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FREE APP CLASS SCHEDULE

MECHANICAL ENGINEERING

GATE

HMT	MONDAY Live @11AM	YOGESH SIR	
✓ PRODUCTION	TUESDAY Live @11AM	GAURAV SIR	3HRS
SOM	WEDNESDAY Live @8PM	MUKESH SIR	
3PM ✓ THERMODYNAMICS	THURSDAY Live @11AM	KANISTH SIR	3HRS
ENGINEERING MATHEMATICS	FRIDAY Live @11AM	ANANT SIR	

ISRO | BHEL | DRDO & OTHER PSUs

GATE

Thermodynamics

Second Law

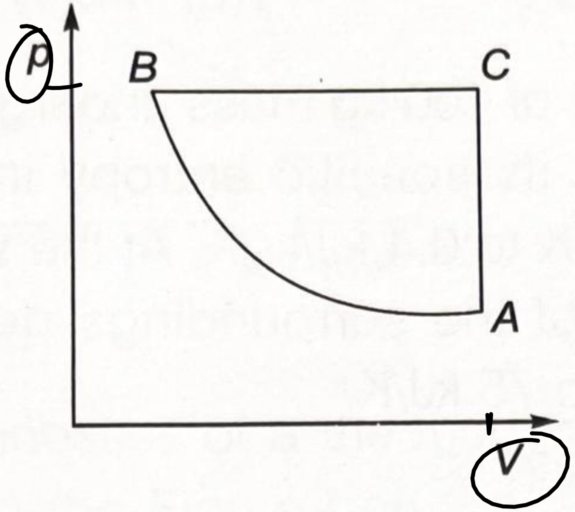
MOST EXPECTED QUESTIONS

Live@ 3pm

