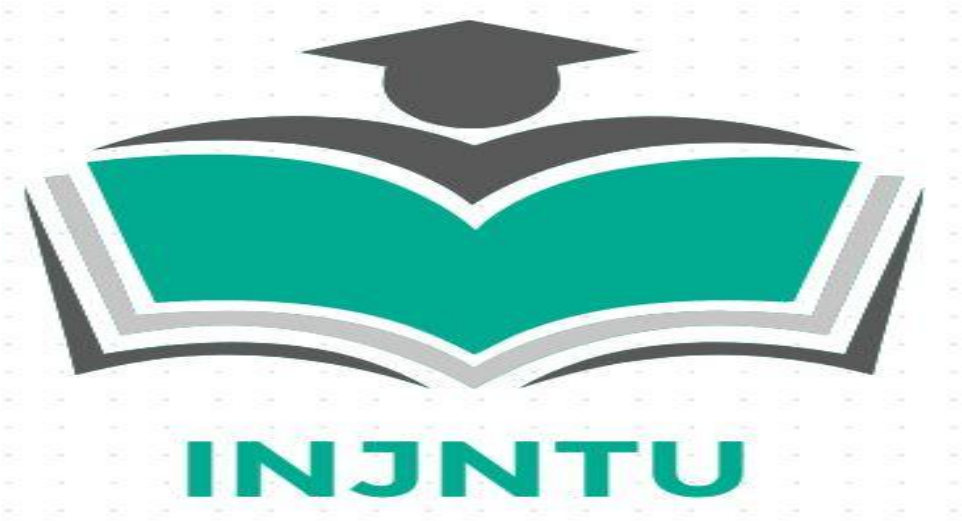

OBJECTIVES

To get the basic concepts of thermodynamics, temperature measurement, first law and also ability to determine the heat, work in various flow & non-flow processes.

1. To gain the knowledge about second law of thermodynamics and determine the change in entropy, availability in various processes.
2. To get the knowledge various phases of pure substance and calculate its properties using steam tables and Mollier chart to determine properties of perfect gases in various processes.
3. To develop to learn the concepts of mixture of gases and to calculate the property values during any process.
4. To get the knowledge about the working of different types of cycles and their performance which emphasizes knowledge in IC engines.

1. Group - A (Short Answer Questions)

S. No.	Question	Blooms Taxonomy Level	Course Outcomes
	Unit – I		
1	(a) Explain Zeroth law of Thermodynamics. (b) When a stationary mass of gas was compressed without friction at constant pressure, its initial state of 0.4m^3 and 0.105MPa was found to change to final state of 0.20m^3 and 0.105MPa. There was a transfer of 42.5kJ of heat from the gas during the process. How much did the internal energy of the gas change?	Concept Application	1
2	(a)Define System, Surroundings and Boundary? (b) 0.44kg of air at 180^{0}C, expands adiabatically to 3times its original volume and during the process there is a fall in temperature to 15^{0}C. The work done during the process is 52.5kJ. Calculate Cp and Cv ?	Concept Application	1
3	(a) Distinguish between macroscopic and microscopic point of view? (b)Two thermometers one centigrade and other Fahrenheit are immersed in a fluid, after the thermometers reached equilibrium	Application, Synthesis	1

