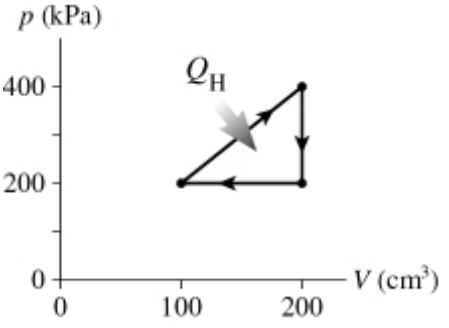
Physics 182
Spring 2026

Exam 1

Multiple Choice. For all questions/problems, choose the one alternative that BEST completes the statement or answers the question, and code your choice, A, B, C, D, or E on your scan sheet. For numerical answers, BEST means the closest to what you calculated. Each question is equally weighted.

1) The graph in the figure shows a cycle for a heat engine for which Q_H=72 J. What is the thermal efficiency of this engine?



A) 6.9 %
B) 11 %
C) 28 %
D) 14 %
E) 8.4 %

Answer: D

2) An ideal gas is kept in a rigid container that expands negligibly when heated. The gas starts at a temperature of 20.0°C, and heat is added to increase its temperature. At what temperature will its root-mean-square speed be double its value at 20.0°C?

A) 899°C
B) 313°C
C) 40.0°C
D) 141°C
E) 400°C

Answer: A

3) A 905-g meteor impacts the earth at a speed of 1629 m/s. If all of its energy is entirely converted to heat in the meteor, what will be the resulting temperature rise of the meteor, assuming it does not melt? The specific heat for the meteor material is 472 J/kg · K, which is about the same as that of iron.

A) 11,700°C
B) 2810°C
C) 3.10°C
D) 2,540,000°C
E) 6370°C

Answer: B

4) A certain amount of ideal monatomic gas is maintained at constant volume as it is cooled from 455K to 405 K. This feat is accomplished by removing 400 J of heat from the gas. How much work is done by the gas during this process?

A) 0.00 J
B) 200 J
C) 400 J
D) -400 J
E) -200 J

Answer: A

5) Is it possible to transfer heat from a cold reservoir to a hot reservoir?

A) Theoretically yes, but it hasn't been accomplished yet.
B) No; this is forbidden by the second law of thermodynamics.
C) Yes; this will happen naturally.
D) Yes, but work will have to be done.
E) No; this is forbidden by the first law of thermodynamics.

Answer: D

6) When a fixed amount of ideal gas goes through an isothermal expansion,

A) its temperature must decrease.
B) the gas does no work.
C) no heat enters or leaves the gas.
D) its pressure must increase.
E) its thermal energy does not change.

Answer: E

7) An expansion process on an ideal diatomic gas has a linear path between the initial and final states on a *pV* diagram. The initial pressure is 300 kPa, the initial volume is 0.020 m^3, and the initial temperature is 390 K. The final pressure is 60 kPa and the final temperature is 240 K. The work done **by the gas** is closest to

A) 5600 J.
B) 7500 J.
C) 9300 J.
D) 3700 J.
E) 11,000 J.

Answer: B

8) An air conditioner with a coefficient of performance of 3.5 uses 30 kW of power. How much power is it discharging to the outdoors?

A) 210 kW
B) 105 kW
C) 30 kW
D) 75 kW
E) 135 kW

Answer: E

9) When a vapor condenses,

A) the temperature of the substance decreases.
B) heat energy leaves the substance.
C) heat energy enters the substance.
D) the temperature of the substance increases.
E) None of the above

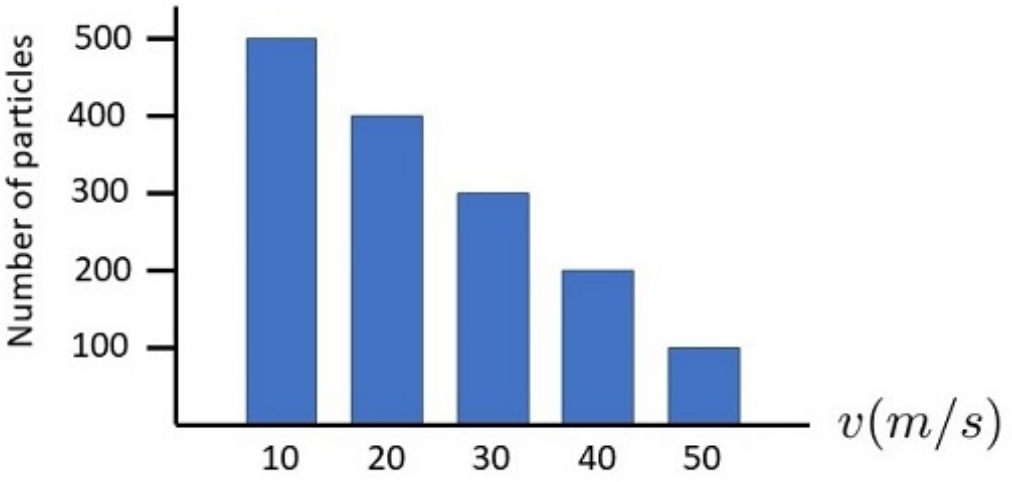
Answer: B

10) The French scientist Sadi Carnot, who pioneered the study of the thermodynamics of heat engines, died in what manner?

