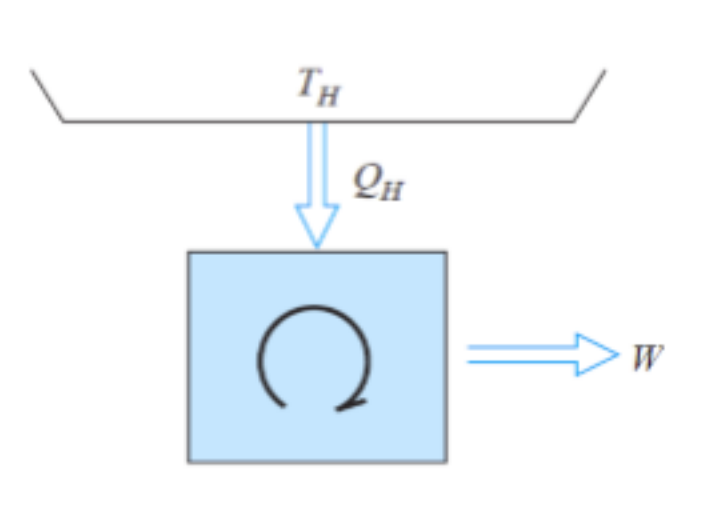
Unit 10 - Week 7 :

Assignment 7

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-09-18, 23:59 IST.

1) Consider a heat engine that operates in a cycle, receives a given amount of heat Q_H from a high temperature thermal reservoir, and does an equal amount of work $W\ (= Q_H)$ as shown in the figure below. *1 point*



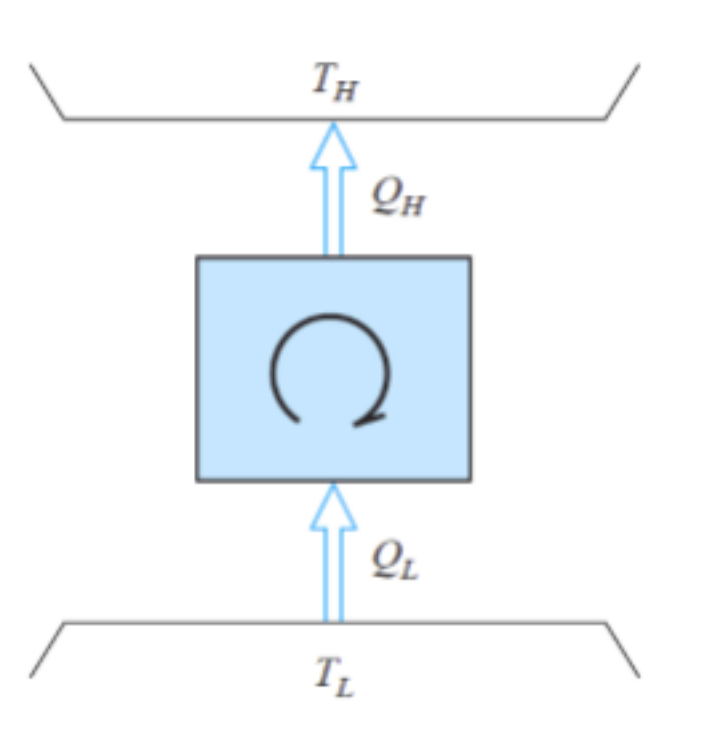
Which among the following statements about this heat engine is TRUE?

(a) It obeys both the first law and the second law of thermodynamics.
(b) It obeys the first law but violates the second law of thermodynamics.
(c) It violates the first law but obeys the second law of thermodynamics.
(d) It violates both the first law and the second law of thermodynamics.

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
b

2) Consider a refrigerator that operates in a cycle, receives a given amount of heat Q_L from a low temperature thermal reservoir and transfers the same amount of heat $Q_H\ (= Q_L)$ to a high temperature thermal reservoir as shown in the figure below. *1 point*



Which among the following statements about this refrigerator is TRUE?

(a) It violates both the first law and the second law of thermodynamics.
(b) It violates the first law but obeys the second law of thermodynamics.
(c) It obeys the first law but violates the second law of thermodynamics.
(d) It obeys both the first law and the second law of thermodynamics.