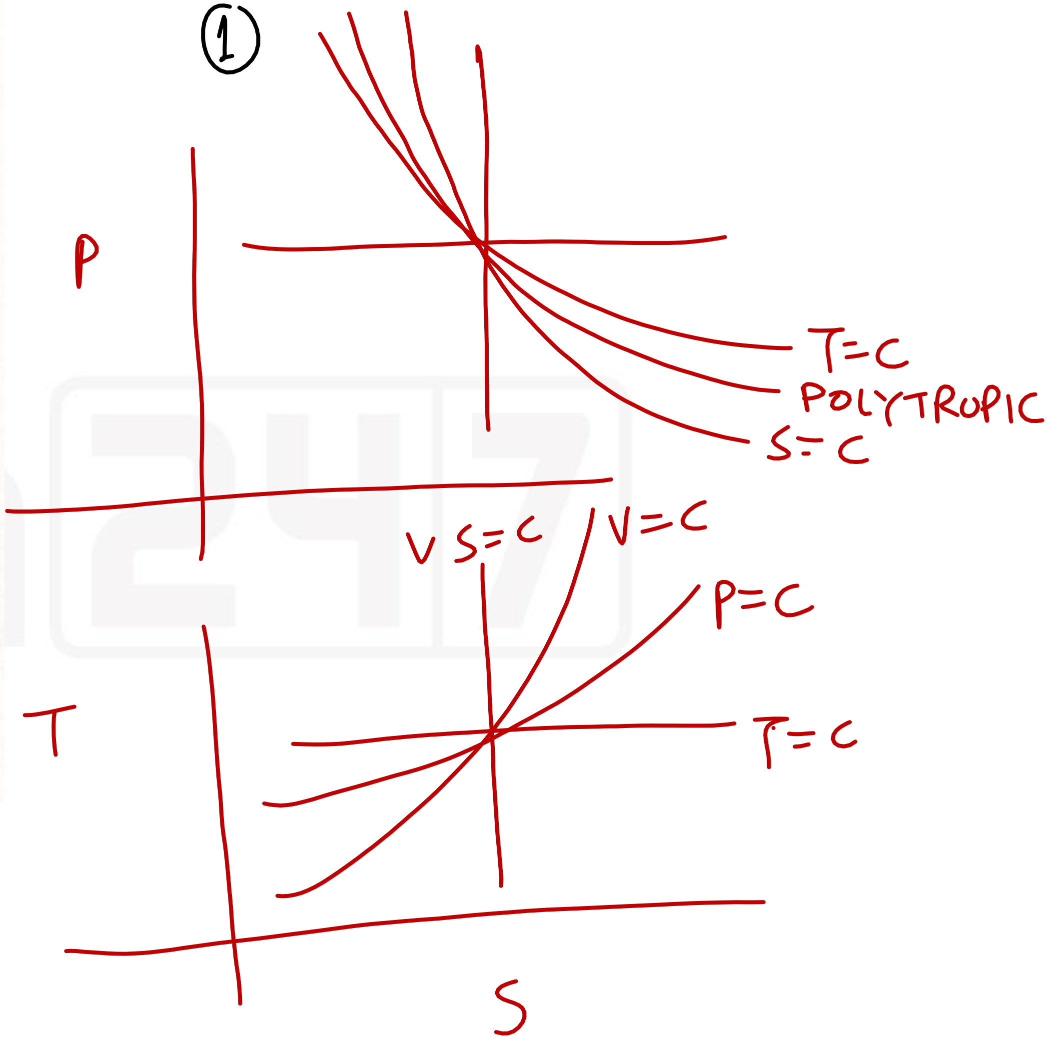
PART-1

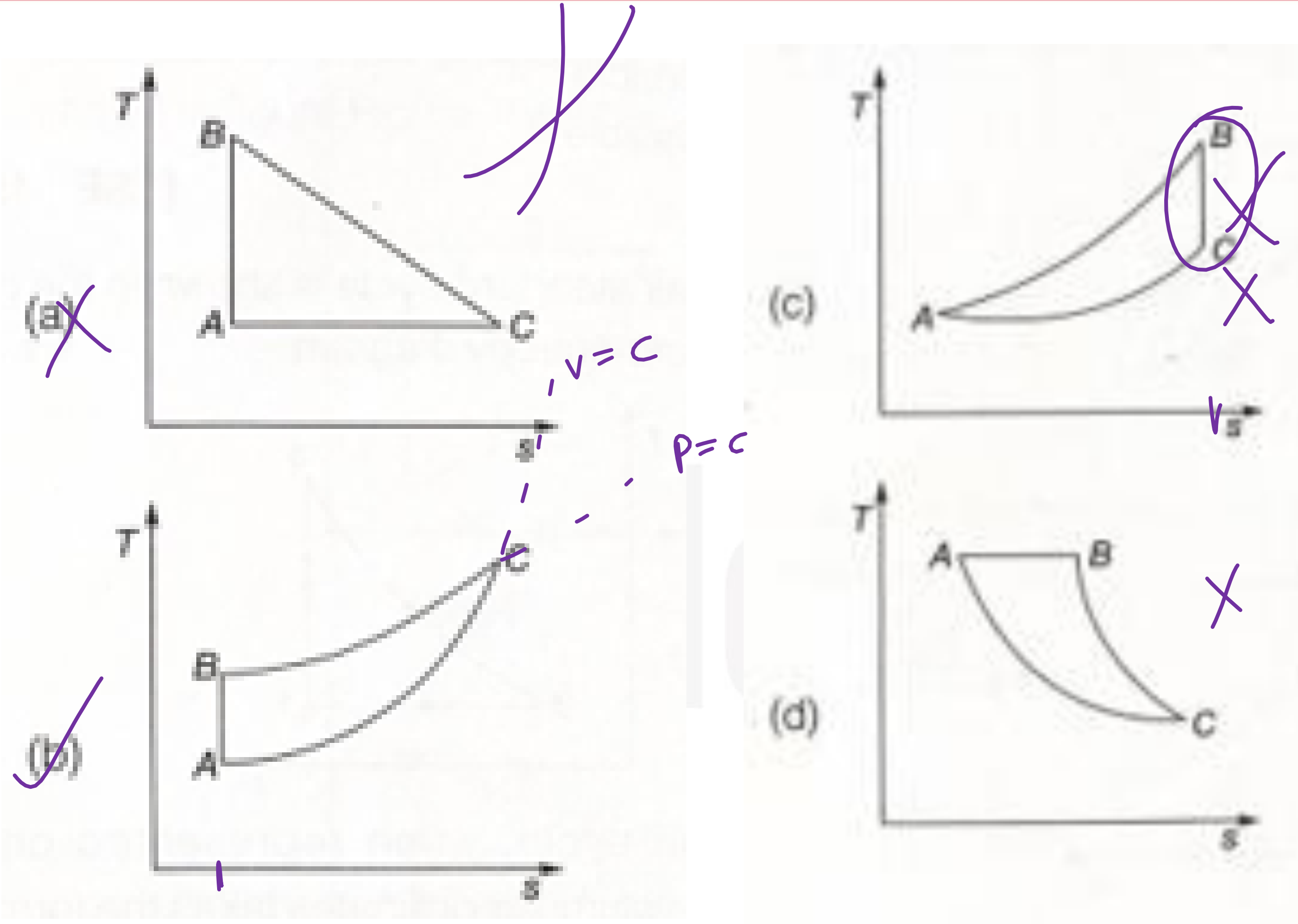
Kanisth sir

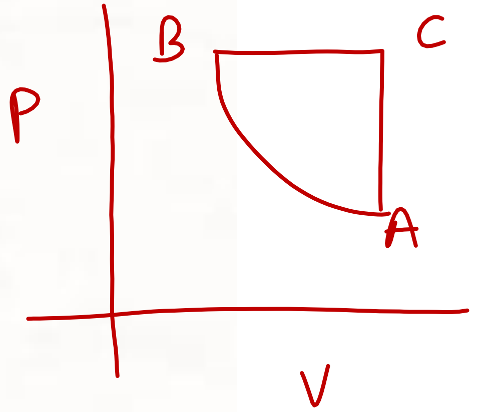
Q 1 A cycle of pressure-volume diagram is shown in the given figure



Same cycle on temperature-entropy diagram will be represented by







AB → ISENTROPIC

BC → P = C

CA → V = C

[ESE : 1995]

Which one of the following statements applicable to a perfect gas will also be true for an irreversible process? (Symbols have the usual meanings)

