

# Unit 4 - Week 2: Thermochemistry,Thrust Equation & Performance Parameters of Rocket Engine

## Course outline

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### Week-0

### Week 1: Introduction to Rocket Engines & Governing Equations

### Week 2: Thermochemistry,Thrust Equation & Performance Parameters of Rocket Engine

Lecture 6: Adiabatic Steady 1-D flow & Speed of Sound

Lecture 7: Basics of Thermochemistry

Lecture 8: Adiabatic Flame Temperature & Chemical Equilibrium

Lecture 9: Ideal Rocket Engine, Thrust Equation and Performance Parameters

Lecture 10: Performance Parameters of Rocket Engine

Quiz : Week 2: Assignment

Week 2: Assignment Solution

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### Week 3: Nozzle Characteristics

### Week 4: Characteristic Parameters of Rocket Nozzle

### Week 5: Flight Trajectory & Elements of Orbital Mechanics

### Week 6: Types of Propellant & its Selection, Multi-staging of rocket and SRPE

### Week 7: Solid, Liquid & Composite Propellant Rocket Engine, Burning and Flame Structure

### Week 8: Solid Propellants: Characteristics & Regression Rate Relation

### Week 9: Evolution of Burning surface, Ignition System of Solid Propellant Grains, Types of Liquid Propellant Rocket Engine and Injection System

### Week 10: Liquid Propellant Rocket Engines: Injection system, Atomization, Combustion Process and Feed System

### Week 11: Feed System, Ignition System, Combustion Instability & Cooling System in LPRE

### Week 12: Hybrid Propellant Rocket Engine and Non-chemical Rocket Engine

## Week 2: Assignment

The due date for submitting this assignment has passed.  
As per our records you have not submitted this assignment.

**Due on 2019-08-21, 23:59 IST.**

- 1) The speed of sound in helium gas at 400 K is: 1 point
- 1175 m/s  
 1090 m/s  
 443 m/s  
 1235 m/s
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*1175 m/s*
- 2) Identify the correct statement with respect to the adiabatic flame temperature: 1 point
- Constant pressure adiabatic flame temperature is higher as compared to the constant volume adiabatic flame temperature.  
 Constant pressure adiabatic flame temperature is lower as compared to the constant volume adiabatic flame temperature.  
 Constant pressure adiabatic flame temperature is always equal to the constant volume adiabatic flame temperature.  
 None of the above mentioned
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*Constant pressure adiabatic flame temperature is lower as compared to the constant volume adiabatic flame temperature.*
- 3) The stoichiometric air to fuel ratio for  $C_4H_{10}$  on mass basis is: 1 point
- 12.36  
 9.35  
 15.38  
 18.45
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*15.38*
- 4) The amount of excess air present in a mixture for equivalence ratio  $\phi=0.8$ : 1 point
- 100%  
 75%  
 50%  
 25%
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*25%*
- 5) The amount of thrust developed for a fully expanded rocket nozzle that consumes 400 kg of propellant in 10 s with equivalent exhaust velocity of 1850 m/s is: 1 point
- 50 kN  
 74 kN  
 130 kN  
 64 kN
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*74 kN*
- 6) Adiabatic flame temperature always increases with equivalence ratio. Given statement is: 1 point
- True  
 False
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*False*
- 7) The reaction will attain its chemical equilibrium when Gibbs free energy attains its maximum value. Given statement is: 1 point
- True  
 False
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*False*
- 8)  $I_{sp}$  does not depend on the flight velocity for non-air breathing engines. Given statement is: 1 point
- True  
 False
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*True*
- 9) The  $I_{sp}$  value for electric rocket engine is high as compare to the solid propellant rocket engines. This statement is: 1 point
- True  
 False
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*True*
- 10) Mass flow coefficient depend on: 1 point
- Mass flow rate of propellant  
 Chamber pressure  
 Nozzle throat area  
 All of these
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*All of these*
- 11) Exhaust gas ( $\gamma=1.3$ ) at pressure 100 kPa and temperature 600 K enters into a C-D nozzle with inlet Mach number 0.8. If the exit pressure is 70 kPa, then the exit Mach number and temperature are: 2 points
- 1.20 & 470 K  
 1.20 & 553 K  
 1.12 & 553 K  
 1.12 & 470 K
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*1.12 & 553 K*
- 12) An aviation engine operates at air-fuel ratio of 5 on mass basis using octane as fuel. Corresponding equivalence ratio for this operating condition is: 2 points
- 0.63  
 0.96  
 0.80  
 0.75
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*0.63*
- 13) Higher heating value of liquid ethanol and oxygen at 298 K is: 2 points  
( Heat of formation data:  
 $h_f(CO_2) = -394.0$  kJ/mol,  
 $h_f(H_2O(l)) = -286$  kJ/mol,  
 $h_f(H_2O(g)) = -243$  kJ/mol,  
 $h_f(C_2H_5OH) = -228$  kJ/mol)
- 13.5 MJ/kg  
 30.8 MJ/kg  
 20.2 MJ/kg  
 9.3 MJ/kg
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*30.8 MJ/kg*
- 14) Consider the following equilibrium reaction 2 points  
 $H_2 \rightarrow 2H$   
The mole fractions of  $H_2$  and H at 3000 K and 3 atm are: ( $K_p=10^{-0.8}$ )
- 0.914 & 0.086  
 0.825 & 0.175  
 0.855 & 0.145  
 0.784 & 0.216
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*0.914 & 0.086*
- 15) 2 moles of  $CH_4$  react with air in stoichiometric proportion at 298K in a constant pressure vessel. The adiabatic flame temperature is: 2 points  
Heat of formation data:  
 $h_f(CH_4) = -72.1$  kJ/mol,  
 $h_f(CO_2) = -394.0$  kJ/mol,  
 $h_f(H_2O) = -244.5$  kJ/mol,  
Specific heat capacity data:  
 $C_p(CH_4) = -75.328$  J/mol.K,  
 $C_p(CO_2) = 55.396$  J/mol.K,  
 $C_p(H_2O) = 42.44$  J/mol.K,  
 $C_p(N_2) = 33.0$  J/mol.K)
- 2130.6 K  
 2250.5 K  
 2385.6 K  
 2440.8 K
- No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*2385.6 K*