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
c

3) Heat engines and heat pumps (refrigerators) are energy conversion devices altering amounts of energy transfer between heat, Q and work, W. Which conversion direction ($Q \to W$ or $W \to Q$) is limited (100 % conversion not possible) and which is unlimited (100 % conversion possible) according to the second law? *1 point*

(a) The conversion direction $Q \to W$ is limited but $W \to Q$ is unlimited.
(b) The conversion direction $W \to Q$ is limited but $Q \to W$ is unlimited.
(c) Both conversion directions $Q \to W$ and $W \to Q$ are limited.
(d) Both conversion directions $Q \to W$ and $W \to Q$ are unlimited.

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
a

4) Which among the following is the correct definition of a reversible process? *1 point*

(a) A reversible process for a system is defined as a process that, once having taken place, can be reversed and in doing so leaves no change in the system but may change its surroundings.
(b) A reversible process for a system is defined as a process that, once having taken place, can be reversed and in doing so may change the system but leaves no change in its surroundings.
(c) A reversible process for a system is defined as a process that, once having taken place, can be reversed and in doing so may change either the system or its surroundings.
(d) A reversible process for a system is defined as a process that, once having taken place, can be reversed and in doing so leaves no change in either the system or its surroundings.

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
d

5) Which among the following statements is/are TRUE? *1 point*

(a) Heat is a form of energy that is transferred across the system boundary by virtue of the temperature difference between the system and its surroundings.
(b) Heat transfer through a finite temperature difference is an irreversible process.
(c) A heat transfer approaches a reversible process as the temperature difference between the two bodies tends to infinity.
(d) A heat transfer approaches a reversible process as the temperature difference between the two bodies approaches zero.

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
a
b
d

6) Which among the following statements is/are TRUE? *1 point*

(a) A totally reversible expansion or compression process is necessarily a quasi-equilibrium process.
(b) A totally reversible expansion or compression process need not necessarily be a quasi-equilibrium process.
(c) A quasi-equilibrium expansion or compression process need not necessarily be totally reversible.
(d) A quasi-equilibrium expansion or compression process is necessarily totally reversible.

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
a
c

7) Consider the following statements: *1 point*

(I) Unrestrained expansion of a gas is an irreversible process.
(II) In the absence of any friction and other external irreversibilities, a heat engine can have an efficiency of 100 percent.

(a) Statement (I) is true but statement (II) is false.
(b) Statement (I) is false but statement (II) is true.
(c) Both statement (I) and (II) are true.
(d) Both statement (I) and (II) are false.

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
a

8) Which among the following statements is/are TRUE? *1 point*

(a) All heat engines operating between a given constant temperature source and a given constant temperature sink are more efficient than a reversible heat engine operating between the same two reservoirs.
(b) The efficiencies of all reversible heat engines operating between the same two reservoirs are the same.
(c) The efficiency of a reversible heat engine depends on the nature or amount of the working substance undergoing the cycle.
(d) A reversible heat engine operating between a given constant temperature source and a given constant temperature sink is more efficient than all heat engines operating between the same two reservoirs.

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
b
d

9) Consider the following processes: *1 point*

(I) A cold canned drink is left in a warmer room where its temperature rises as a result of heat transfer.
(II) By means of a refrigerator, heat is transferred from a low temperature reservoir (the refrigerated space) to a high temperature reservoir (the kitchen air).

Which among the following statements is /are TRUE about these processes?

(a) Process (I) obeys the second law of thermodynamics but process (II) is a violation of the second law.
(b) Both the processes (I) and (II) violate the second law of thermodynamics.
(c) Both the processes (I) and (II) obey the second law of thermodynamics.
(d) Process (I) is a reversible process.
(e) Process (I) is an irreversible process.

- a
- b
- c
- d
- e

No, the answer is incorrect.
Score: 0
Accepted Answers:
c
e

10) Consider two heat engines operating between the same two energy reservoirs, and both receive the same Q_H. One engine is reversible and the other is not. What can you say about the two Q_L's? *1 point*

(a) $Q_{L,rev} > Q_{L,irrev}$
(b) $Q_{L,rev} = Q_{L,irrev}$
(c) $Q_{L,rev} < Q_{L,irrev}$
(d) Can't say

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
c

11) *1 point*

Consider two heat pumps operate between the same two energy reservoirs, and both receive the same Q_L. One heat pump is reversible and the other is not. What can you say about the two Q_H's?

