Shanu Arora

Msc, IIT Bombay

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- Top 1% in **NGPE**

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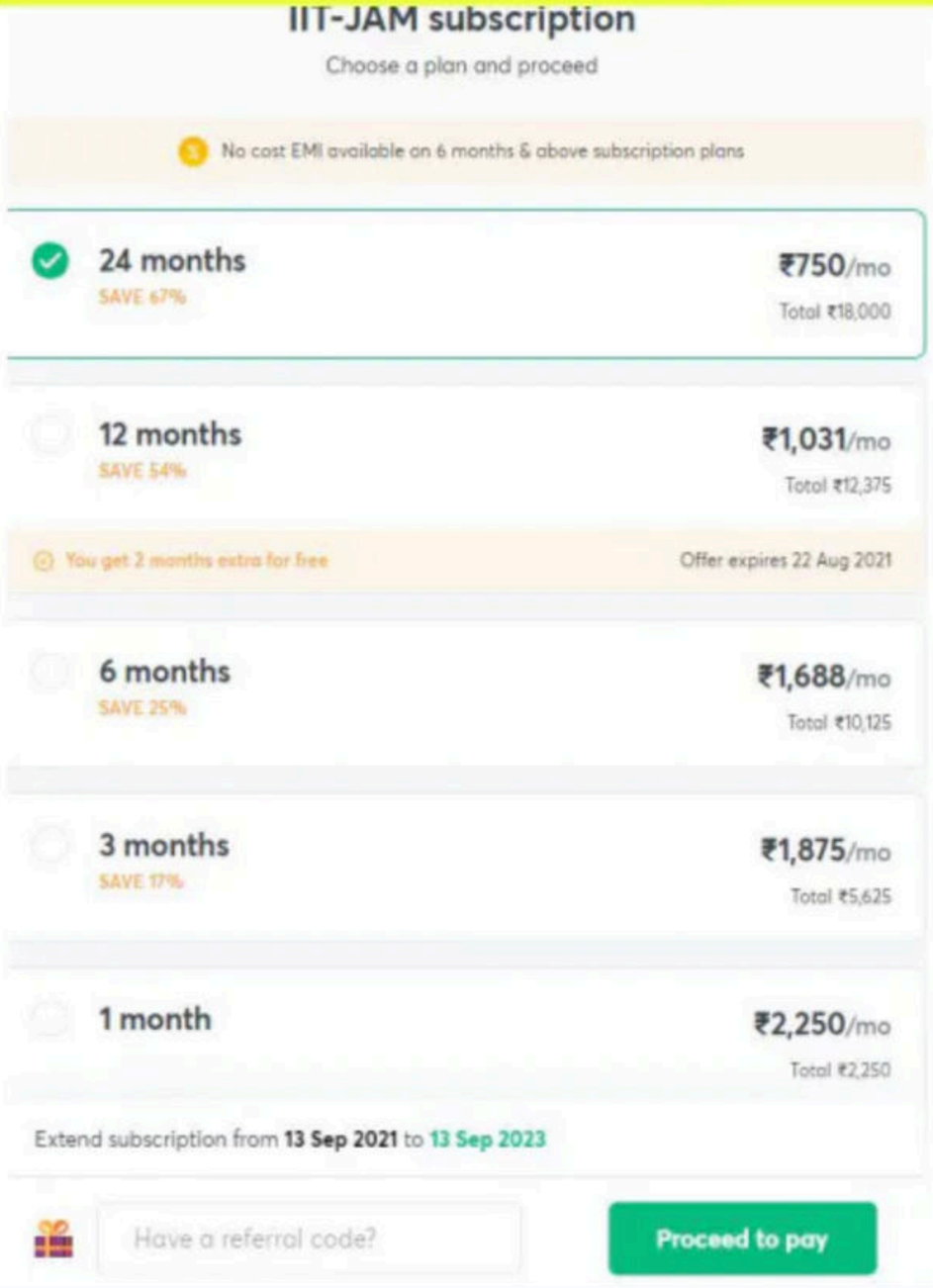

