Distinguish between work and energy.
A) Energy is a property: an object may possess energy. Work is a process: an object may do work.

Which of the following is not allowed by the law of energy conservation?
C) Energy can be created or destroyed; i.e., as the bowling ball on the carpet slowed down, its kinetic energy was completely destroyed.

Which of the following is allowed by the law of energy conservation?
A) Energy can be moved from one object to another as one object does work on the other; i.e., as the bowling ball rolled across the carpet, energy was transferred to the carpet in the form of heat.

If an object’s internal energy decreases,
A) its temperature will also decrease.

During the 19th century, why was Lord Kelvin reluctant to accept the idea that the earth must be hundreds of millions of years old?
B) Because he treated the problem as one of thermodynamics, and analyzed the rate of energy loss. His calculations implied a much younger earth.

Lord Kelvin’s method for determining the age of the earth
B) was modified in the light of new information. He made an assumption (that no energy was being produced from within the earth) that was later shown to be false (when radioactive decay was discovered).

The first law of thermodynamics is written: \( \Delta U = Q - W \). What does \( \Delta U \) mean?
B) \( \Delta U \) is the change in an object’s internal energy as a result of doing work.

According to the first law of thermodynamics, energy
D) is conserved: it can be moved around as heat or mechanical work, but not created or destroyed.

According to the second law of thermodynamics,
D) natural processes result in a system’s tendency toward increasing disorder.

You set your cup of fresh, hot coffee on the counter while you answer the phone. Ten minutes later, the coffee has cooled considerably. The energy lost by the coffee has been gained by the surroundings: the countertop, the air.

You have a lovely plate of leftover enchiladas from your favorite Mexican restaurant. When you place the leftovers in the refrigerator, they are cooled from room temperature (68°F) to 38°F.
D) Thermo #2 is not violated. The refrigerator is able to chill the plate of food because it draws energy in the form of electricity from an external source. The process is not spontaneous.

Why does heat flow from a colder to a warmer object?
A) It doesn’t. The warmer object has more energy, and transfers some of it to the colder object that has less energy.

What is a heat engine?
B) A device that converts heat energy into useful work.

When you ride your bicycle,
C) your efficiency is \( e < 1 \). Not all of the energy you expend is used to do work. Some of the energy ends up going to waste—literally. You will use some of your energy to raise your own temperature.

The theoretical efficiencies of most commonly used heat engines
B) are typically around 50%, but the actual efficiencies are lower—around 25–30%.

According to the definition of efficiency, if a heat engine is 25% efficient,
A) for every 100J of energy input, 25J of useable work is produced.
17. Describe the Otto cycle four-stroke engine.
   A) Suck: the air-fuel mixture into the cylinder
   Squash: the air-fuel mixture to compress
   Bang!: the spark plug ignites the mixture
   Blow: the exhaust out
   B) Push: the spark plug into the cylinder
   Pull: the fuel mixture into the chamber
   Twist: the crankshaft to open the valve
   Pop!: ignite the fuel mixture

18. An engine’s displacement, measured in liters, is equal to
   C) the difference between the maximum and minimum volumes of the chamber.

19. How does the four-stroke cycle show why any engine cannot be 100% efficient?
   C) Once the fuel mixture is ignited (stroke 3), the piston must be returned to its original position before the cycle can repeat. Compressing the exhaust gases raises their temperature, but the energy can’t be used.

20. Efficiency can be defined in terms of temperature: \( \epsilon = (T_{\text{hot}} - T_{\text{cold}})/T_{\text{hot}} \) Which of the following is a logical consequence of this definition?
   A) For an engine to be 100% efficient, the cold reservoir would have to exist at OK—absolute zero. Because no engine can be 100% efficient, then nothing can really exist at a temperature of OK.

21. As a real pendulum swings, energy is converted back and forth from potential to kinetic
   C) but slowly dissipates. The energy is lost to the surrounding air in the form of heat, and the pendulum gradually loses its ability to do work. It eventually stops swinging entirely.

22. Which of the following cannot be used to characterize the concept of entropy?
   D) Entropy decreases for naturally occurring processes as order decreases.

23. Which of the following violates the Law of Entropy?
   C) You are stirring together the sugar and cocoa powder for brownies. The sugar ends up entirely on the left side of the bowl, and the cocoa powder ends up entirely on the right side of the bowl.

24. You open a fresh bag of M&Ms, and dump them on the table. Because you are just a little bit compulsive, you sort them into piles by color: brown, red, orange, yellow, green, blue. You find that you have more red pieces than green.
   C) Not only is this possible, but it does not violate any physical laws. Sorting the pieces and creating order is allowed, because it comes at a price. The work you did increased your own entropy.

25. When you throw a shuffled deck of cards into the air, why don’t you expect the cards to land in a pile, sorted by suit and in order of increasing face value?
   B) Because a deck of cards is a set with 52 members, which makes \( 8 \times 10^{67} \) possible ways for the cards to fall. Only 24 of these outcomes fits the criteria, which results in a vanishingly small probability.