(a) $dQ = dU + pdV$ (b) $dQ = TdS$

(c) $Tds = dU + pdV$ (d) None of these

[ESE : 1996]

Q → C

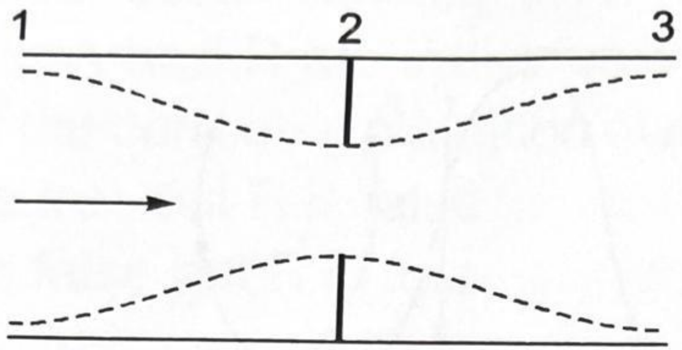
REV & IRRE

ANY SYSTEM

ANY WORKING FLUID

③

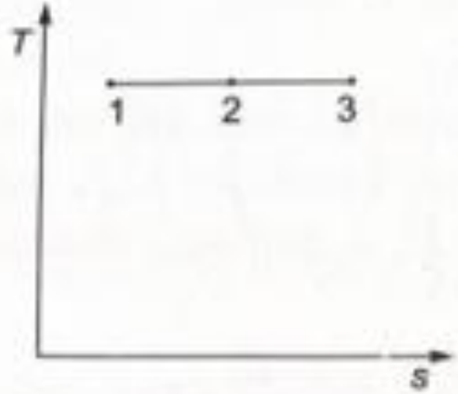
The throttling process undergone by a gas across an orifice is shown by its states in the following figure:



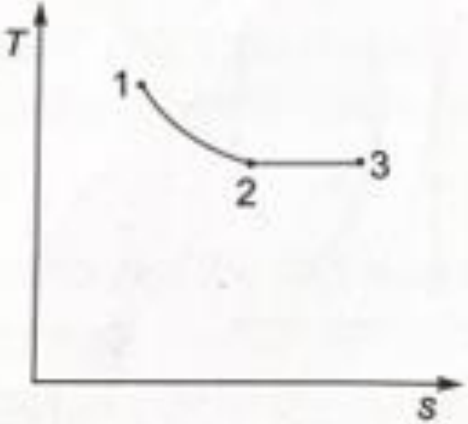
It can be represented on the diagram as

③

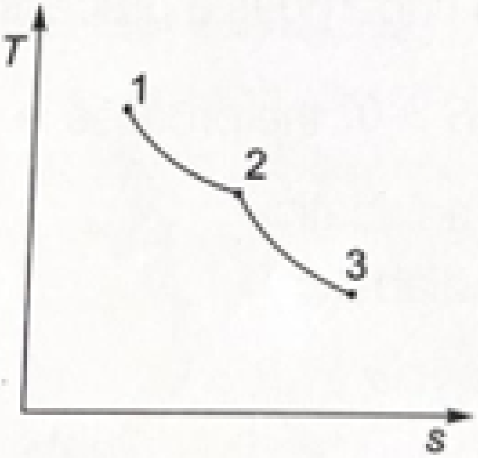
(a)