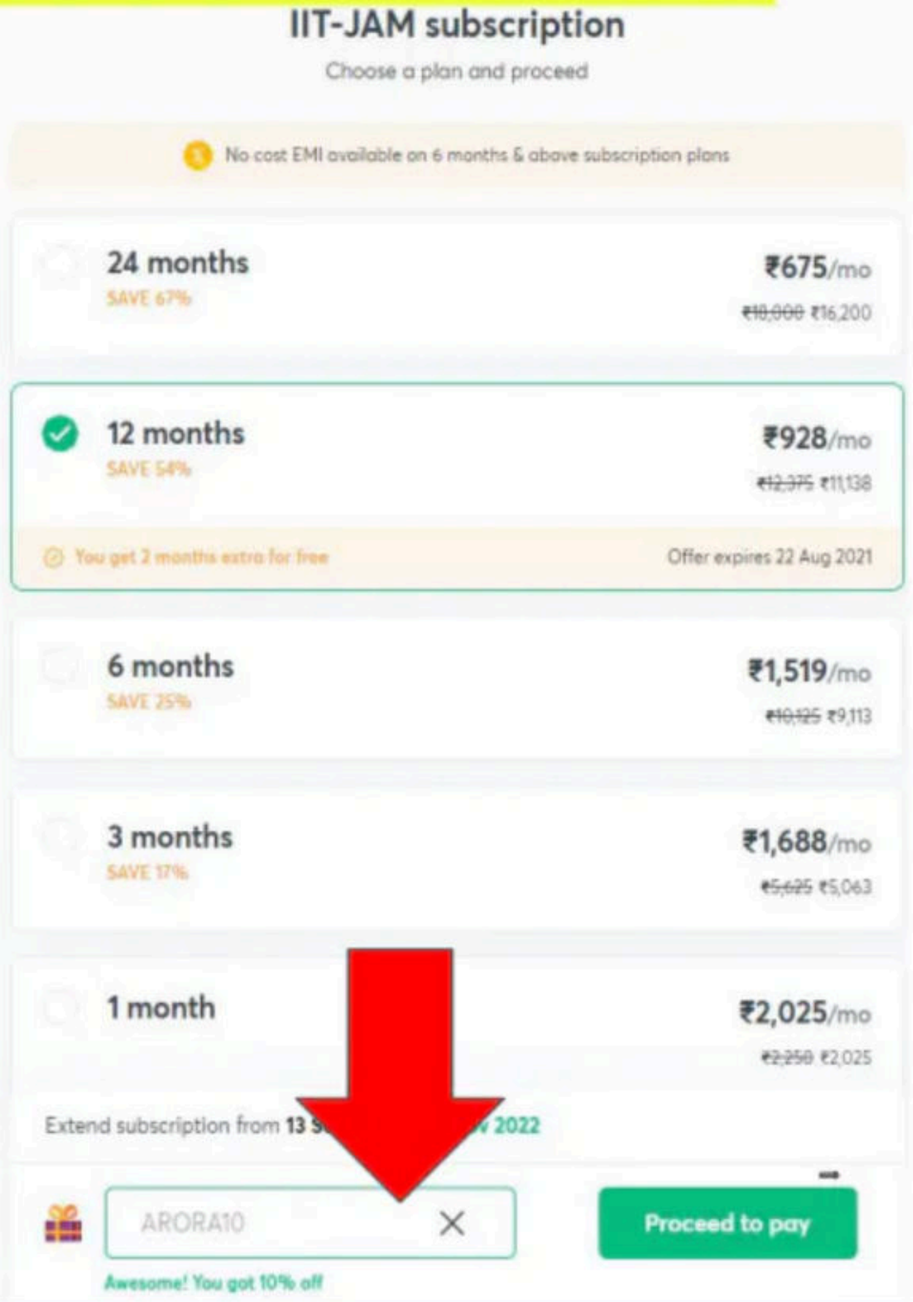

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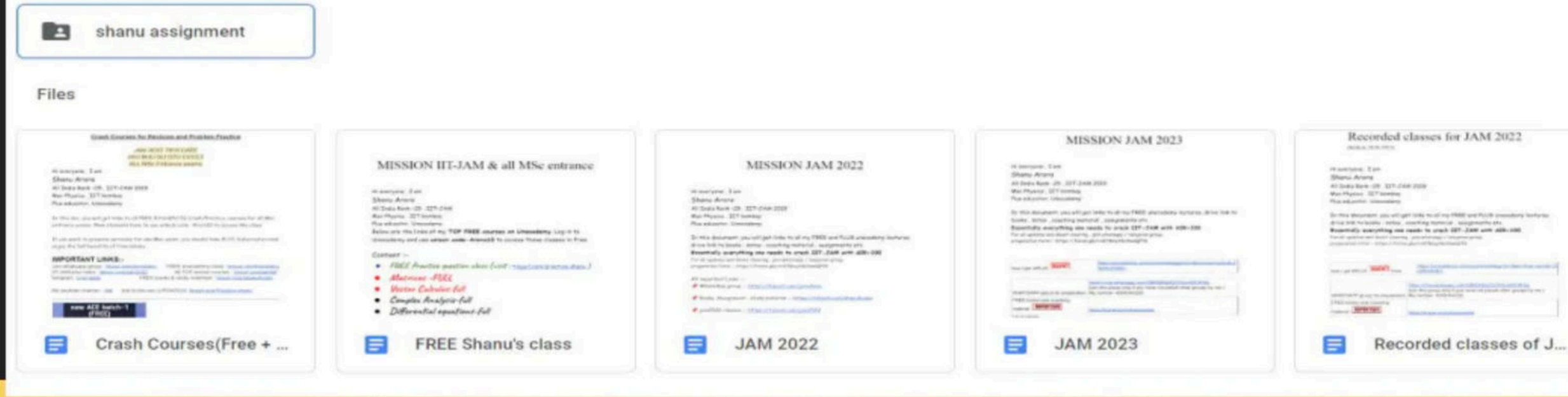


* 2nd law ✓

* Carnot Engine

Today 2nd law

Thermo Potential

Maxwell Relation

8. Which of the following integrals depends only on the initial and final states of a thermodynamic system (i.e., independent of the path of transformation)? **[JNU-2009]**

(a) $\int pdV$ (b) $\int dQ$ (c) $\int \frac{dQ}{T}$ (d) $\int T^2 dQ$

9. An ideal gas with adiabatic exponent γ undergoes a process in which its pressure P is related to its volume V by the relation $P = P_0 - \alpha V$, where P_0 and α are positive constants. The volume starts from being very close to zero and increases monotonically to P_0/α. At what value of the volume during the process does the gas have maximum entropy? **[JEST 2016]**

(a) $\frac{P_0}{\alpha(1+\gamma)}$ (b) $\frac{\gamma P_0}{\alpha(1-\gamma)}$ (c) $\frac{\gamma P_0}{\alpha(1+\gamma)}$ (d) $\frac{P_0}{\alpha(1-\gamma)}$

14. An ideal gas undergoes an isothermal expansion (at a constant temperature T) from an initial volume V_1 to a final volume V_2. The change in the entropy per mole is: **[JNU 2010]**

(a) $R(V_1/V_2)$ (b) $R\ln|V_1 - V_2|$ (c) $R\ln(V_1/V_2)$ (d) $R\ln(V_2/V_1)$

15. A monoatomic ideal gas of N atoms undergoes isothermal reversible expansion from volume V_1 to V_2. The change in entropy of the gas is **[IISc 2009]**

(a) 0 (b) $N\kappa_B \ln\frac{V_1}{V_2}$ (c) $2N\kappa_B \ln\frac{V_2}{V_1}$ (d) $N\kappa_B \ln\frac{V_2}{V_1}$

16. An ideal gas consisting of N particles undergoes isothermal change of state from initial state (P_i, V_i, T) to final state (P_f, V_f, T), then the increase in entropy is **[B.H.U-2011]**

(a) $Nk \ln\left(\frac{V_f}{V_i}\right)$ (b) $Nk \ln\left(\frac{P_f}{P_i}\right)$ (c) $Nk \ln\left(\frac{V_f P_i}{V_i P_f}\right)$ (d) $Nk \log\left(\frac{V_f}{V_i}\right)$