<table>
<tr><th>S. No.</th><th>Question</th><th>Blooms Taxonomy Level</th><th>Course Outcomes</th></tr>
<tr><td></td><td>with the fluid, it is noted that both the thermometers indicate the same numerical values. Find that the identical numerical values shown by the thermometers? What would be the corresponding temperature of the fluid, expressed in degrees Kelvin and degrees Rankine?</td><td></td><td></td></tr>
<tr><td>4</td><td>(a) What is Quasi Static process, what are its characteristics?
(b) Define path function and point function. Describe the following whether they are path functions or point functions, explain how?
i). Heat ii) Work iii)Temperature</td><td>Concept, synthesis</td><td>1</td></tr>
<tr><td>5</td><td>(a)Distinguish between different types of systems with examples
(b)Derive the expression for work done in
i) Isothermal process
ii) Polytropic process</td><td>Concept</td><td>1</td></tr>
<tr><td>6</td><td>a) Explain the features of constant volume gas thermometer.
b) A piston cylinder device operates 1kg of fluid at 20atm pressure with initial volume is 0.04m^3. Fluid is allowed to expand reversibly following $pV^{1.45}$=C. So that the volume becomes double. The fluid is cooled at constant pressure until the piston comes back. Determine the work done in each process?</td><td>Comprehension, Application</td><td>1</td></tr>
<tr><td>7</td><td>a). What is the First law of thermodynamics, explain Joule’s experiment.
b).A fluid contain in a horizontal cylinder with a frictionless leak proof piston is continuously agitated by a stirrer passing through the cylinder cover. The diameter of the cylinder is 50cm and the piston is held against the fluid due to atmospheric pressure equal to 100kPa. The stirrer turns 8000 revolutions with an average torque of 1.5Nm. If the piston slowly moves outwards by 60cm. Determine the net work transfer to the system?</td><td>Comprehension, Application</td><td>1</td></tr>
<tr><td>8</td><td>a) Define PMM 1.
b) A Piston and cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle the sum of all heat transfers is -170kJ. The system completes 100cycles/minute. Complete the following table showing the method for each item and compute net rate of work output in kW.
<table>
<tr><td>Process</td><td>Q(kJ/min)</td><td>W(kJ/min)</td><td>ΔE(kJ/min)</td></tr>
<tr><td>a-b</td><td>0</td><td>2170</td><td>----</td></tr>
<tr><td>b-c</td><td>21000</td><td>0</td><td>----</td></tr>
<tr><td>c-d</td><td>-2100</td><td>----</td><td>-36600</td></tr>
<tr><td>d-a</td><td>----</td><td>----</td><td>----</td></tr>
</table></td><td>Comprehension, Application</td><td>1</td></tr>
<tr><td>9</td><td>a) What are the causes of irreversibility?
b) A fluid is confined in a cylinder by a spring loaded friction less piston, so the pressure in the fluid is a linear function of</td><td>Reason Synthesis</td><td>1</td></tr>
</table>

S. No.	Question	Blooms Taxonomy Level	Course Outcomes
	volume (p=a+bV).The internal energy of the fluid is given by the following equation U=34+3.15pV. Where U is in kJ, p in kPa and V is in m^3. If the fluid changes from initial state of 170kPa, 0.03m^3 to a final state of 400kPa, 0.06m^3 with no work other than that done on the piston. Find the direction and magnitude of work and heat transfer.		
10	a) Derive Steady Flow Energy Equation, when the device is an air compressor. b) Air flows steadily at the rate of 0.5kg/sec through an air compressor, entering at 7m/sec velocity, 100kpa pressure and 0.95m^3/kg volume and leaving at 5m/sec, 700kpa and 0.19m^3/kg. The internal energy of air leaving is 90kJ/kg greater than that of air entering. Cooling water in the compressor jacket absorbs heat from the air at the rate of 58kw.Compute the rate of shaft work input to the air in KW.	Comprehension, Application	1
	UNIT – II		
1	(a) What are the limitations of first law of thermodynamics? (b) A heat engine working on Carnot cycle converts 1/5th of the heat input into work. When the temperature of the sink is reduced by 80^{0}C, the efficiency gets doubled. Make calculations for temperature of sink?	Comprehension, Evaluation	3
2	(a) Describe second law of thermodynamics by Kelvin-Plank statement and Clausius statement? (b) Establish the equivalent of Kelvin-Plank and Clausius statements?	Evaluation, Application	3
3	a) What is PMM 2, why is it impossible .Explain b) 1kg of ice at -5^{0}C expose to the atmosphere which, is at 20^{0}C. The ice melts and comes into thermal equilibrium with the atmosphere. Determine the entropy increase of Universe. Cp for ice is 2.039 kJ/kgK, and the enthalpy of fusion of ice is 333.3kJ/kg. c) State and explain Carnot Theorem with neat sketch on P-V and T-S diagram	Comprehension, Application	3
4	a) What is Carnot Cycle, what are the processes which constitutes the cycle. Draw on PV and TS diagrams? b) A domestic food freezer maintains a temperature of -15^{0}C, the ambient air temperature is 30^{0}C, if heat leaks into the freezer at the continuous rate of 1.75kJ/sec. What is the least power necessary to pump this heat out continuous?	Evaluation , Application	3
5	a) State and prove Clausius inequality? b)A heat engine is operating between two reservoirs 1000K and 300K is used to drive a heat pump which extracts heat from the reservoir at 300K at a rate twice that at which the engine rejects the heat to it. If the efficiency of the engine is 40% of the maximum possible and COP of heat pump is 50% of the maximum possible, then determine the temperature of the reservoir to which the heat pump rejects heat. Also determine the rate of heat rejection from the heat pump, if the rate of heat supply to the heat engine is 50kW?	Application	3