A) He took his own life.
B) He was killed in combat.
C) He was killed when a steam powered locomotive exploded near him.
D) He caught cholera during an epidemic and died.
E) He drowned in the ocean.

Answer: D

11) What is the root-mean-square speed for this distribution of molecular speeds?



A) 31.4 m/s
B) 10.0 m/s
C) 36.7 m/s
D) 26.5 m/s
E) 23.3 m/s

Answer: D

12) A real (non-Carnot) heat engine, operating between heat reservoirs at temperatures of 520 K and 270 K, performs 4.0 kJ of net work and rejects 7.4 kJ of heat in a single cycle. The thermal efficiency of this heat engine is closest to

A) 0.28.
B) 0.39.
C) 0.35.
D) 0.32.
E) 0.42.

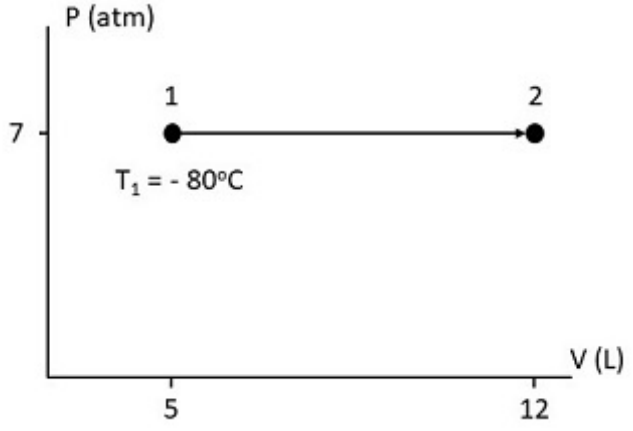
Answer: C

13) A cube at 100.0°C radiates heat at a rate of 80.0 J/s. If the length of each side is cut in half, the rate at which it will now radiate is closest to

A) 56.6 J/s.
B) 40.0 J/s.
C) 10.0 J/s.
D) 20.0 J/s.
E) 28.3 J/s.

Answer: D

14) For the ideal gas process shown, determine the temperature T_2 .



A) 360^{O} C
B) 190^{O} C
C) 680^{O} C
D) 240^{O} C
E) 450^{O} C

Answer: B

15) An engine manufacturer makes the claim that the engine they have developed will, on each cycle, take 100 J of heat out of boiling water at 100°C, do mechanical work of 80 J, and exhaust 20 J of heat at 10°C. What, if anything, is wrong with this claim?

A) There is nothing wrong with this claim because 100 J = 20 J + 80 J.
B) An engine would operate by taking in heat at the lower temperature and exhausting heat at the higher temperature.
C) The heat exhausted must always be greater than the work done according to the second law of thermodynamics.
D) This engine violates the first law of thermodynamics because 100 J + 20 J $\neq$ 80 J.
E) The efficiency of this engine is greater than the ideal Carnot cycle efficiency.

Answer: E

16) Under steady state conditions, a piece of wood 350 mm by 350 mm and 15 mm thick conducts heat through its thickness and loses no appreciable heat through its well-insulated sides. The rate of heat flow is measured to be 14.0 W when the temperature difference across its thickness is 28°C. Determine the thermal conductivity of this wood.

A) 33 W/(m · °C)
B) 270 W/(m · °C)
C) 16 W/(m · °C)
D) 9.2×10^{-4} W/(m · °C)
E) 0.061 W/(m · °C)

Answer: E

17) A substance has a melting point of 20°C and a heat of fusion of 3.9×10^4 J/kg. The boiling point is 150°C and the heat of vaporization is 7.8×10^4 J/kg at a pressure of 1.0 atm. The specific heats for the solid, liquid, and gaseous phases are 600 J/(kg·K), 1000 J/(kg·K), and 400 J/(kg·K), respectively. The quantity of heat required to raise the temperature of 3.80 kg of the substance from -6°C to 128°C, at a pressure of 1.0 atm, is closest to

A) 470 kJ.
B) 770 kJ.
C) 210 kJ.
D) 560 kJ.
E) 620 kJ.

Answer: E

18) Assuming the radius of diatomic molecules is approximately 1.0×10^{-10}m, for what pressure will the mean free path in room-temperature (20°C) nitrogen (N_2) be 4.3 m?

A) 1.6×10^{-7} atm
B) 6.9×10^{-7} atm
C) 5.2×10^{-8} atm
D) 7.4×10^{-8} atm
E) 2.3×10^{-7} atm

Answer: C

19) The second law of thermodynamics leads us to conclude that

A) it is theoretically impossible to convert work into heat with 100% efficiency.
B) the total energy of the universe is constant.
C) the total energy in the universe is decreasing with time.
D) disorder in the universe is increasing with the passage of time.
E) the total energy in the universe is increasing with time.

Answer: D

20) A sample of gas in an experiment is at a temperature of $-50^{o}C$ and a pressure of 1.8 atm. If the sample's temperature is doubled, what is its new temperature?

A) $-100^{o}C$
B) $123^{o}C$
C) $173^{o}C$
D) $100^{o}C$
E) $-25^{o}C$

Answer: C