17. An ideal gas undergoes an isothermal change of volume. The initial and final volumes are given to be 1.0 litre and 2.7 litres respectively. If in this process the entropy per mole changes from S_1 to S_2. The value of differences $S_2 - S_1$ is nearest to (R is the universal gas constant). **[JNU 2009]**

(a) +2.7 R (b) +1.7R (c) +1.0 R (d) −1.0R

18. A 100 ohms resistor carrying current of 1 Amp is maintained at a constant temperature of 30°C by a heat bath. What is the rate of entropy increase of the resistor? **[JEST 2014]**

(a) 3.3 Joules/K/sec
(b) 6.6 Joules/K/sec
(c) 0.33 Joules/K/sec
(d) None of the above

24. 1 kg of ice at 0°C melts reversibly to water at the same temperature at atmospheric pressure. If the latent heat of melting is 79.8 cal/gm, the entropy change caused by melting is nearly **[H.C.U.-2014]**

(a) 100 Joules/K (b) 1500 Joules/K (c) 1220 Joules/K (d) 1520 Joules/K

25. What is the change of entropy when 1 gm atom solid mercury at its melting point is raised to a temperature of 40°C? (Given, for mercury, Melting point = –39°C, latent heat of fusion = 3.00 cal/gm; mean specific heat = 0.0335 cal/gm-K and one gm. atom of mercury = 200 gm)

(a) 40.61 cal/K (b) 40.61 J/K (c) 4.51 J/K (d) 4.51 cal/K

26. What is the increase in entropy when 20 gm of water at 20° is converted into vapour at 100°C? (Given specific heat of water = 4.2 joule gm^{-1} deg^{-1}, latent heat of water = 2.27×10^3 joule gm^{-1})

(a) 71 J/K (b) 142 J/K (c) 14.2 J/K (d) 284 J/K

solve this 3 min

6. The change in entropy when 5 kg of water at 15°C are mixed with 8 kg of water at 40°C is _____kcal/K ,where specific heat of water may be assumed to be equal to 1 kilo cal/kg °C between 15°C and 40°C(upto three place decimal).

7. 10 gm of water at a temperature of 20°C is converted into ice at –10°C at constant atmospheric pressure. Assuming specific heat of ice at constant pressure to be 0.5 cals, per gm per °C, the total entropychange of the system is _____cal/K. (upto one place of decimal) (Latent heat of ice is 80 cal/gm)

27. The melting point of tin is 232°C, its latent heat of fusion 14 cals/gm. and the specific heat of solid and molten tin 0.055 and 0.064 cal/gm K respectively. The change in entropy when 1 gm of tin is heated from 150°C to 314°C is

(a) 0.047 cal/K (b) 0.047 J/K (c) 0.47 cal/K (d) 0.47 J/K

28. A quantity q of energy is transferred in the form of heat from a reservoir at absolute temperature T_1 to another reservoir at absolute temperature T_2, quasi-statically and reversibly. The change in entropy of the combined system is

(a) $q\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$ (b) $q\left(\frac{1}{T_2}-\frac{1}{T_1}\right)$ (c) $\frac{q}{\sqrt{T_1T_2}}\log\left(\frac{T_2}{T_1}\right)$ (d) $q\left(\frac{1}{T_1}+\frac{1}{T_2}\right)$ **[H.C.U.-2011]**

29. Consider an amount of heat Q transferred between two heat reservoirs at temperatures T_1 and $T_2\,(T_1>T_2)$. Then the change in entropy is **[H.C.U.-2016]**

(a) $\frac{Q}{\sqrt{T_1T_2}}\ln\left(\frac{T_1}{T_2}\right)$ (b) $\frac{Q}{\sqrt{T_1T_2}}$ (c) $\frac{Q}{T_1-T_2}$ (d) $\frac{Q}{T_1T_2}(T_1-T_2)$

36. Consider a ideal gas of mass 'm' at temperature T_1 which is mixed isobarically (i.e. at constant pressure) with an equal mass of same gas at temperature T_2 in a thermally insusulated container. What is the change of entropy of the universe? **[JEST 2012]**

(a) $2mC_p \ln\left(\frac{T_1+T_2}{2\sqrt{T_1T_2}}\right)$ (b) $2mC_p \ln\left(\frac{T_1-T_2}{2\sqrt{T_1T_2}}\right)$ (c) $2mC_p \ln\left(\frac{T_1+T_2}{2T_1T_2}\right)$ (d) $2mC_p \ln\left(\frac{T_1-T_2}{2\sqrt{T_1T_2}}\right)$

37. Consider two identical blocks of constant specific heat capacity, one of which is at temperature T_1 and the other at T_2. A reversible engine transfers heat from the hotter block to the colder until they reach the same temperature which is **[IISc]**

(a) $\sqrt{T_1T_2}$ (b) $\frac{T_1+T_2}{2}$ (c) $\frac{T_1T_2}{T_1+T_2}$ (d) T_2

38. Two solid blocks, one at the temperature T_1 and the other T_2 ($T_1 > T_2$), with the same temperature independent heat capacity C are put in contact with each other. The change in entropy of the universe after they have equilibrated is: **[IISc 2011]**

(a) $C\ell n\left[\frac{(T_1+T_2)^2}{4T_1T_2}\right]$ (b) $C\ell n\left(\frac{T_1}{T_2}\right)$ (c) $C\ell n\left(\frac{T_1-T_2}{T_1+T_2}\right)$ (d) C

42. N molecules of an ideal monoatomic gas and diatomic gas are kept in identical containers at the same pressure. If the temperatures of the monoatomic gas and diatomic gas are T_M and T_D respectively and their entropies are S_M and S_D, in general **[IISc 2011]**

(a) $T_M = T_D$ and $S_M = S_D$ (b) $T_M = T_D$ and $S_M \neq S_D$

(c) $T_M \neq T_D$ and $S_M = S_D$ (d) $T_M \neq T_D$ and $S_M \neq S_D$

43. One mole of an ideal monoatomic gas is kept in a volume V and is at temperature T. If the volume and temperature of the gas are respectively changed to V' and T' in such a way that the entropy of the gas is unchanged, then which of the following is true? **[IISc]**