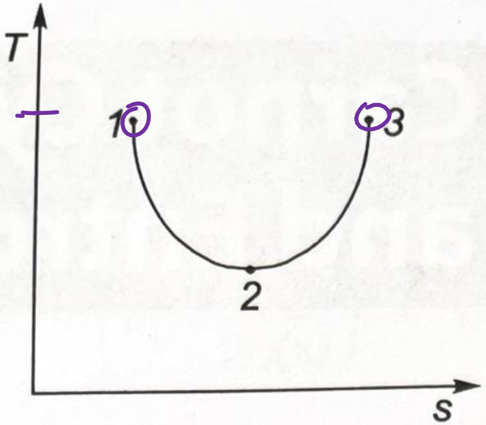
(b)



(c)



(d)



THROTTLING

⇓

IRREVERSIBLE

$h_1 = h_2$

(d)

[ESE : 1996]

When a system undergoes a process such that

$\int \frac{dQ}{T} = 0$ and $\Delta S > 0$, the process is

(a) irreversible adiabatic

(b) reversible adiabatic

(c) isothermal

(d) isobaric

[ESE : 1997]

4 → a

IRREVERSIBLE ADIABATIC

$\int \frac{\delta Q}{T} = 0$

IRRE

Sgen ↑

$\Delta S > 0$

CSE-PRE

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Consider the following statements:

When a perfect gas enclosed in a cylinder piston device executes a reversible adiabatic expansion process

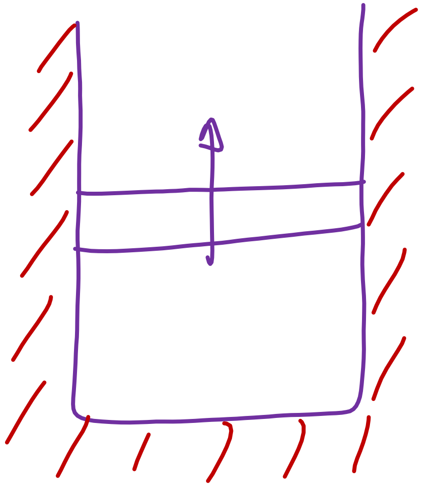
1. Its entropy will increase.
2. its entropy change will be zero. ✓
3. the entropy change of the surroundings will be zero. ✓

Which of these statements is/are correct?

(a) 1 and 3 (b) 2 only

(c) 2 and 3 ✓ (d) 1 only [ESE : 1997]

5 → (c)



REV + ADIABATIC ⇓ ISENTROPIC PROCESS

$\Delta S_{UNI} \geq 0$ | $\Rightarrow \Delta S_{UNI} = 0$ (REV)

$\Downarrow$

$\Delta S_{SYS} + \Delta S_{SURR} = 0$

$\Delta S_{SYS} = 0$

$\Delta S_{SURR} = 0$

A system of 100 kg mass undergoes a process in which its specific entropy increases from 0.3 kJ/kgK to 0.4 kJ/kgK. At the same time, the entropy of the surroundings decreases from 80 kJ/K to 75 kJ/K.

The process is:

(a) Reversible and isothermal

(b) Irreversible ✓

(c) Reversible

(d) Impossible

[ESE : 1997]

