

## Quiz 2 Version D

- 1) A heat pump transfers heat from the outside air to the interior of a house. In winter, the outside air averages 2 degree Celsius, and the pump operates by heating water to 80 degree Celsius for circulation through the house. How much work does the pump require for each joule of heat supplied to the house in winter?
- a) 0.2 J b) 0.4 J c) 0.6 J d) 0.7 J e) 0.8 J
- 2) A mixture of monoatomic and di-atomic gases has a specific heat ratio (also referred to as adiabatic exponent)  $\gamma = 1.52$ . What fraction of the molecules are monoatomic. Assume the degrees of freedom are 3 and 5 for the mono and di-atomic gas in this case.
- a) 20% b) 40% c) 60% d) 80% e) 90%

A tightly sealed flask contains 5.0 liter of air at 0 degree Celsius and 100 kPa of pressure.

How much heat is required to raise the air temperature to 20 degree Celsius?

- 3) The molar specific heat of air at constant volume is  $2.5R$ .  
a) 100 J b) 500 J c) 1000 J d) 1500 J e) 2000 J
- 4) A weather balloon is filled with helium and released. What kind of a process is approximated as the balloon rises in the air? Assume the balloon material is an excellent insulator.  
A) Isobaric                      B) Isochoric                      C) Adiabatic                      D) Isothermal
- 5) A system has a heat source supplying heat at a rate of 352W and is doing work at a rate of 235W. At what rate is the internal energy of the system changing?  
A) 50W                      B) 100W                      C) 200W                      D) 400W
- 6) It costs \$140 each summer to operate a home air conditioner with a COP of 1.7. What will be the savings each summer in upgrading to a model with a COP of 2.7 ? Assume the same amount of heat is to be extracted from the house.  
a) \$25 b) \$50 c) \$75 d) \$100 e) \$110

A gas of a single type of molecule undergoes an adiabatic expansion.

- 7) After the expansion, the volume of the gas is 3.5% larger and the pressure of the gas is 5% smaller. Which of the following best describes the accessible degrees of freedom of the gas?

- a) The gas is monatomic, so the molecules don't rotate or vibrate.
- b) Some of the gas molecules rotate, none of them vibrate.
- c) All of the gas molecules rotate, none of them vibrate.
- d) All of the gas molecules rotate, some of them vibrate.

- 8) A power plant's electrical output is 750 MW. Cooling water at 15 degree Celsius flows through the plant at  $2.8 \times 10^4$  kg/sec, and its temperature rises by 8.5 degree Celsius. Assume the plant is a perfect Carnot engine, and its only energy loss is to the cooling water and that the cooling water is effectively the low temperature reservoir. What is the high temperature ?

- a) 100 degree Celsius
- b) 200 degree Celsius
- c) 300 degree Celsius
- d) 400 degree Celsius
- e) 500 degree Celsius

- Given the cyclic processes 1 and 2, which of the statements is most accurate.
- 9) Process 1: Isochoric pressure increase, followed by adiabatic expansion, followed by isothermal compression to arrive back at the starting point.  
Process 2: Isochoric pressure decrease, followed by isobaric expansion, followed by isothermal compression to arrive back at the starting point.
- A) One of the two processes is not possible as it can't get you back to the starting point.
  - B) In both cases, the gas does the same amount of work.
  - C)  $W$  is larger in process 1 than in process 2.
  - D)  $W$  is smaller in process 1 than in process 2.
  - E) Neither of the two processes makes any sense because neither can possibly get you back to the starting point.
- 10) A 50g ice cube at -10 degree Celsius is placed into 50g of water. What must be the initial water temperature if the final mixture still contains equal amounts of water and ice? Assume that all the heat gained by the ice was lost by the water, with no heat transfer to a container or the surroundings. Assume that the experiment takes place at atmospheric pressure, i.e. the melting point of ice is 0 degree Celsius. The specific heat of ice is roughly half that of water.
- a) 0 degree Celsius
  - b) 5 degree Celsius
  - c) 10 degree Celsius
  - d) 12 degree Celsius
  - e) 14 degree Celsius