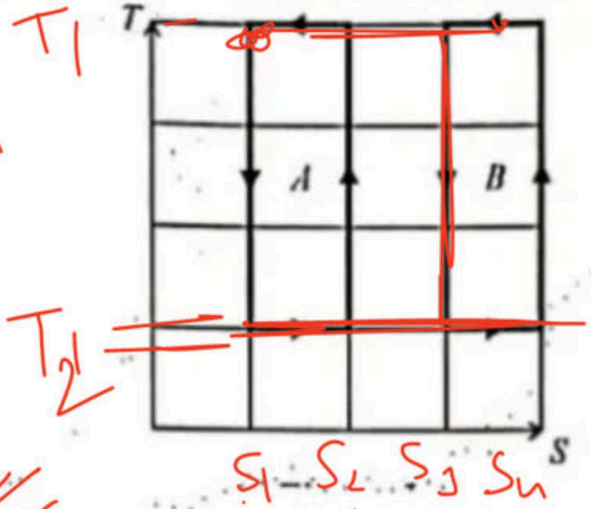
(a) $V' = 2V$, $T' = T/2$ (b) $V' = 8V$, $T' = T/4$

(c) $V' = 4V$, $T' = 8T$ (d) $V' = V/2$, $T' = 2T$

44. One mole of a perfect gas at volume V_A, temperature T_A and pressure P_A changes from state A to state B, where volume is V_B, temperature is T_B and pressure is P_B. The change in entropy is **[B.H.U-2011]**

(a) $C_V \ln\frac{V_B}{V_A} + R\ln\frac{T_B}{T_A}$ (b) $C_V \ln\frac{T_B}{T_A} + R\ln\frac{V_B}{V_A}$ (c) $C_V \ln\frac{V_A}{V_B} + R\ln\frac{T_A}{T_B}$ (d) $C_V \ln\frac{T_A}{T_B} + R\ln\frac{V_A}{V_B}$

48. The entropy temperature diagram of two Carnot engines, A and B, are shown in the figure 5. The efficiencies of the engines are η_A and η_B, respectively. Which one of the following equalities is correct ? **[JEST 2015]**



$\eta = 1 - \frac{T_2}{T_1}$

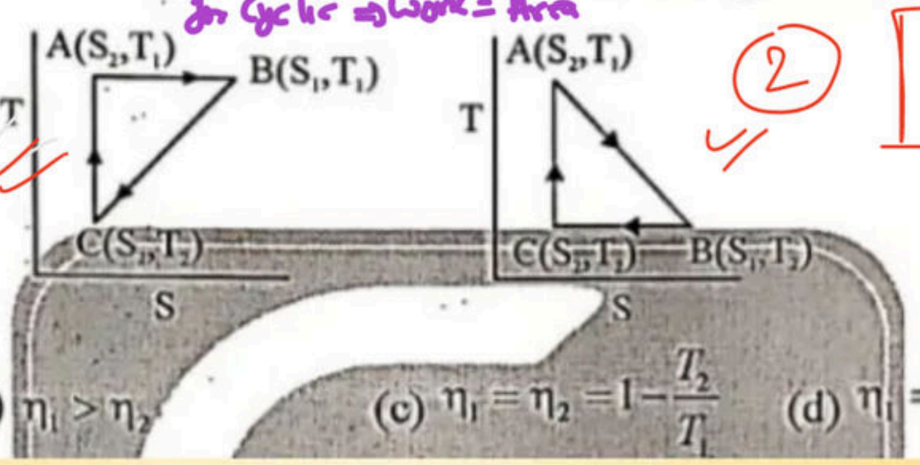
(a) $\eta_A = \eta_B/2$ (b) $\eta_A = \eta_B$ (c) $\eta_A = 3\eta_B$ (d) $\eta_A = 2\eta_B$

49. Depicted below are two reversible engines, marked 1 and 2 in T-S phase plane. Let η_1 and η_2 denote the efficiencies of the engines 1 and 2 respectively. Which of the following statement is correct? **[H.C.U.-2013]**

$\eta = \frac{W}{Q_1} = \frac{\text{Area}}{Q_1}$ $\eta = \frac{W}{Q_1}$

$A_1 = \frac{1}{2} \times (S_1 - S_2) \times (T_1 - T_2)$

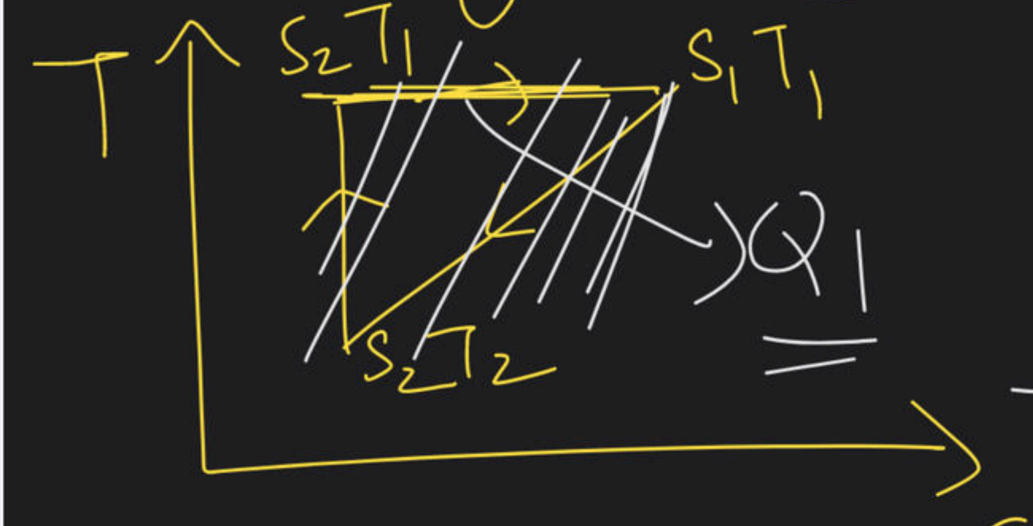
$A_2 = \frac{1}{2} \times (S_1 - S_2) \times (T_1 - T_2)$