⑥ – ⓑ

{0.3 kJ/kgK, 0.35 kJ/kgK}

$\Delta S_{uni} \geq 0$ → $\Delta S_{uni} > 0$ IRRE ; $\Delta S_{uni} = 0$ REV

$\Delta S_{sys} + \Delta S_{surr}$

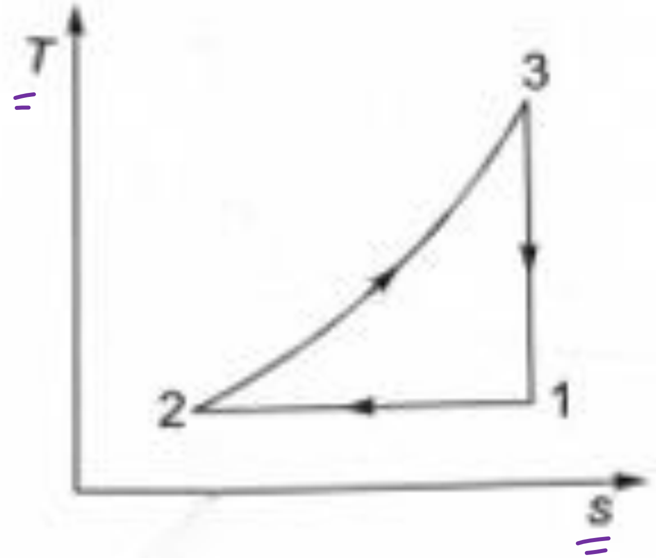
$m(s_2 - s_1) + S_2 - S_1$

$100(0.4 - 0.3) + (75 - 80)$

$10 - 5 = 5$

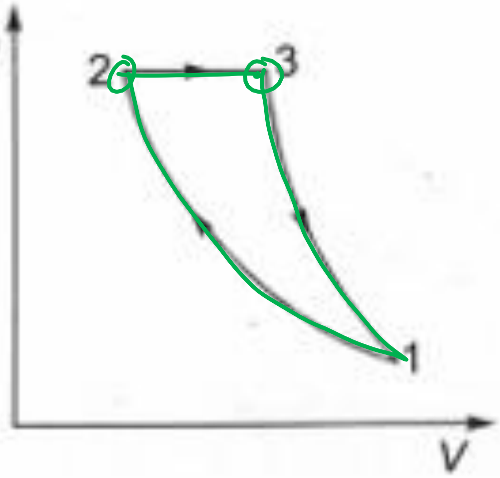
$5 - 5 = 0$

An ideal air standard cycle is shown in the given temperature-entropy diagram

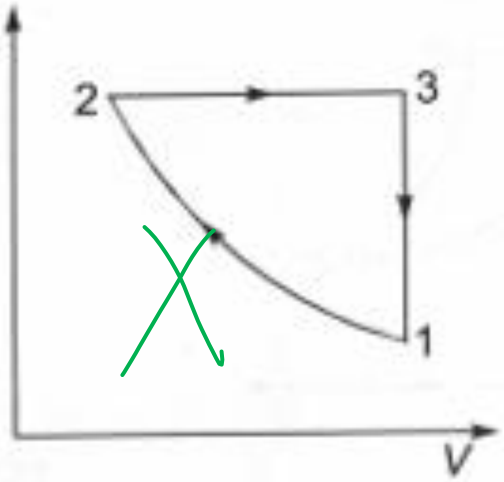


The same cycle, when represented on the pressure-volume coordinates takes the form

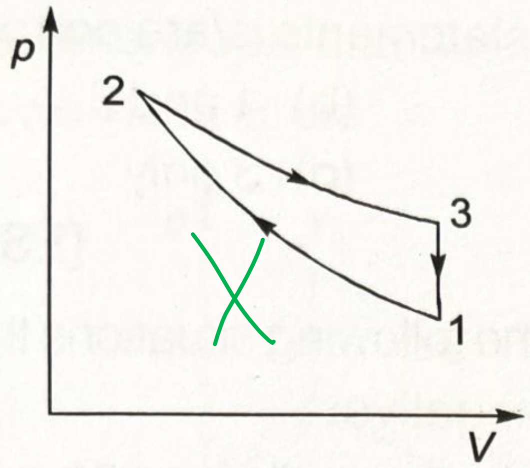
(a)



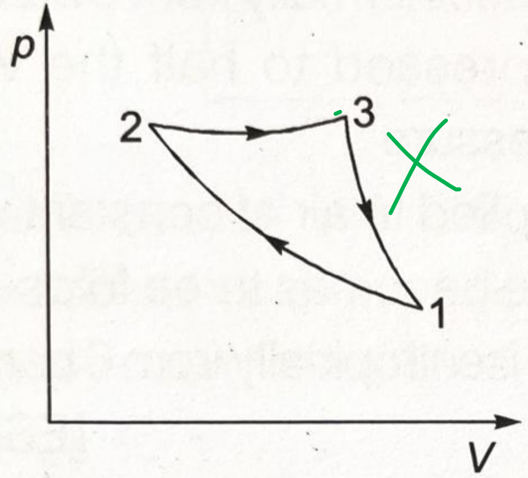
(b)