S. No.	Question	Blooms Taxonomy Level	Course Outcomes
6	(a)What is absolute temperature scale? Develop this scale from Carnot cycle? (b) Three Carnot engine are arranged in series. The first engine takes 4000kJ of heat from a source at 2000K and delivers 1800kJ of work. The second and third engines deliver 1200kJ and 500kJ of work respectively. Make calculations for the exhaust temperature of second and third Carnot engines?	Analysis, Application	3
7	(a) Explain the principle of entropy increase? (b) Two bodies of equal capacities C and T_1 and T_2 from an adiabatically closed system. Determine the final temperature, if the system is brought to an equilibrium state. i) Freely ii) reversibly , Proceed to calculate the maximum work which can be obtained from the system?	Evaluation , Application	3
8	a) What is an inversion curve? Show that on T and P coordinates while giving the definition of Joule Kelvin coefficient? b) A heat engine is supplied with 2512kJ/min of heat at 650^0C. Heat rejection takes place at 100^0C. Specify which of the following heat rejection represent a reversible, irreversible or impossible result. i)867kJ/min ii)1015kJ/min iii)1494kJ/min	Application , Evaluation	3
9	a) Using Maxwell's relations, deduce the two T -dS equations? b) Heat flows from a hot reservoir at 800K to another reservoir at 250K.If the entropy change of overall process is 4.25kJ/K, make calculation for the heat flowing out of the high temperature reservoir?	Application	3
10	a) What is the Third law of Thermodynamics? b) Air expands through a turbine from 500kPa, 520^0C to 100kPa, 300^0C. During expansion 10kJ/kg of heat is lost to the surroundings, which is at 98kPa, 20^0C. Neglecting K.E and P.E changes, determine per kg of air i)the decrease in availability ii)the maximum work iii)irreversibility for air take Cp=1.005kJ/kgk	Application	3
	UNIT – III		
1	(a) Write the equation of state and explain. (b) The volume of a high altitude chamber is $40m^3$.It is put into operation by reducing pressure from 1bar to 0.4bar and temperature from 25^0C to 5^0C.How many kg of air must be removed from the chamber during the process? Express this mass as a volume measured at 1bar and 25^0C.	Application, Comprehension	3, 4
2	(a) Derive the changes in internal energy during a process with variable specific heats. (b) A fluid at 200kPa and 300^0C has a volume of $0.8m^3$ in a frictionless process at constant volume, the pressure changes to	Knowledge, Comprehension	3, 4

S. No.	Question	Blooms Taxonomy Level	Course Outcomes
	100kPa. Find the final temperature and heat transfer, if the fluid is air?		
3	a) Derive the changes in enthalpy during a process with variable specific heats. b) A fluid at 250^0C and 300kPa is compressed reversibly and isothermally to $1/16^{th}$ of its original volume. Find the final pressure, work done and change of internal energy per kg of fluid, if the fluid is air?	Analysis, Comprehension	3, 4
4	a) Explain the process of free expansion? (b) Show that for an ideal gas the slope of the constant volume line on the T-S diagram is more than that of the constant pressure line.	Comprehension	3, 4
5	a) Explain the process of Throttling? b)The specific heats of a gas are given by $C_p=a+kT$ and $C_v=b+kT$ where a, b, k are constants and T is in Kelvin. Show that for an isentropic expansion of gas $T^bv^{(a-b)}e^{kT}$=constant.	Synthesis	3, 4
6	(a) Write the expression for Vander Wall's equation and determine the constants? (b) A reversible polytropic process begins with a fluid at p_1=10bar, T_1=200^0C and at p_2=1bar, the exponent n has the value 1.15. Find the final specific volume, the final temperature and the heat transfer per kg of fluid, if the fluid is air.	Comprehension, Synthesis	3, 4
7	a) On what coordinates compressibility charts can be drawn, explain? b) A certain gas has Cp=1.968 and C_v=1.507kJ/kg K. Find its molecular weight and the gas constant?	Knowledge	3, 4
8	a) What are molar specific heats, explain? b) A constant volume of $0.3m^3$capacity contains 2kg of this gas at 5^0C. Heat is transferred to the gas until the temperature is 100^0C. Find the work done, the heat transfer and changes in internal energy, enthalpy and entropy?	Knowledge, Comprehension	3, 4
9	a) Derive the expression for work done in a non-flow process, if the process is adiabatic? b) A reversible adiabatic process begins at p_1=10bar, T_1=300^0C and ends with p_2=1bar. Find the specific volume and the work done per kg of fluid, if the fluid is air?	Synthesis, Comprehension	3, 4
10	a) Write short notes on reduced properties and define reduced temperature, reduced volume and reduced pressure? b) Derive an expression for entropy change of an ideal gas from Tds equations?	Comprehension	3, 4
	UNIT – III-B		
1	(a) What is a Pure Substance and what do you understand by a saturation stage? (b) Saturated steam has entropy of 6.76kJ/kg K. What are its pressure, temperature, specific volume, enthalpy and internal energy?	Application, Comprehension	3, 4
2	(a) Draw the phase diagram on p-v diagrams with water as pure substance?	Knowledge, Comprehension	3, 4

