1. (CH10, Q01) An object at 0°C is **hotter than** an object at 0°F. 0°C is the freezing point of water, while 0°F is far **below** the freezing point of 32°F.

2. (CH10, Q02) **10 Celsius degrees** spans a greater range of temperature than 10 Farenheit degrees. From the equations on page 190, for example

\[ T_C = \frac{5}{9}(T_F - 32) \]

we can see that 10 Farenheit degrees only spans \((5/9) \times 10 = 5.55\) Celsius degrees.

3. (CH10, Q08) **Yes.** Heat will always flow from the warmer object to the colder object. The warm object will get colder, and the cold object will get warmer until they come to the same temperature.

4. (CH10, Q10) **No.** The two objects may have a different **heat capacity**, therefore they will change temperature by different amounts for the same amount of heat added.

5. (CH10, Q25) **No.** The fact that the air has expanded, meaning it occupies a larger volume though its mass is unchanged, means that it has a lower density. The balloon will float, as it displaces a greater weight of dense unheated air outside.

6. (CH10, Q31) **Yes.** We know electromagnetic radiation can travel through a vacuum, *e.g.* light from distant stars reaches us through the vacuum of space. Since radiation is a means by which heat can flow, heat can flow across a vacuum.

7. (CH10, E01) From the second equation on page 190

\[ T_F = \frac{9}{5}T_C + 32 \]

\[ = \frac{9}{5} \times 45 + 32 = 113°F \]

8. (CH10, E02) From the first equation on page 190

\[ T_C = \frac{5}{9}(T_F - 32) \]

\[ = \frac{5}{9}(14 - 32) = -10°C \]
9. (CH11, Q01)

(a) An automobile engine: **Yes.** The expansion of a heated gas in the piston is used to do work.

(b) An electric motor: **No.** This uses the electromagnetic force to do work. No heat is input to an electric motor.

(c) A steam turbine: **Yes.** Heat is used to generate steam, it is the expansion of the steam which is harnessed to do work.

10. (CH11, Q07) **No,** this is not possible. The engine is converting 100% of the input heat to work. According to the Second Law of Thermodynamics, no heat engine can be 100% efficient. There must be some “exhaust”.

11. (CH11, Q08) **No,** this is not possible. Although the engine is outputting heat in the form of exhaust, the work done is greater (arrow is wider) than the heat input. The efficiency would be greater than 100%.

12. (CH11, Q10) **No,** it can never equal exactly one. If some energy is lost to exhaust, the work done must be less than the heat input. So work/(heat input) < 1.

13. (CH11, Q23) The **shuffled deck** has higher entropy. Entropy is a measure of the state of *disorder* of a system: A shuffled deck is more disordered than an organized deck.

14. (CH11, Q25) **No.** While the coffee in the cup becomes more organized, the thermal energy it held has been dispersed to the environment and hence become more *disorganized.* On the whole, more disorder has been created than order, so the Second Law of Thermodynamics remains valid.

15. (CH11, E01) Applying the definition of efficiency (page 210) we have

\[
e = \frac{W}{Q_H} = \frac{400 \ J}{1,000 \ J} = 0.40 = 40%\]

16. (CH11, E02) Again apply the definition of efficiency, solving for the heat \( Q_H \) taken from the high-temperature source:

\[
Q_H = \frac{W}{e} = \frac{400 \ J}{0.25} = 1,600 \ J\]