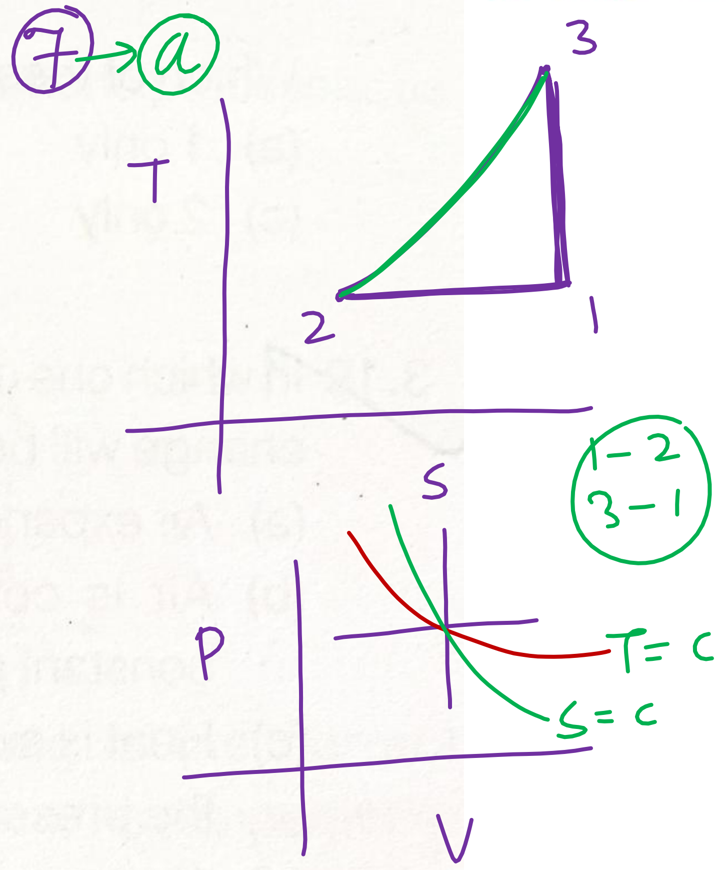


(c)



(d)





[ESE : 1997]

(b) → (d)

Four processes of a thermodynamic cycle are shown in the Figure-I on the T-s plane in the sequence 1-2-3-4. The corresponding correct sequence of these processes in the p-V plane shown in figure Figure-II will be

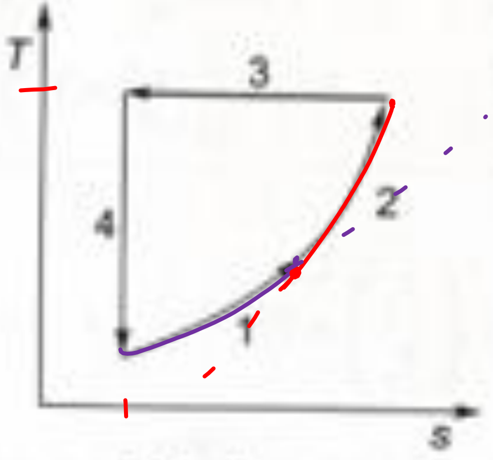


Fig.-I

1 → P = C → B
2 → V = C → C
3 → T = C → D
4 → S = C → A

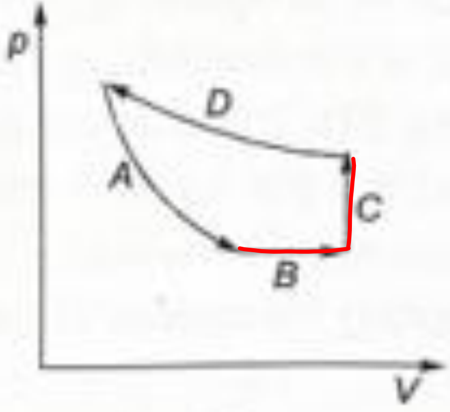


Fig.-II

(a) C–D–A–B
(b) C–A–B–D
(c) A–B–C–D
(d) B–C–D–A ✓

[ESE : 1998]

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For a thermodynamic cycle to be irreversible, it is necessary that

(a) $\oint \frac{\delta Q}{T} = 0$

(b) $\oint \frac{\delta Q}{T} < 0$

(c) $\oint \frac{\delta Q}{T} > 0$

(d) $\oint \frac{\delta Q}{T} \geq 0$

[ESE : 1998]

9 → b

Consider the following statements:

In an irreversible process

1. Entropy always increases
2. The sum of the entropy of all the bodies taking part in a process always increases.
3. Once created, entropy cannot be destroyed.