(a) $Q_{H,rev} > Q_{H,irrev}$
(b) $Q_{H,rev} < Q_{H,irrev}$
(c) $Q_{H,rev} = Q_{H,irrev}$
(d) Can't say

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
b

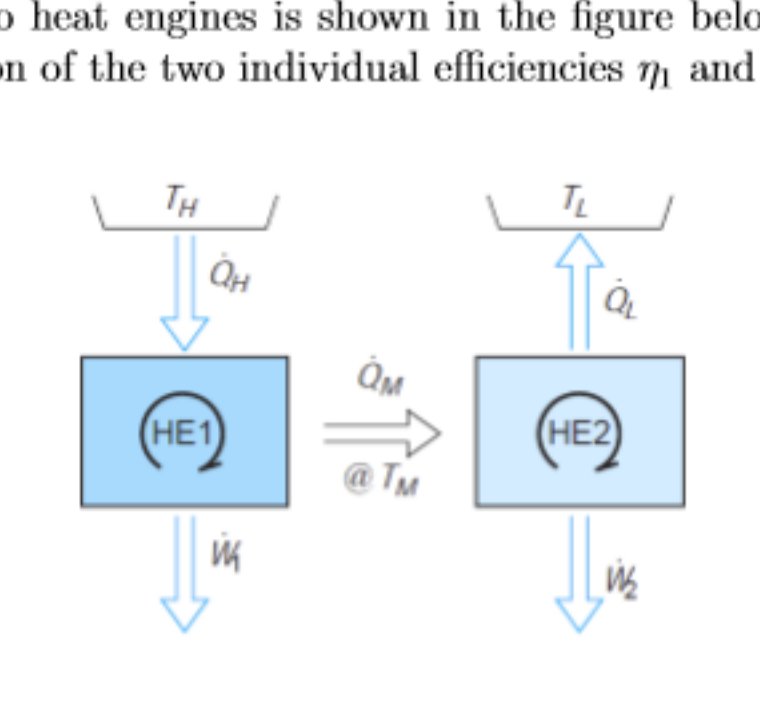
12) Which among the following statements regarding the thermal efficiency of a heat engine is/are TRUE? *1 point*

(a) The thermal efficiency of a heat engine increases as the temperature of the energy source decreases.
(b) The thermal efficiency of a heat engine increases as the temperature of the energy source increases.
(c) The thermal efficiency of a heat engine increases as the temperature of the energy sink decreases.
(d) The thermal efficiency of a heat engine increases as the temperature of the energy sink increases.

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
b
c

13) A combination of two heat engines is shown in the figure below. Find the overall thermal efficiency as a function of the two individual efficiencies η_1 and η_2. *1 point*

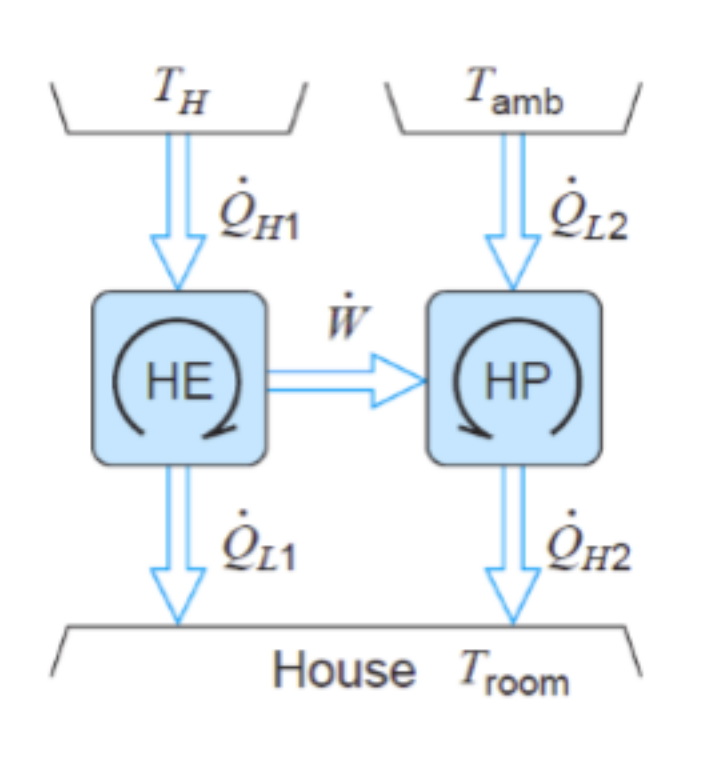


(a) $\eta_1 + \eta_2$
(b) $\eta_1 \eta_2$
(c) $\eta_1 + \eta_2 - \eta_1 \eta_2$
(d) $\eta_1 + \eta_2 + \eta_1 \eta_2$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
c