S. No.	Question	Blooms Taxonomy Level	Course Outcomes
	(b) A large insulated vessel is divided in to two chambers. One is containing 5kg of dry saturated steam at 0.2MPa and other 10kg of steam, 0.8quality at 0.5MPa. If the partition between the chambers is removed and the steam is mixed thoroughly and allow to settle. Find the final pressure steam quality and entropy change in the process?		
3	a) Explain the concept of p-v-T surface? Represent on p-T coordinates? b) Find the enthalpy and entropy of steam and the pressure is 2MPa and the specific volume is 0.09m3/kg.	Analysis, Comprehension	3, 4
4	a) What is the critical state? Explain the terms critical pressure, critical temperature and critical volume of water? b) The following data were obtained with a separating and throttling calorimeter. Pressure in pipe line is 1.5MPa. Condition after throttling is at 0.1MPa,110^{0}C, During 5minutes moisture collected in the separator 0.15lt at 70^{0}C steam condense after throttling during 5 min 3.24kg Find the quality of steam in the pipe line?	Comprehension	3, 4
5	a) Draw the phase equilibrium diagram for a pure substance on T-s plot with relevant constant property line? b) Steam flows in a pipe line at 1.5MPa. After expanding to 0.1MPa in a throttling calorimeter, the temperature is found to be 120^{0}C.Find the quality of the steam in pipe line?	Synthesis	3, 4
6	(a) Draw the phase equilibrium diagram for a pure substance on H-s plot with relevant constant property line? (b) Steam initially at 1.5MPa, 300^{0}C expands reversibly and adiabatically in a steam turbine to 40^{0}C. Determine the ideal work output of the Turbine per kg of steam?	Comprehension, Synthesis	3, 4
7	a) Why do isobar on Mollier diagram diverse from one another? b) A vessel of volume 0.04m^3 contains a mixture of saturated water and saturated steam at a temperature of 250^{0}C. The mass of the liquid present is 9kg.Find the pressure, mass, specific volume, enthalpy, entropy and internal energy?	Knowledge	3, 4
8	a) Explain Mollier chart by representing all the properties on it? b) Find the enthalpy, entropy and volume of steam at 1.4MPa, 380^{0}C.	Knowledge, Comprehension	3, 4
9	a) What do you understand by degree of superheat and degree of sub cooling? b) Find the saturation temperature, the changes in specific volume, enthalpy and entropy during evaporation at 1MPa.	Synthesis, Comprehension	3, 4
10	a) Define dryness fraction? What are the different methods of measurement of dryness fraction? b) Why can not a throttling calorimeter measure the quality, if the steam is wet? Explain how is the quality been measured?	Comprehension	3, 4
	UNIT – IV		
1	(a) State Dalton's law of partial pressures?	Comprehension	3

