

# Thermoacoustic Engine

## Theory Question 3

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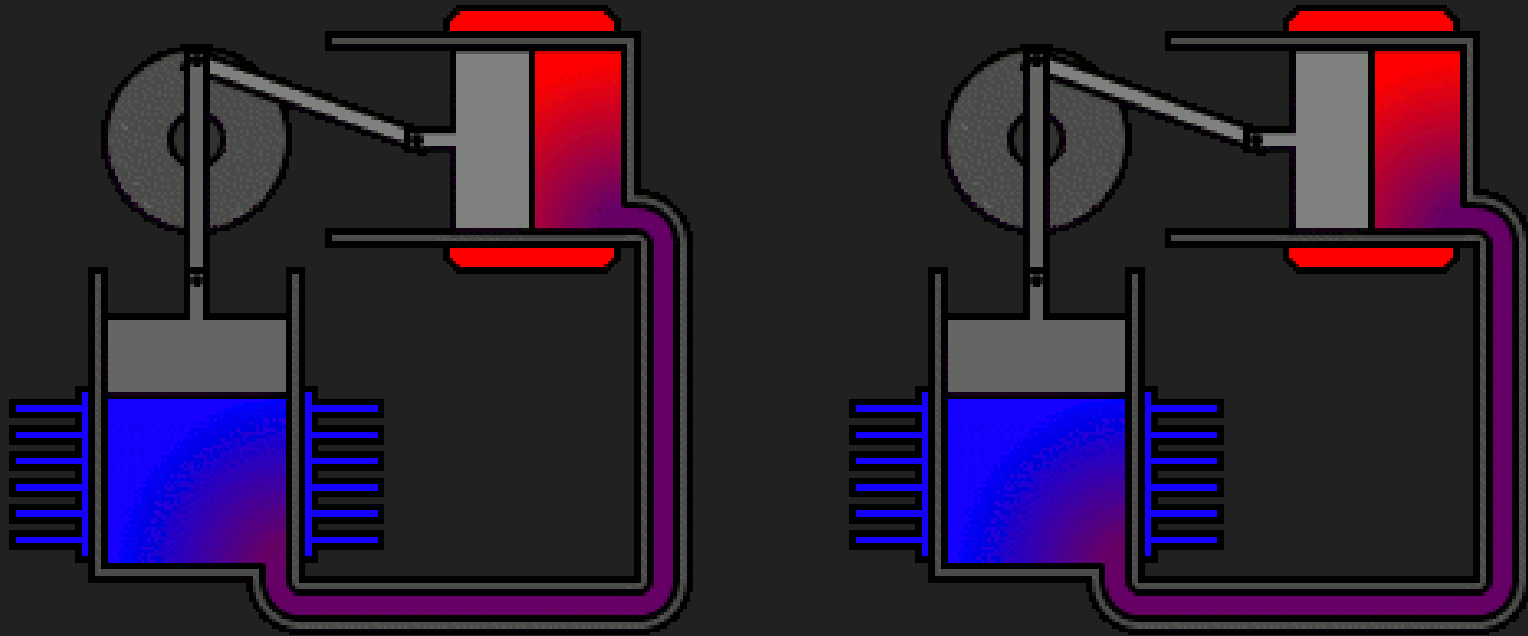
Solar-thermal