$A_1 = A_2$

(a) $\eta_1 < \eta_2$ (b) $\eta_1 > \eta_2$ (c) $\eta_1 = \eta_2 = 1 - \frac{T_2}{T_1}$ (d) $\eta_1 = \eta_2 = 1 - \frac{S_2}{S_1}$

* In Diagram (1)

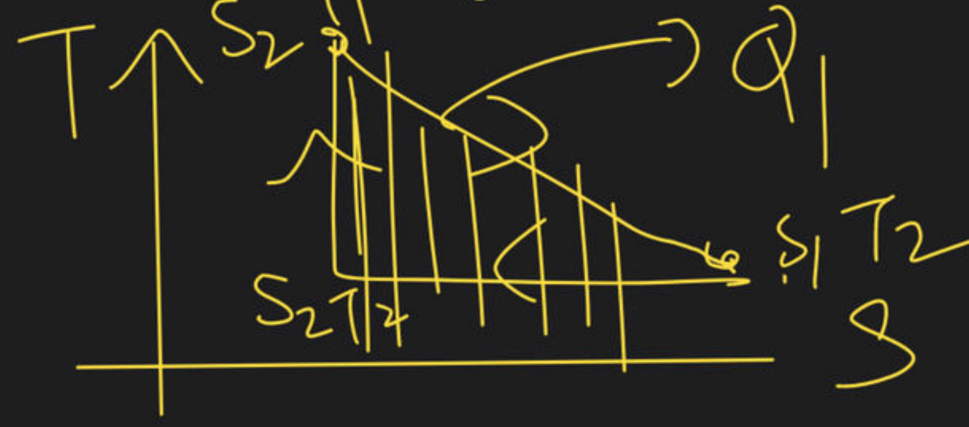


Q_1 → heat into System

Area under Curve = heat

$$Q_1 = (S_1 - S_2) \times T_1$$ ✓

* In Diagram (2)



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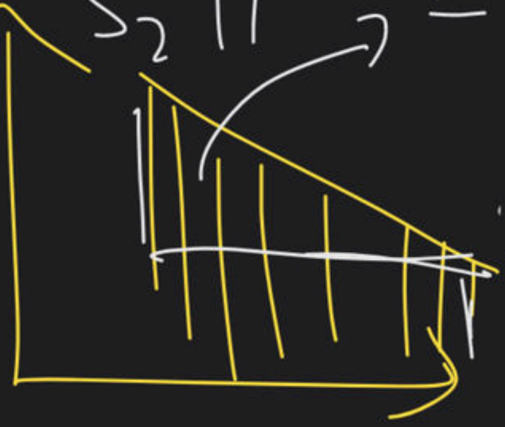


Q_1' = Area of △ + □

$= \frac{1}{2} \times (S_1 - S_2) \times (T_1 - T_2) + (S_1 - S_2) T_2$

$Q_1' = \frac{1}{2} (S_1 - S_2)(T_1 + T_2)$

$$Q_1 = (S_1 - S_2)\, T_1$$

$$Q_1' = \frac{1}{2}(S_1 - S_2)(T_1 + T_2)$$

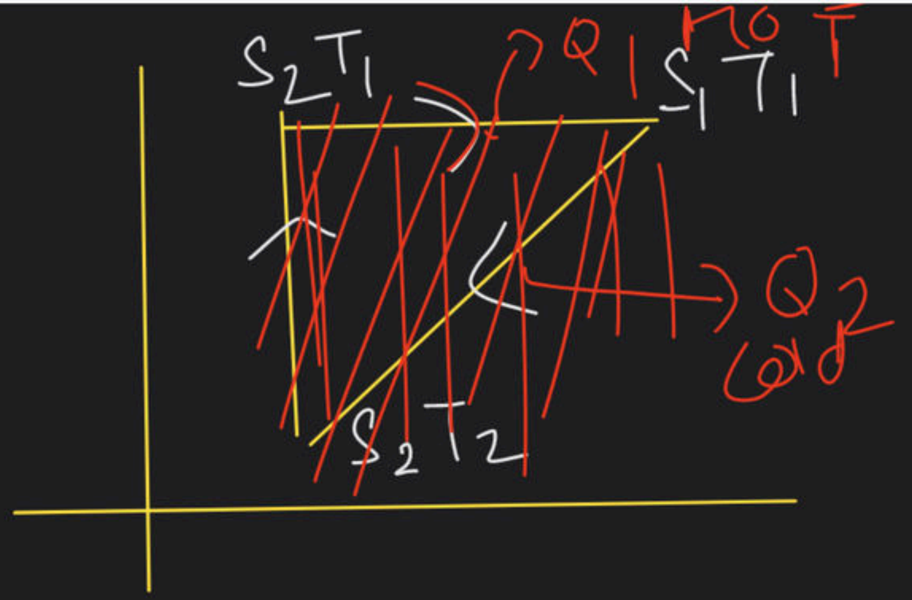
$$T_1 \text{ — } \frac{1}{2}(T_1 + T_2)$$

