Kafr El-Sheikh University
Faculty of Engineering
Mechanical Power Eng. Dept.
December 29, 2019 – 3rd Year

First Semester Exam
Theory of Combustion
Time: 3 hours – Full Mark: [75]

Answer the following questions. Assume any necessary assumptions.

1- Choose the correct answer. (15 marks)(a1, a8,b7)

1- Which are the main constituents of fuel from given options?
   a) Carbon and Nitrogen
   b) Oxygen and Hydrogen
   c) Carbon and Hydrogen
   d) Helium and Oxygen

2- The minimum temperature at which a substance begins to burn and extent is called
   a) Fire point temperature
   b) Auto ignition temperature
   c) Ignition temperature
   d) Flash point temperature

3- How much percent of hydrogen gas does methane contain?
   a) 25% b) 50% c) 68% d) 85%

4- Which of the following is the lightest and most volatile liquid fuel?
   a) diesel b) kerosene c) gasoline d) fuel oil

5- During combustion of gaseous fuels, deficiency of air
   a) tends to slower the flame.
   b) tends to faster the flame.
   c)does not affect the flame speed.
   d) increases the flame temperature

6- Gross and net calorific value of a fuel will be the same
   a) if its ash content is zero.
   b) under no circumstances.
   c) if its carbon content is very low.
   d) if its hydrogen/hydrogen compound content is zero.

7- Dry air required to burn 1 kg of carbon completely may be around _____ kg.
   a)1 b)11 c)20 d)32

8- Initial pressure of oxygen introduced into the 'bomb' of the bomb calorimeter for determination of calorific value of coal/fuel oil may be around _____ atm.
   a) 20-30 b) 10-20 c) 60-65 d) 95-100

9- _____ prohibits the use of alcohols directly in petrol engines.
   a) Low calorific value
   b) Low octane number

c) High cost & availability
d) Low flash point

10- _____ present in coal is not determined in its ultimate analysis.

a) Hydrogen b) Total carbon c) Fixed carbon d) Nitrogen

11- The maximum adiabatic flame temperature is attained, when the fuel is burnt with.

a) less than theoretically required amount of air.
b) more than theoretically required amount of air.
c) theoretically required amount of oxygen.
d) theoretically required amount of air.

12- How many kg of air are used to combust 40kg of gasoline C_8H_{18}?

a) 600 b) 615 c) 630 d) 645

13- Change in enthalpy when 1 mol of compound is formed under standard conditions is called

a) Reaction b) formation c) combustion d)neutralization

14- During the process of combustion _____is given out

a) Heat b) Light c) Sound d) Both heat & light

15- If equivalence ratio is 0.6 the excess air is.

a) 0.67 b) 0.76 c) 0.87 d) 1

2- Given reason _____ (6 marks)(a8,c1)

1- Bioethanol is often blended with normal gasoline.

2- the enthalpy formation of CO2 is negative

3- Flame speed with diluents helium is higher than with argon.

3- a) Explain, How can you convert the solid fuel to liquid fuel? And why?**(5 marks)(c1, b11,a8,b5)**

3-b) Mention the types of Elementary reactions with write equations? **(5 marks) (c1)**

3-c) Explain the effect of temperature on the reaction rate, flame speed, and flammability?

(9 marks) (c1, b11,a8,b5)

4- A table of thermodynamic data gives the enthalpy of formation for liquid water $\Delta\hat{H}^{\circ}_{H_2O(l)} = -285.8$ kJ/mol as. A bomb calorimeter burning 1 mol of H_2 with O_2 measures 282.0 kJ of heat transfer out of the reacted mixture. Estimate the error of the enthalpy measurement. **(5 arks)(b11,c7)**

5- A fuel has the following percent analysis by weight :

C: 82 , H_2: 10, S: 3 , O_2 : 2.5 , Ash : 2.5 for an air / fuel ratio of 12 : 1 , calcaulate

a)- the mixture strength as a percentage rich or lean.

b)- the volumetric analysis of the dry products of combustion .

c) the partial pressure of water vapor in the products. **(10 marks)(a8,c7)**

6- Consider combustion of stoichiometric methane-air at a constant temperature of 1,800 K and 101.3 kPa. Using a one-step reaction formulation for the rate constant, estimate the amount of time required to completely consume the fuel. The consumption is assumed constant. And then, estimate the laminar burning velocity at 300 K and 1 atm ,the adiabatic flame temperature is 2,240 K and the ignition temperature is 600 K.

Take α= 2.35 cm2/s. $A_0 = 1.3 \cdot 10^9$, $E_a = 48.4$ kcal/mol, $a = -0.3$, $b = 1.3$ **(20 marks)(b7,c7)**

Good luck, Dr. M. K. El-Fakharany