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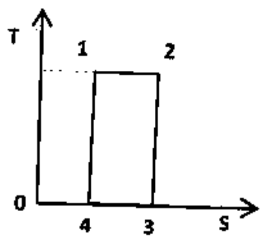
AS5

QP Code 54367.

N.B : (1) All questions are compulsory. (2) Figures to the right indicate maximum marks. (3) Use of non-programmable calculators is permitted. (4) Symbols used have their usual meaning			
Q1.	**A)**	**Select correct answer**	**(12)**
	1	A spring stretches by 5cm when a mass of 2Kg is suspended at one end, The spring constant is: c) 392 N/m	
	2	At what rate must the fuel burn to give a 20kg rocket an acceleration of 1g having exhaust velocity 2500 m/sec. b) 78.4 gm/s	
	3	The efficiency of a Carnot engine is 100%. The temperature of the sink is a)0 K	
	4	The thermodynamic scale of temperature does not have d) – 50 K	
	5	If $C_P = 6$ and $C_V = 4$ then the value of γ is b) 1.5	
	6	In Otto engine, the spark plug fires shortly before the following stroke d) expansion	
	B)	**Answer in one sentence**	**(03)**
	1	Definition	
	2	Statement	
	3	Air	
	C)	**Fill in the Blanks**	**(5)**
	1	The projection of Uniform Circular motion on the diameter is Linear simple harmonic motion or SHM	
	2	As damping increases the resonant frequency decreases.	
	3	The entropy of the universe is maximum.	
	4	A reversible process is necessarily quasistatic.	
	5	In case of substance that contracts on melting, $\frac{dP}{dT}$ is **negative.**	
Q2.	**A)**	**Attempt any one**	**(8)**
	1	Equation for damped oscillation (1 Mark) Solving and final expression (7 marks)	
	2	Equation of motion (1 mark) Remaining steps till the final expression (7 marks)	
	B)	**Attempt any one**	**(8)**
	1	Equation for damped oscillation (1 Mark) Solving and final expression (7 marks)	
	2	Equation of motion (1 mark) Remaining steps till the final expression (7 marks)	

	C)	**Attempt any one**	
	1	Equation is $\frac{1}{LC} > \frac{R^2}{4L^2}$ (1 Mark) Answer is 1054 ohms (3 marks	(4)
	2	R= i+1/3j+2/3k and V= 5/3 i+2/3j+2/3 k (2 marks each)	
Q3.	A)	**Attempt any one**	
	1	Diagram – 2m Each stage – ($1\frac{1}{2}$ m)	(8)
	2	Statements – 2m each Proofs – 2m each	
	B)	**Attempt any one**	
	1	Proof	(8)
	2	For each expression – 1m each	
	C)	**Attempt any one**	
	1	Formula η = 1 (T_2/T_1) – 1m Calculation of T_1 = 193.7^{0}C for η = 40% – 1m Calculation of T_1 = 287^{0}C for η = 50% – 1m Increase in temperature T_1 = 93.3^{0}C – 1m	(4)
	2	Explanation – 4m	
Q4.	A)	**Attempt any one**	
	1	Fall in temperature of the gas on expansion due to passage through the plug when initial temperature is below T_i. The drop in temperature is proportional to the drop in pressure. As the initial temperature is increased upto T_i, the drop in temperature becomes smaller and above T_i the gas is heated up. This phenomena is Joule-Thomson effect. .... (2 Marks) Isenthalpic process : $U_1 + p_1V_1 = U_2 + p_2V_2$, $H_1 = H_2$ ..... (6 Marks)	(8)
	2	Diagram .... (3 Marks) Derivation .... (5 Marks)	
	B)	**Attempt any one**	
	1	Properties .... (5 Marks) Uses .... (3 marks)	(8)
	2	Diagram .... (3 Marks) Working .... (5 Marks)	
	C)	**Attempt any one**	
	1	$dT = \frac{T(V_2-V_1)}{L} dP$: .... (1 M) Substitution and calculation . . . (2 M), dT = - 0.0148 K. . . (1 M)	(4)
	2	Formula . . . . (1 M), substitution and calculations . . . . (2 M) η = 53.1% ....(1 Mark)	

Q5.		**Attempt any Four**	
	1	Equation for natural frequency and damped frequency (1 Mark) proof (4 marks)	**(20)**
	2	Velocity = $-2.56\text{X } 10^7$ m/sec (2 marks) KE = 0.077MeV (3 marks)	
	3	Note on reversible – 2m Irreversible – 2m	
	4	Derivation – 5m	
	5	Considering entropy as a function of temperature and volume, prove that $C_P - C_V = T\left(\frac{\partial P}{\partial T}\right)_V\left(\frac{\partial V}{\partial T}\right)_P$ using Maxwell's thermodynamic relation. Answer : S = S(T, V) $dS = \left(\frac{\partial S}{\partial T}\right)_V dT + \left(\frac{\partial S}{\partial V}\right)_T dV$ $\left(\frac{\partial S}{\partial T}\right)_P = \left(\frac{\partial S}{\partial T}\right)_V + \left(\frac{\partial S}{\partial V}\right)_T\left(\frac{\partial V}{\partial T}\right)_P$ $T\left(\frac{\partial S}{\partial T}\right)_P - T\left(\frac{\partial S}{\partial T}\right)_V = T\left(\frac{\partial S}{\partial V}\right)_T\left(\frac{\partial V}{\partial T}\right)_P$ $\left(\frac{\partial Q}{\partial T}\right)_P - \left(\frac{\partial Q}{\partial T}\right)_V = T\left(\frac{\partial P}{\partial T}\right)_V\left(\frac{\partial V}{\partial T}\right)_P$	
	6	Answer : The entropy S $\rightarrow 0$ as T$\rightarrow 0$ may be equivalently stated that the absolute zero is unattainable. To show this, let us assume the contrary so that a Carnot engine may be operated between two reservoirs – one at absolute zero and the other at some finite temperature T, as shown in figure.  For cyclic process, $\Delta S = \oint \frac{dQ}{T} = 0$ But $\Delta S = \Delta S_{12} + \Delta S_{23} + \Delta S_{34} + \Delta S_{41}$ and $\Delta S_{12} = Q/T$ For an adiabatic process, $\Delta S_{23} = \Delta S_{41} = 0$ and by third law, $\Delta S_{34} = 0$ Therefore $\Delta S = \oint \frac{dQ}{T} = \Delta S_{12} \neq 0$ This is in violation of the second law of thermodynamics. The inconsistency implies a Carnot engine cannot be operated with a single reservoir. It is thus impossible to attain the absolute zero.	