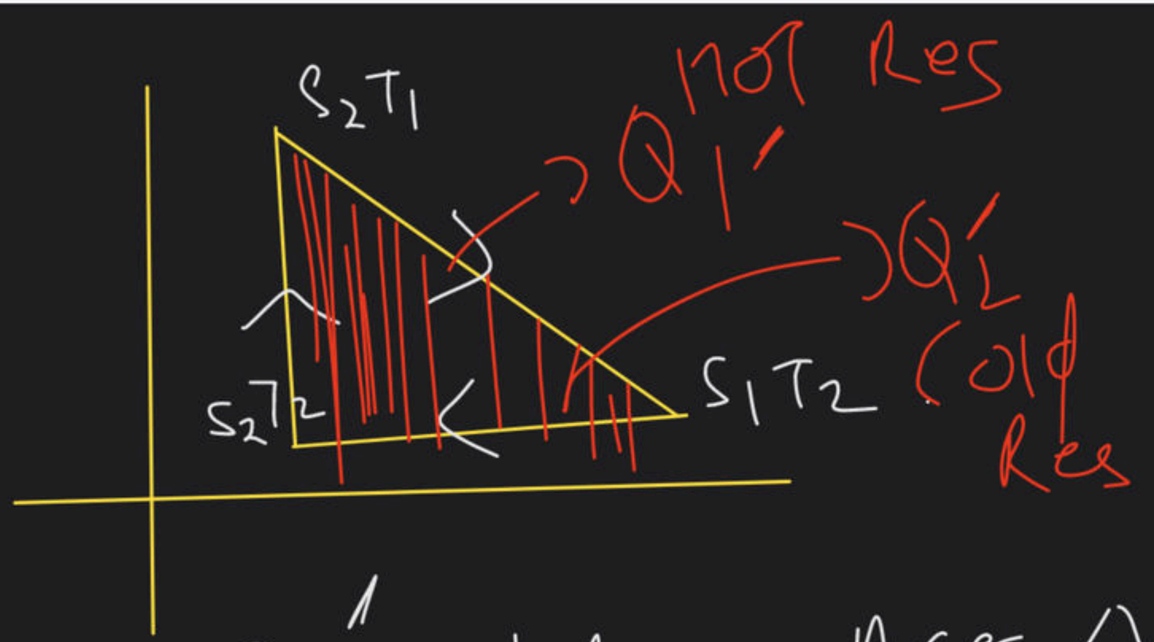
$$Q_1 > Q_1'$$

$$\eta = \frac{w}{Q_1} \quad , \eta' = \frac{w}{Q_1'}$$

$$\boxed{\eta < \eta'}$$

Q





$$\eta = \frac{W}{Q_1} = \frac{\text{Area } \Delta}{Q_1}$$

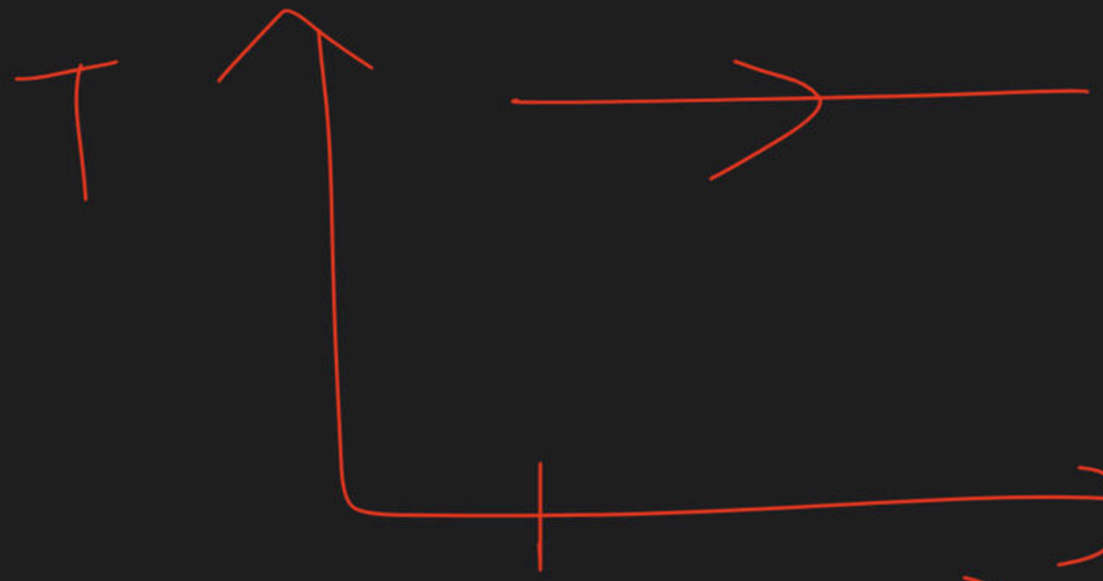
$$\eta' = \frac{W}{Q_1'} = \frac{\text{Area } \Delta}{Q_1'}$$