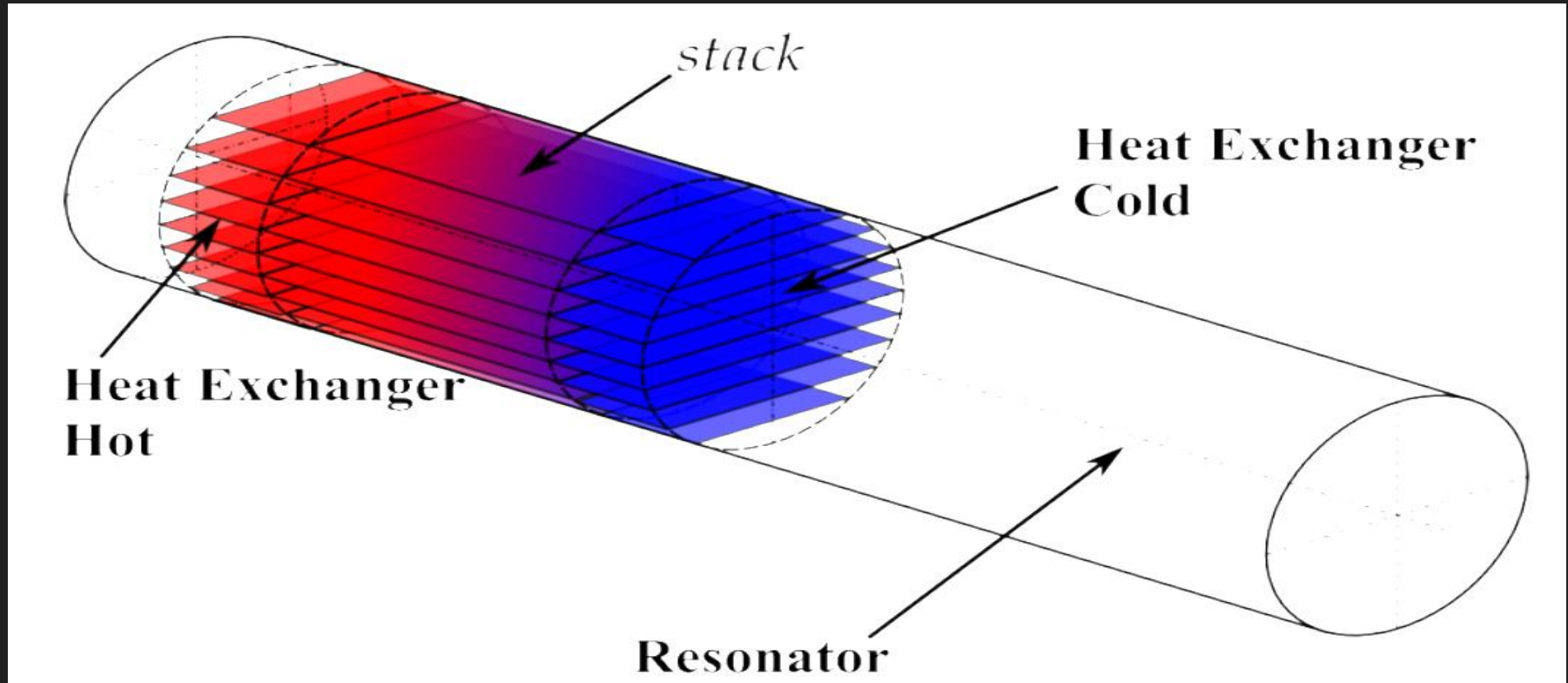
Waste heat

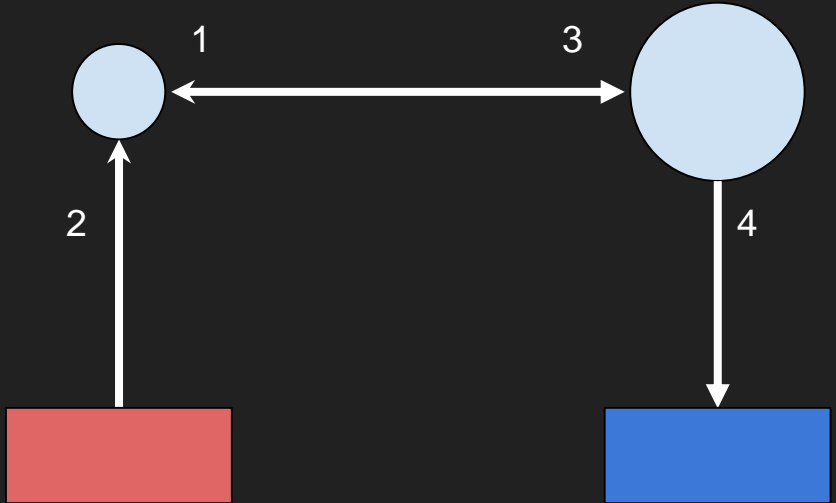
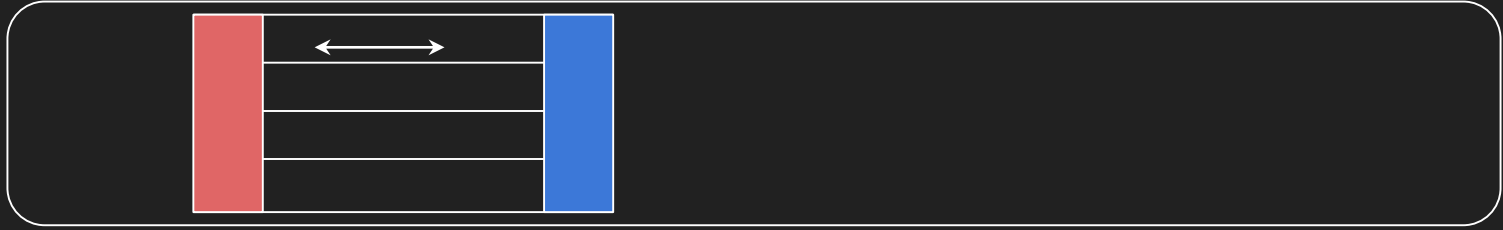


# Inspiration: the Stirling engine



# Standing Wave Thermoacoustic Device





## The Thermoacoustic Cycle

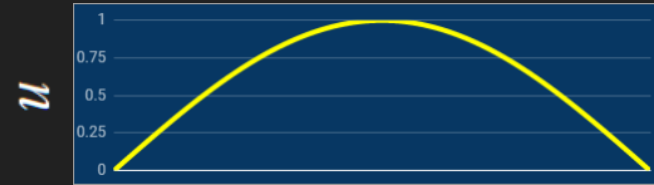
The stroke boundaries are “blurred”

1. Compression
2. Heat injection
3. Expansion
4. Heat removal

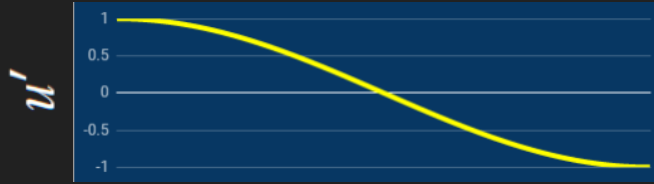
And now, let's look at the question...

Please open the Theory Question 3 to the page 1..

# Part A: Standing wave, no heat exchangers



A1.  $u \propto \sin(kx)$