<table>
<tr><th>S. No.</th><th>Question</th><th>Blooms Taxonomy Level</th><th>Course Outcomes</th></tr>
<tr><td></td><td>(b) The analysis by weight of a perfect gas mixture at 20^0C and 1.3bar is 10%O_2, 70%N_2,15%CO_2 and 5%CO. For a reference state of 0^0C and 1bar, determine partial pressure of the constituent and gas constant of mixture.</td><td>, knowledge</td><td></td></tr>
<tr><td>2</td><td>(a) How are the characteristic gas constant and the molecular weight of the gas mixture computed?
(b) In an engine cylinder a gas has a volumetric analysis of 13%CO_2, 12.5%O_2 and 74.5%N_2. The temperature at the beginning of expansion is 950^0C and gas mixture expands reversibly through a volume ratio of 8:1. According to the law $pV^{1.2}$=constant. Calculate per kg of gas, the work done and the heat flow. Take Cp for CO_2=1.235kJ/kgK and O_2=1.088kJ/kgK and N_2 is 1.172kJ/kgK.</td><td>Synthesis, Comprehension</td><td>3</td></tr>
<tr><td>3</td><td>(a) Obtain the expression for internal energy, enthalpy of gas mixture?
(b) The following is the volumetric analysis of a producer gas: CO=28%,H_2=13%,CH_4=4%,CO_2=4%,N_2=51%. The values of Cp for the constituent CO,H_2, CH_4,CO_2 and N_2 are 29.27kJ/mol.K,28.89kJ/mol.K, 35.8kJ/mol.K,37.22kJ/mol.K,29.14kJ/mol.K respectively. Calculate the values of Cp,Cv for the mixture.</td><td>Comprehension, Analysis</td><td>3</td></tr>
<tr><td>4</td><td>(a) Define mole fraction, mass fraction and law of additive volumes?
(b) The gravimetric analysis of air and other data are as follows:
<table>
<tr><td>Constituent</td><td>Percentage</td><td>Molecular weight</td></tr>
<tr><td>Oxygen</td><td>23.14</td><td>32</td></tr>
<tr><td>Nitrogen</td><td>75.53</td><td>28</td></tr>
<tr><td>Argon</td><td>1.28</td><td>40</td></tr>
<tr><td>Carbon dioxide</td><td>0.05</td><td>44</td></tr>
</table>
Calculate i) Gas constant for air ii)Apparent molecular weight</td><td>Analysis, Knowledge</td><td>3</td></tr>
<tr><td>5</td><td>a) Explain about volumetric and gravimetric analysis?
b) A mixture of hydrogen and oxygen is to be made, so that the ratio of H_2 to O_2 is 2:1 by volume. If the pressure and temperature are 1bar and 25^0C, respectively. Calculate mass of oxygen required and volume of the container?</td><td>Analysis Synthesis,</td><td>3</td></tr>
<tr><td>6</td><td>a) Define Dry bulb temperature, Wet bulb temperature , Dew point temperature and Degree of Saturation?
(b)Air at 10bar and a DBT of 40^0Cand WBT of 36^0C.Compute degree of saturation, dew point temperature and enthalpy of the mixture?</td><td>Analysis, Application</td><td>3</td></tr>
<tr><td>7</td><td>a) Write short notes on adiabatic saturation temperature?
b) Atmospheric air at 1.0132bar has DBT of 32^0C and a WBT of 26^0C. Compute partial pressure of the water vapor, specific humidity, dew point temperature and relative humidity?</td><td>Comprehension</td><td>3</td></tr>
<tr><td>8</td><td>a) Explain psychrometric charts while representing all the properties?
b) Air at 20^0C,40% RH is mixed adiabatically with air at 40^0C,</td><td>Analysis, Application</td><td>3</td></tr>
</table>