* Q_1 = Area Under Curve for TS

$$Q_1 > Q_1'$$

$$\eta < \eta'$$

Ans



$\Delta S > 0$

$\Delta G > 0$

positive Heat

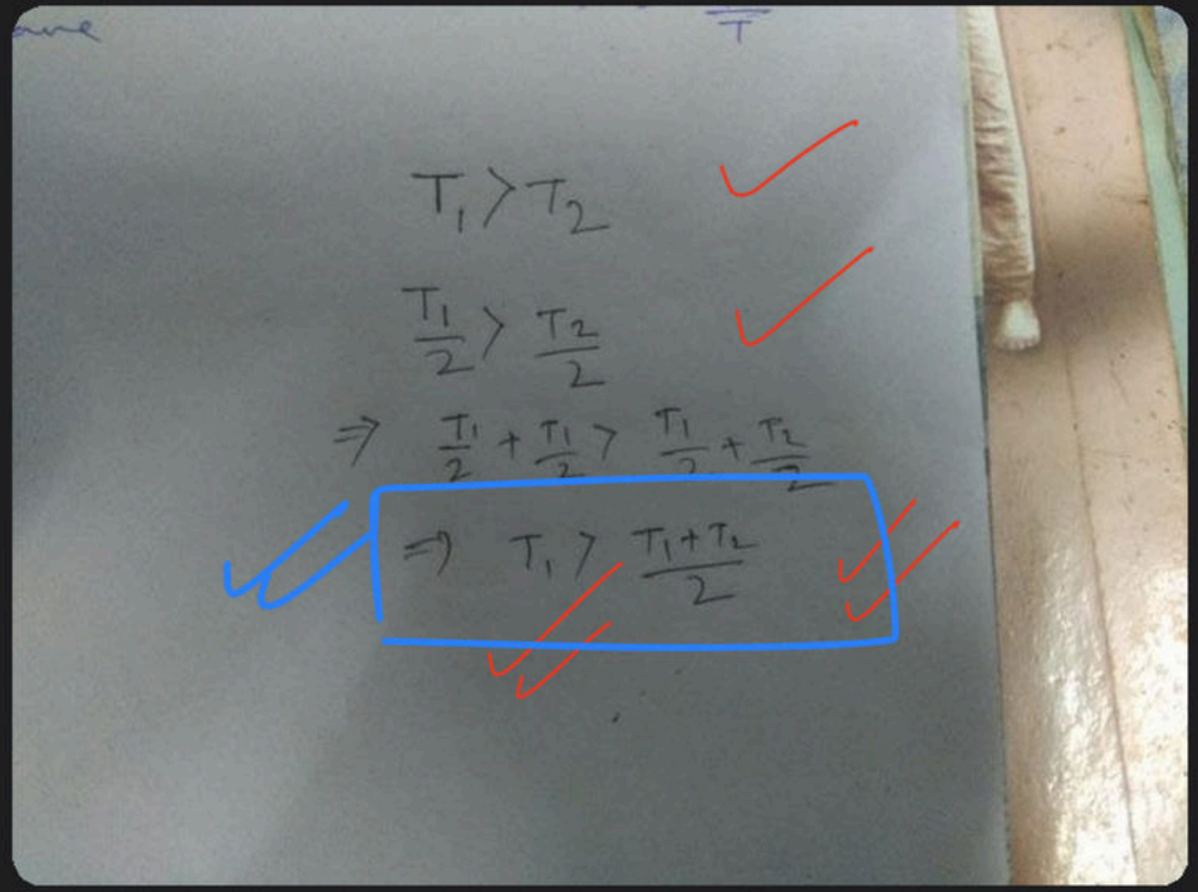
$\Delta S < 0$

$\Delta G < 0$

Cold Res

-ve heat

Question
from Anirban



Slow process → Isothermal

$\Delta S = \int \frac{dQ}{T} = \int \frac{P dV}{T} = \frac{nR}{V} dV$

$\Delta S = R \ln (V_2/V_1)$

56. A thermally insulated cubical box has two chambers of equal volume. Initially one mole of a mono atomic ideal gas is placed in one of the chambers while the other chamber is kept empty. The gas slowly leaks through a small hole and eventually occupies the whole box. The change in entropy of the gas is given by

(a) $\frac{R}{\ln 2}$ (b) $R \ln 2$ Ans (c) zero (d) 2R **[IISc]**

57. The change in entropy (in SI units) in an adiabatic free expansion of one mole of an ideal gas, to double its initial volume is

$\Delta S = R \ln 2 = 8.314 \times 0.693 = 5.762$

(a) 5.762 (b) 0 (c) 8.314 (d) 1.38 **[B.H.U-2015]**

58. Consider a gas contained in a box at pressure P and temperature T having entropy S. If the box is divided into two parts of volume V_1 and V_2 with corresponding entropies S_1 and S_2, then $S-(S_1+S_2)$ is

(a) >0 (b) <0 (c) $=0$ (d) none of these **[B.H.U-2013]**

59. The Clausius mathematical statement of the second law of thermodynamics, for an irreversible process is

(a) $\oint \frac{\delta Q}{T} \le 0$ (b) $\oint \frac{\delta Q}{T} \ge 0$ Univer (c) $\oint \frac{\delta Q}{T} < 0$ Irreversible (d) $\oint \frac{\delta Q}{T} = 0$ → Reversible **[B.H.U-2015]**

801 (58)

L

P, V

δ = for this: Entropy $\Rightarrow 0$

$\Delta S = \int \frac{dQ}{T} = \int \frac{P\,dV}{T} = \int \frac{nR}{V}\,dV = nR\ln\left(\frac{V_f}{V_i}\right)$

$\Delta S_1 = nR\ln\left(\frac{V/2}{V}\right) = nR\ln(1/2)$

$\Delta S_2 = nR\ln\left(\frac{V/2}{V}\right) = nR\ln\left(\frac{1}{2}\right)$

$\Delta S_1 + \Delta S_2 = 2nR(-\ln 2)$

$= -2nR\ln(2)$

Sol

4 pm & 8 pm

final

1. One mole of an ideal gas with molar heat capacity C_v goes through a process in which its entropy S depends on T as $S = \alpha / T$, where α is a constant. The gas temperature varies from T_1 to T_2.

(a) The molar heat capacity of the gas as a function of its temperature is $-\frac{\alpha}{T}$

(b) The amount of heat transferred to the gas is $\alpha \ell n \frac{T_1}{T_2}$

(c) The molar heat capacity of the gas as a function of its temperature is $\frac{\alpha}{T}$

