Explanation Chapter 2

2.1 What is the SI unit for specific entropy?
Ans: J/(kg*K)

2.2 How is enthalpy defined regarding total energy change formula? h = ?
Ans: u+Pv

2.3 Which of the following items is not a path function
a) Heat
b) Work
c) Pdv
d) Tds
e) T
Ans: E. Note that pdV = a differential amount of work and Tds = a differential amount of heat. Work and heat are quantities that are transferred to or from a system during an interaction. They are not properties since the amount of such a quantity depends on more than just the state of the system. Heat and work are energy transfer mechanisms between a system and its surroundings. Both are path functions (this is their magnitude depends on the path followed during a process). Properties are quantities that depend on a state like pressure, temperate, internal energy, entropy. There are state functions. So T is not a path function.

2.4 We have a car with a combustion engine. The efficiency of the engine is $\eta 1$ = 40%. The efficiency of the crank that spins the wheels is $\eta 2$= 98% due to friction and the efficiency of the wheel moving the car is $\eta 3$=90% due to some loss in elastic energy and heating. The efficiency of the AC is $\eta 4$=50%. What is the overall efficiency of the car?
a) 40%
b) 30%
c) 35%
d) 17.6%
e) 19.6%
Ans: C. It is obtained by multiplying the first 3 efficiencies as the AC efficiency does not have to do with moving the car, it was put there as a diversion.

2.5 The efficiency of a power plant burner is η=35%. We extract 100MW of net heat by burning coal on a mass rate of m_dot = 10 kg/s. What is the higher heating value of the burned coal?
a) 35 MJ/kg
b) 150 MJ/kg
c) 10 MJ/kg
d) 350 MJ/kg
e) 28.5 MJ/kg
Ans: E. Using the formula 2.42 or 2.43 from the book, the HHV or heating value can be calculated.

2.6 One litre of an ideal gas with a pressure of 1 atmosphere and a temperature of 298 K is expanded isothermally and reversibly to a volume of 10 litres. Subsequently, it is heated to 500 K, compressed to 1 l and cooled down to 25 degree C so that the gas returns to the initial state. What is the total change of the internal energy U of the gas?
a) 2020 J
b) -2020 J
c) 0 J
d) 4040 J
e) -4040 J
Answer: C. The internal energy does not change. U is a state function, so the total internal energy of the gas has not changed if the system returns to the same state. At the states the system goes through during the processes the system has a different internal energy but in the end all energy differences cancel.

2.7 The temperature of a mono-atomic gas corresponds to:
a) its heating value
b) kinetic energy of molecules
c) repulsion of molecules
d) attraction of molecules
e) surface tension of molecules
Ans: B. The temperature of a gas is determined by the movement of the molecules. The faster they move the more kinetic energy they have, the higher the temperature.

2.8 What is the correct symbol for the rate of heat transfer?
a) Q_dot
b) Q
c) q
d) q_dot
Ans: A. The rate of heat transfer is the amount of heat transferred per second. Heat energy is denoted by the symbol Q (capital) for the total heat (unit J) or q (small) for the specific heat energy (J/kg). The dot is used to denote the transfer of heat per second (unit J/s = W)

2.9 Properties of substances like pressure, temperature, and density, are ....

a) path functions

b) state functions

c) cyclic functions

d) real functions

e) thermodynamic functions

Ans: B. Properties like pressure, temperature and density, are quantities that depend on a state. There are state functions. Opposite, work and heat transfer are quantities that are transferred to or from a system during an interaction. They are not properties since the amount of such a quantity depends on more than just the state of the system. Heat and work are energy transfer mechanisms between a system and its surroundings. Both are associated with a process, not a state. Unlike properties, heat or work has no meaning at a state. They are path functions (this is their magnitude depends on the path followed during a process).

2.10 Heat and work are:

a) point functions

b) system properties

c) path functions

d) intensive properties

e) extensive properties

Ans: C. Work and heat transfer are quantities that are transferred to or from a system during an interaction. They are not properties since the amount of such a quantity depends on more than just the state of the system. Heat and work are energy transfer mechanisms between a system and its surroundings. There are many similarities between them:

-both are boundary phenomena, as they cross the boundary of a system.

-systems possess energy, but not heat or work.

-both are associated with a process, not a state. Unlike properties, heat or work has no meaning at a state.

-both are path functions (this is their magnitude depends on the path followed during a process).

Properties are quantities that depend on a state like pressure, temperate, internal energy, entropy. Those are state functions.

2.11 If a system after undergoing a series of processes, returns to the initial state then

a) process is thermodynamically in equilibrium

b) process is executed in closed system cycle

c) its entropy will change due to irreversibility

d) sum of heat transfer and work will be zero

e) no work will be done by the system

Ans: D. For a system that returns to the initial state the total energy will not change, all heat transfer in or out of the system will be equal to all work added or subtracted from the system. The system can produce work, this net work will be equal to the net heat input. Like the total energy the entropy of the initial state of the system will not change as entropy is a state function, by returning to the initial state the entropy change will be zero. Processes can be executed in open systems (think about a power plant). Boilers, pumps, turbines and condensers are all open systems.

2.12 How much energy is required to increase the temperature of 2 liters water from 20 degree Celsius to 100 degree Celsius? Use a density of 1000 kg/m^3 and a specific heat of 4.2 kJ/kgK.

a) 672 kJ
b) 672 J
c) 672 J/kg
d) 672 kJ/kg
e) 627 MJ/kg

Ans: A.

$$Q = m * c_p * \Delta T = \rho * V * c_p * \Delta T = 2 * 10^{-3} * 4.2 * 80 * 10^3 \frac{m^3 * kJ * K}{kg * K} * \frac{kg}{m^3} = 672 \text{ kJ}$$