A2.  $\Delta V \propto u' \propto \cos(kx)$



A3.  $ma = F = -SP'\Delta x$

A4.  $\Delta P/P = -\gamma \Delta V/V$

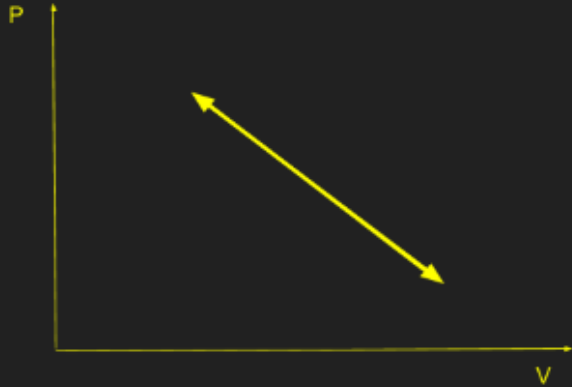
A5.  $\Delta T \propto \Delta P \propto -\Delta V \propto u'$

A6. *Heat flux*  $\propto u \cdot u'$

$$\sin(kx) \cdot \cos(kx) \propto \sin(2kx)$$



## Part B: The self-amplifying mode of oscillations



B1-B2.  $T_{st} > T_1$

B3. The 1st Law,

a.k.a. energy conservation

B4. Solve B3 for both phases

B5-B7. Integrate some cosines

to get  $W$ ,  $Q$ ,  $\eta$

