Q. P. Code: 52366 AS3

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 body is moving in a circular orbit. Its angular momentum at a point is c) perpendicular to the plane of orbit	
	2	The time in which the amplitude of a damped harmonic oscillator decays to 1/e of its original value is called c) relaxation time	
	3	A heat engine absorbs heat at 1000 K and rejects heat at 600 K. If the engine operates at maximum possible efficiency the work done by the engine at 2000 J input is b) 1200 J	
	4	The thermal efficiency of all reversible engines working between the same two temperature limits are a) the same	
	5	A diesel engine has compression ratio from c) 15 to 20	
	6	In Joule-Thomson effect, if $\frac{2a}{RT} - b$ is positive then after expansion, the temperature a) decreases	
	B)	**Answer in one sentence**	**(03)**
	1	$x = C_0 e^{-2rt} \sin(qt + \emptyset)$	
	2	Statement of property.	
	3	zero	
	C)	**Fill in the Blanks**	**(5)**
	1	An oscillator returns to its equilibrium state in the shortest time when it is critically damped.	
	2	Time period of a compound pendulum about centre of suspension and centre of oscillation is same or equal.	
	3	The heat engine is a system operating in a cyclic process that converts heat into work	
	4	If two or more engines operate between the same source but different sinks the one operating with the highest temperature difference will have the highest efficiency.	
	5	In Otto engine air is used as a working substance.	
Q2.	**A)**	**Attempt any one**	**(8)**
	1	Finding K.E and P.E – 2 Marks Total energy – 6 Marks	
	2	Expression for b and Ψ – 2 Marks Various cases – 6 Marks	

	B)	**Attempt any one**	**(8)**
	1	Definition- 2 Marks Theory – 6 Marks	
	2	Derivation – 5 Marks Max and Min time period – 3 Marks	
	C)	**Attempt any one**	**(4)**
	1	$\frac{1}{3}\left[(4+3t)\hat{\imath}+(5+6t)\hat{\jmath}+9\hat{k}\right]$	
	2	Theory – 4 Marks	
Q3.	A)	**Attempt any one**	**(8)**
	1	Statement of theorem – 4m Proof – 4m	
	2	p – V diagram – 2m explanation of each stage – $1\frac{1}{2}$ m	
	B)	**Attempt any one**	**(8)**
	1	Starting with the equation TdS = C_v dT + pdV obtain expressions for entropy change in isothermal, isobaric and isochoric processes.	
	2	Proof – 8m	
	C)	**Attempt any one**	**(4)**
	1	Explanation – 4m	
	2	dS = $\int_{T_1}^{T_2}\frac{dH}{T}$ - 1m dH = m x s = 10 x 1 = 10 cal/K – 1m dS = dH x ln $(\frac{T_2}{T_1})$ – 1m dS = 12.1 cal/K -1m	
Q4.	A)	**Attempt any one**	**(8)**
	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) Diagram .... (2 Marks) Explanation with equations .... (4 Marks)	
	2	Statement : It is impossible to attain the absolute zero by any finite sequence of thermodynamic processes. .... (2 Marks) Consequences : Heat capacities, expansion coefficients, surface tension degeneracy of an ideal gas etc. .... (any two) (3 Marks each)	
	B)	**Attempt any one**	**(8)**

3

	1	Answer : Derivation of Clausius-Clapeyron equation . . . . (4 Marks) If substance expands on melting, dP/dT is positive and therefore increase in pressure raises the melting point and vice-versa. . . . . (2 Marks) If substance expands on boiling, dP/dT is positive and therefore increase in pressure raises the boiling point and vice-versa. . . . . (2 Marks)	
	2	p-V diagram . . . . (3 Marks) Working . . . . (5 Marks)	
	C)	**Attempt any one**	**(4)**
	1	Using Maxwell's thermodynamic relation, show that for a perfect gas $\left(\frac{\partial U}{\partial V}\right) = 0$ Answer : dU = dQ + pdV, $\frac{\partial U}{\partial V} = \frac{\partial Q}{\partial V} - p$, $\frac{\partial U}{\partial V} = T(\frac{\partial S}{\partial V}) - p$ Maxwell' relation $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$ $\quad \frac{\partial U}{\partial V} = T(\frac{\partial P}{\partial T}) - p$ for perfect gas pV = RT $\quad \frac{\partial U}{\partial V} = T\left(\frac{R}{V}\right) - p = p - p = 0$	
	2	$T_i = \left(\frac{27}{4}\right) T_c$ . . . . (1 Mark) Substitution, calculation and result . . . . . . (4 Marks) T_i for hydrogen is **195.75** K and for helium is **35.1** K	
Q5.		**Attempt any Four**	**(20)**
	1	Definition- 2 Marks Derivation – 3 Marks	
	2	Proof – 5 Marks	
	3	Expression for efficiency of a Carnot engine – 1m Proof – 5m	
	4	Short Note – 5m	
	5	1 Mark per point	
	6	$dp = \frac{L.dT}{T(V_2 - V_1)}$ . . . . (1 Mark) Substitution and calculations . . . .(2 Marks) dP = 0.363 atm. . . . . (1 Mark) Therefore required pressure = 1+0.363= 1.363 atm. . . . . . (1 Mark)	