S. No.	Question	Blooms Taxonomy Level	Course Outcomes
	40%RH in the ratio of 1kg of the former with 2kg of later(on dry basis).Find the final condition of air?		
9	a) Represent i) sensible heating ii) sensible cooling iii)heating and humidification iv)heating and dehumidification on Psychrometric chart? b) Saturated air at 21^0C is passed through a dryer, so that its final relative humidity is 20%. The dryer uses silica gel absorbent. The air is then pass through a cooler until its final temperature is 21^0C without a change in specific humidity. Find out i)the temperature of air at the end of the drying process, ii) the relative humidity at the end of the cooling process, iii)The dew point temperature at the end of the drying process?	Synthesis, Application	3
10	a) Define bypass factors represent adiabatic mixing of two air streams on psychrometric chart? b) An air water vapor mixture enters an adiabatic saturator at 30^0C and leaves at20^0C, which is the adiabatic saturation temperature? The pressure remains constant at 100kPa. Determine the relative humidity and humidity ratio of the inlet mixture.	Comprehension	3
	UNIT –V		
1	a) What are the assumptions to be made for the analysis of all air standard cycles? b) Derive the expression for air standard efficiency of a constant volume cycle?	Application	1
2	(a) Describe Otto cycle with all the processes involved and represent on P-V and T-S diagrams? (b) An engine working on Otto cycle has a volume of $0.45m^3$ pressure 1bar and temperature 30^0C at the beginning of the compression stroke. At the end of the compression stroke the pressure is 11bar. 210kJ of heat is added at constant volume. Determine efficiency and mean effective pressure?	Comprehension, Knowledge	1
3	(a) Describe Constant Pressure cycle with all the processes involved and represent on P-V and T-S diagrams? (b)An engine with 200mm cylinder diameter and 300mm stroke working on theoretical diesel cycle. The initial pressure and temperature of air used are 1bar and 27^0C. The cut of is 8% of the stroke. Determine air standard efficiency, mean effective pressure and power of the engine if the working cycles per minute are 300? Assume the compression ratio is 15 and the working fluid is air.	Comprehension	1
4	(a) What are the variable factors which are used for comparison of cycles? Compare between Otto cycle, Diesel and Dual combustion cycle? (b) The efficiency of an Otto cycle is 60% and $\gamma = 1.5$. What is the compression ratio? (c) An inventor claims that a new heat cycle will develop 0.4kw for a heat addition of 32.5kJ/min. The temperature of heat source is 1990K and that of sink is 850K. Is his claim	Application	1

S. No.	Question	Blooms Taxonomy Level	Course Outcomes
	possible?		
5	a) What is Atkinson cycle? How it differs from Otto cycle? b) A perfect gas undergoes a cycle which consists of following processes. i) heat rejection at constant pressure ii) adiabatic compression from 1bar and 27^0C to 4 bar iii) heat addition at constant volume to a final pressure of 16bar iv) adiabatic expansion to 1bar. Calculate work done per kg of gas and efficiency of the cycle. Take Cp = 0.92 and Cv=0.7.	Comprehension, Knowledge	1
6	a) Derive the air standard efficiency of Diesel cycle? b) The stroke and cylinder diameter of Compression Ignition engine are 250mm and 150mm respectively. If the clearance volume is 0.0004m^3 and fuel injection takes place at constant pressure for 5% of the stroke. Determine the efficiency of the engine. Assume the engine working on Diesel cycle?	Synthesis, Knowledge	1
7	a) Define mean effective pressure and deduce the expression for it? b) An engine of 250mm bore and 375mm stroke works on Otto cycle. The clearance volume is 0.00263m^3. The initial pressure and temperature are 1bar and 50^0C. The maximum pressure is limited to 25bar. Find the air standard efficiency and the mean effective pressure of the cycle? Assume ideal conditions?	Analysis, Comprehension	1
8	a) What are the functional parts of simple vapor compression system represents the processes on T-S diagram and hence deduce its COP? b) 28tonnes of ice from and at 0^0C is produced per day in an Ammonia refrigerator. The temperature range in the compressor is from 25^0C to -15^0C. The vapor is dry and saturated at the end of the compression and expansion valve is used. Assuming the C.O.P of 62% of the theoretical. Calculate power required to drive the compressor?	Knowledge, Comprehension	1
9	a) Draw the P-V and T-S diagrams of Bell-Coleman cycle while representing process and hence deduce its COP? b) A Bell-Coleman refrigerator operates between pressure limits of 1bar and 8bar. Air is drawn from the cold chamber at 9^0C, compressed and then it is cooled to 29^0C before entering the expansion cylinder. Expansion and compression follow the law $pV^{1.35}$=C.Calculate theoretical C.O.P of the system. Take ɣ of air is 1.4.	Comprehension, Knowledge	1
10	a) What is a limited pressure cycle, represent the processes of it on P-V and T-S diagrams? b) The swept volume of a Diesel engine working on Dual cycle is 0.0053m^3 and clearance volume is 0.00035m^3. The maximum pressure is 65bar. Fuel injection ends at 5% of stroke. The temperature and pressure of the start of the compression are 80^0C and 0.9bar. Determine air standard efficiency of cycle? Take ɣ of air is 1.4.	Knowledge, Comprehension	1