Which of these statements are correct?

(a) 1 and 2 (b) 1 and 3

(c) 2 and 3 (d) 1, 2 and 3

[ESE : 1998]

A reversible engine exchanges heat from three thermal reservoirs *A*, *B* and *C* at 1000 K, 800 K and 200 K respectively. If the engine receives 500 kJ from *A* and 400 kJ from *B* then what is the heat exchanged from thermal reservoir *C*?

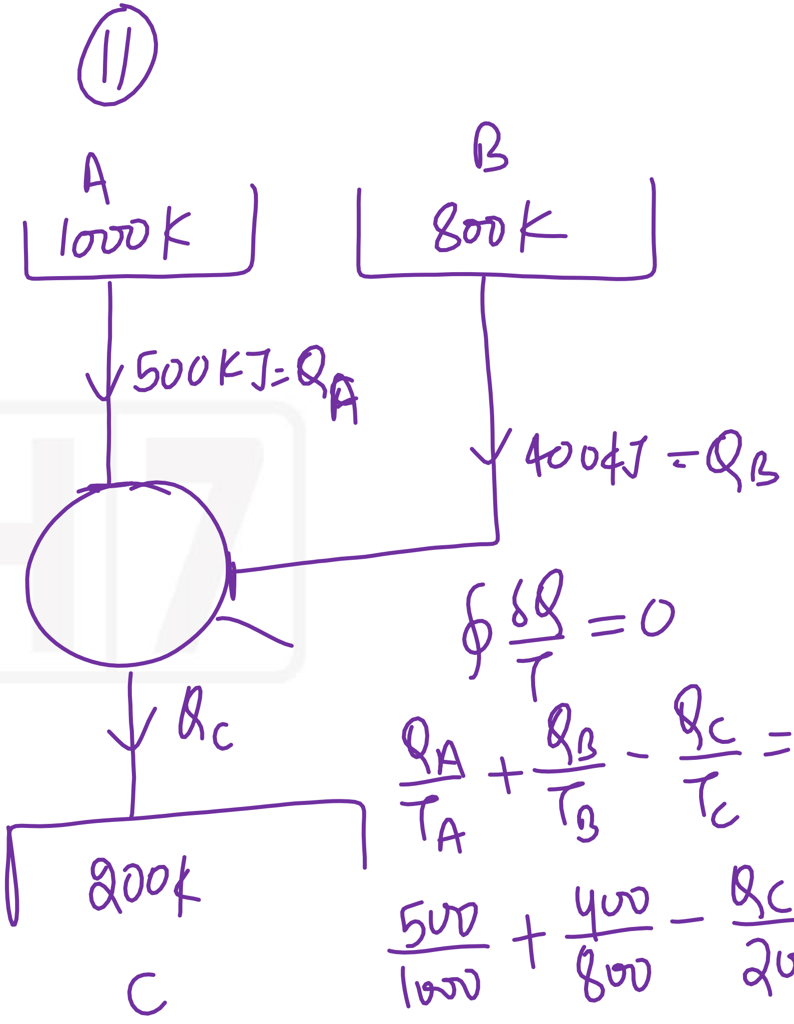
(a) 450 kJ rejected to thermal reservoir *C*

(b) 350 kJ rejected to thermal reservoir *C*

(c) 250 kJ rejected to thermal reservoir *C*

(d) 200 kJ rejected to thermal reservoir *C*

[CSE-Pre : 2005]



$$\oint \frac{\delta Q}{T} = 0$$

$$\frac{Q_A}{T_A} + \frac{Q_B}{T_B} - \frac{Q_C}{T_C} = 0$$

$$\frac{500}{1000} + \frac{400}{800} - \frac{Q_C}{200} = 0$$

$$Q_C = 200$$

Assertion (A): A thermo-dynamic cycle that violates the Clausius inequality also violates the second law of thermodynamics.

Reason (R): The Clausius inequality is given by

$$\oint \frac{\delta Q}{T} \geq 0$$

(a) Both A and R are true and R is a correct explanation of A.

