} = 1 - 0.27 = 0.73$$

PTS: 1 DIF: IIIA OBJ: 10-3.2

16. ANS:
0.311

Given
$Q_h = 2.54 \times 10^5$ J
$Q_c = 1.75 \times 10^5$ J

Solution

$$eff = 1 - \frac{Q_c}{Q_h}$$

$$eff = 1 - \frac{1.75 \times 10^5 \text{ J}}{2.54 \times 10^5 \text{ J}} = 1 - 0.689 = 0.311$$

PTS: 1 DIF: IIIA OBJ: 10-3.2

17. ANS:
0.261

Given
Q_c = 62 500 J
W_{net} = 22 100 J

Solution

$$eff = \frac{W_{net}}{Q_h}$$

$$W_{net} = Q_h - Q_c$$

$$Q_h = W_{net} + Q_c$$

$$eff = \frac{W_{net}}{W_{net} + Q_c} = \frac{22\ 100 \text{ J}}{22\ 100 \text{ J} + 62\ 500 \text{ J}} = \frac{22\ 100 \text{ J}}{84\ 600 \text{ J}}$$

$$eff = 0.261$$

PTS: 1 DIF: IIIB OBJ: 10-3.2

18. ANS:
0.24468

Given
W_{net} = 7100.0 J
Q_c = 7100.0 J

Solution

$$eff = \frac{W_{net}}{Q_h}$$

$$W_{net} = Q_h - Q_c$$

$$Q_h = W_{net} + Q_c$$

$$eff = \frac{W_{net}}{W_{net} + Q_c} = \frac{2300.0\text{ J}}{2300.0\text{ J} + 7100.0\text{ J}} = \frac{2300.0\text{ J}}{9400.0\text{ J}}$$

$$eff = 0.24468$$

PTS: 1 DIF: IIIB OBJ: 10-3.2

19. ANS:
1.29×10^3 J

Given
$\Delta V = 1.40 \times 10^{-3}\text{ m}^3$
$P = 3.56 \times 10^5$ Pa
$eff = 0.278$

Solution
$$W_{net} = P\Delta V$$

$$eff = \frac{W_{net}}{Q_h}$$

$$W_{net} = Q_h - Q_c$$

$$Q_c = Q_h - W_{net} = \frac{W_{net}}{eff} - W_{net} = W_{net}\left(\frac{1}{eff} - 1\right) = P\Delta V\left(\frac{1}{eff} - 1\right)$$

$$Q_c = (3.56 \times 10^5\text{ Pa})(1.40 \times 10^{-3}\text{ m}^3)\left(\frac{1}{0.278} - 1\right)$$

$$Q_c = (3.56 \times 10^5\text{ Pa})(1.40 \times 10^{-3}\text{ m}^3)(3.597 - 1)$$

$$Q_c = (3.56 \times 10^5\text{ Pa})(1.40 \times 10^{-3}\text{ m}^3)(2.597) = 1.29 \times 10^3\text{ J}$$

PTS: 1 DIF: IIIC OBJ: 10-3.2

20. ANS:
1.1×10^3 J

Given
$r = 5.5 \times 10^{-2}$ m
$d = 0.28$ m
$P = 3.5 \times 10^5$ Pa
$eff = 0.44$

Solution

$$W_{net} = P\Delta V = PAd$$

$$A = \pi r^2$$

$$eff = \frac{W_{net}}{Q_h}$$

$$W_{net} = Q_h - Q_c$$

$$Q_c = Q_h - W_{net} = \frac{W_{net}}{eff} - W_{net} = W_{net}\left(\frac{1}{eff} - 1\right) = PAd\left(\frac{1}{eff} - 1\right) = P\pi r^2 d\left(\frac{1}{eff} - 1\right)$$

$$Q_c = (3.5 \times 10^5 \text{ Pa})(\pi)(5.5 \times 10^{-2}\text{m})^2(0.28 \text{ m})\left(\frac{1}{0.44} - 1\right)$$

$$Q_c = (3.5 \times 10^5 \text{ Pa})(\pi)(5.5 \times 10^{-2}\text{m})^2(0.28 \text{ m})(2.3 - 1)$$

$$Q_c = (3.5 \times 10^5 \text{ Pa})(\pi)(5.5 \times 10^{-2}\text{m})^2(0.28 \text{ m})(1.3) = 1.1 \times 10^3 \text{ J}$$

PTS: 1 DIF: IIIC OBJ: 10-3.2