(d) The amount of heat transferred to the gas is $\alpha \ell n \frac{T_2}{T_1}$

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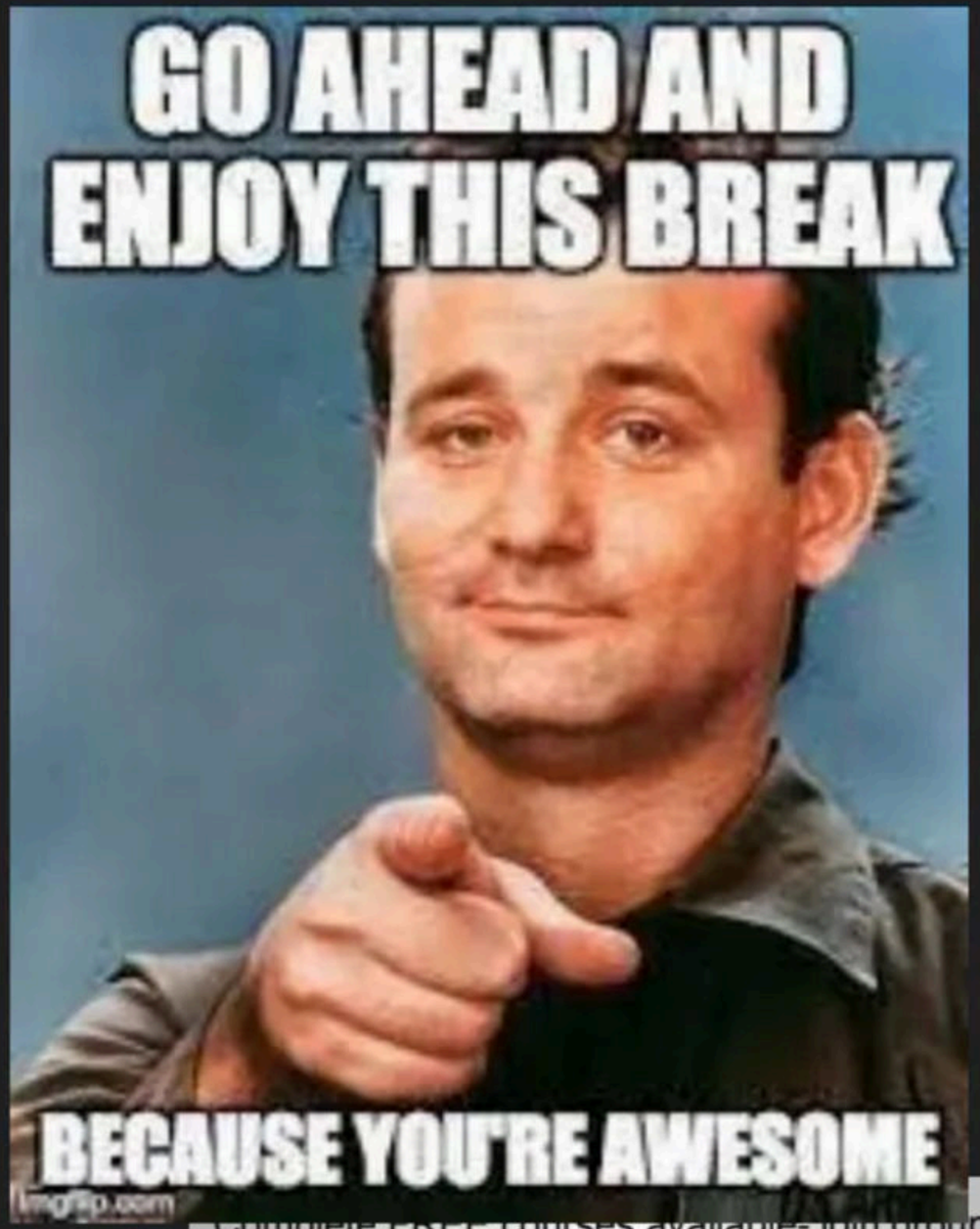

Shanu Arora

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Kumkum Barjugar
Dedicated on 1 Nov 2020

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Dedicated on 18 Oct 2020

""Thankyou" this combination of 8 letters can't describe my respect for you,but I've no other word than this, thankyou so much sir "

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Dedicated on 1 Jan 2021

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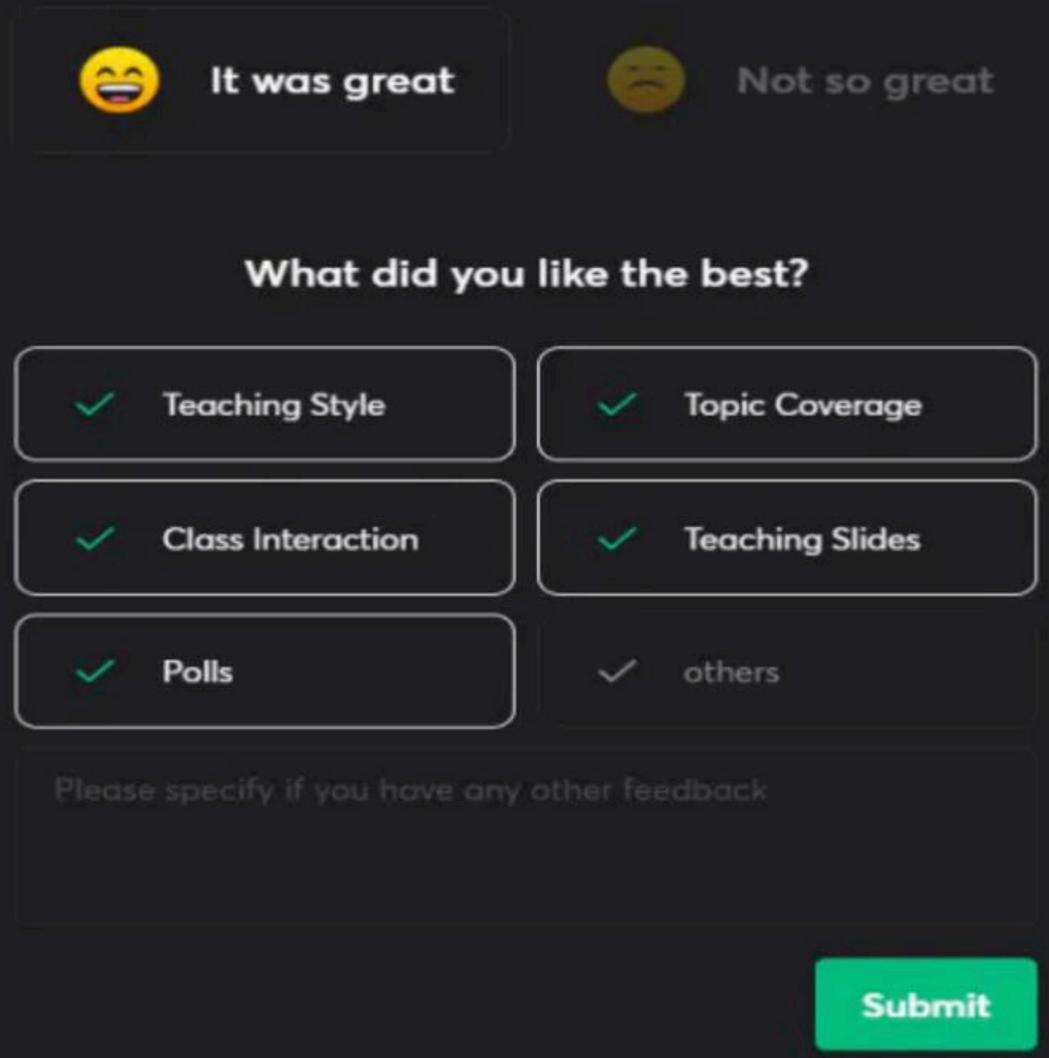
Thankuh sir ."



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