14) A reversible heat pump is driven by the work output of a reversible heat engine, as shown in the figure below. If we assume ideal devices, find the ratio of the total power $\dot{Q}_{L1} + \dot{Q}_{H2}$ that heats the house to the power from the hot energy source $\dot{Q}_{H1}$ in terms of the temperatures. *1 point*



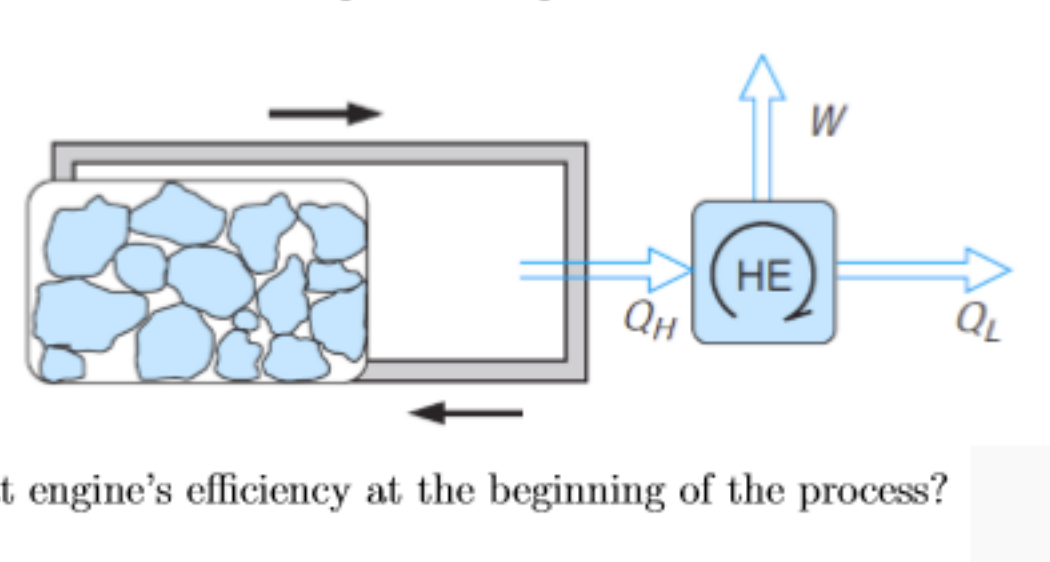
(a) $\frac{T_{room}}{T_H} + \frac{T_H(T_H - T_{room})}{T_{room}(T_{room} - T_{amb})}$
(b) $\frac{T_{room}}{T_H} + \frac{T_{room}(T_H - T_{room})}{T_H(T_{room} - T_{amb})}$
(c) $\frac{T_{room}}{T_H} + \frac{T_{room}(T_{room} - T_{amb})}{T_H(T_H - T_{room})}$
(d) $\frac{T_{room}}{T_H} + \frac{T_H(T_{room} - T_{amb})}{T_{room}(T_H - T_{room})}$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
b

15) *1 point*

Common Data for Questions 15 to 17:
A thermal storage device is made with a rock (granite) bed of mass m that is heated to a temperature T_H using solar energy. A reversible heat engine receives Q_H from the bed and rejects heat to the surroundings at ambient temperature T_{amb}. The rock bed therefore cools down, and as it reaches T_{amb} the process stops.



What is the heat engine's efficiency at the beginning of the process?

(a) $\frac{T_{amb}}{T_H}$
(b) $\frac{T_H}{T_{amb}}$
(c) $1 - \frac{T_{amb}}{T_H}$
(d) $1 - \frac{T_H}{T_{amb}}$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
c

16) What is the heat engine's efficiency at the end of the process? *1 point*

(a) 0 %
(b) 100%
(c) ∞
(d) None of the above

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
a

17) Find the total heat engine work output. *1 point*

Hint: Using constant specific heats, write δQ_H in terms of dT_{rock} and find the expression for δW out of the heat engine. Integrate this expression over temperature.

(a) $Q_H\left(1 - \frac{T_{amb}}{T_H}\right)$
(b) $\frac{Q_H T_{amb}}{T_H - T_{amb}} \ln\left(\frac{T_{amb}}{T_H}\right)$
(c) $\frac{Q_H T_{amb}}{T_H - T_{amb}} \ln\left(\frac{T_{amb}}{T_H}\right) - Q_H$
(d) $\frac{Q_H T_{amb}}{T_H - T_{amb}} \ln\left(\frac{T_{amb}}{T_H}\right) + Q_H$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
d