(b) Both A and R are true but R is not a correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

[CSE-Pre : 2008]

12 → c

$$\oint \frac{\delta Q}{T} \leq 0$$

If a system undergoes an irreversible adiabatic process, then (symbols have usual meanings)

(a) $\int \frac{dQ}{T} = 0$ and $\Delta S > 0$

(b) $\int \frac{dQ}{T} = 0$ and $\Delta S = 0$

(c) $\int \frac{dQ}{T} > 0$ and $\Delta S = 0$

(d) $\int \frac{dQ}{T} < 0$ and $\Delta S < 0$

[CSE-Pre : 1999]

13 → a

$\int \frac{\delta Q}{T} = 0$

$\Delta S > 0$

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Clausius inequality is stated as

(a) $\oint \delta Q < 0$ (b) $\oint \delta Q = 0$

(c) $\oint \delta \frac{Q}{T} > 0$ (d) $\oint \delta \frac{Q}{T} \leq 0$

[CSE-Pre : 2001]

14 → d

PAPER

50% EASY

20 to 30% MODERATE

10 to 20%

80%

For a real thermodynamic cycle

(a) $\oint \frac{dQ}{T} > 0$ but $< \infty$

(b) $\oint \frac{dQ}{T} < 0$

(c) $\oint \frac{dQ}{T} = 0$

(d) $\oint \frac{dQ}{T} = \infty$

[CSE-Pre : 2003]

15 → b

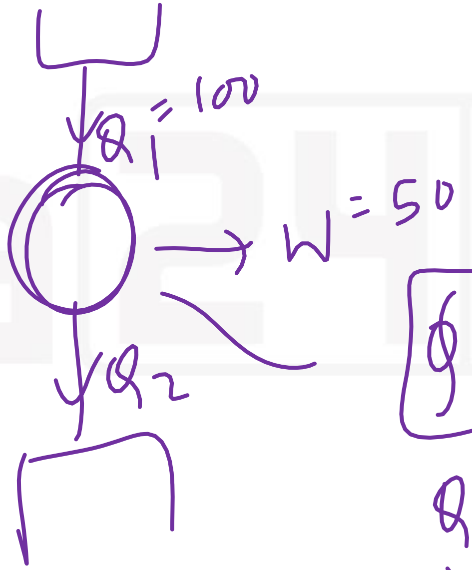
Which one of the following pairs of equations describes an irreversible heat engine? **[1 Mark]**

(A) $\oint \delta Q > 0$ and $\oint \frac{\delta Q}{T} < 0$

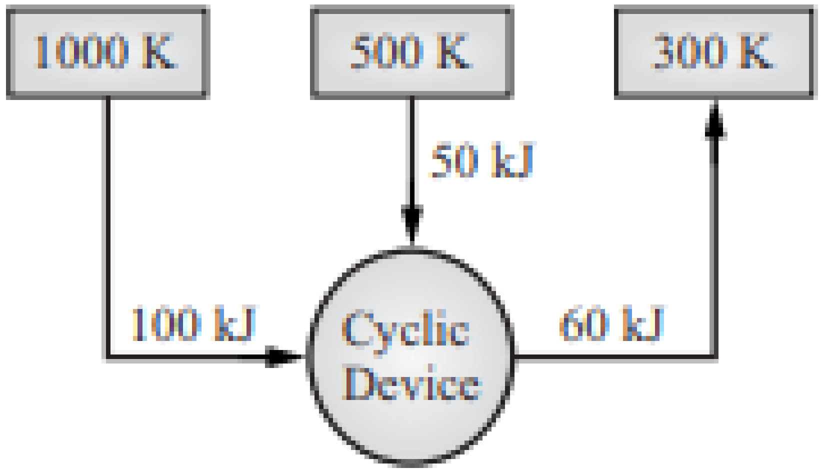
(B) $\oint \delta Q < 0$ and $\oint \frac{\delta Q}{T} < 0$

(C) $\oint \delta Q > 0$ and $\oint \frac{\delta Q}{T} > 0$

(D) $\oint \delta Q < 0$ and $\oint \frac{\delta Q}{T} > 0$



Q. A cyclic device operates between three thermal reservoirs, as shown in the figure. Heat is transferred to/from the cycle device. It is assumed that heat transfer between each thermal reservoir and the cyclic device takes place across negligible temperature difference. Interactions between the cyclic device and the respective thermal reservoirs that are shown in the figure are all in the form of heat transfer. [2 Marks]



3PM

SECOND LAW PART 2

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