PHYSICS

BOOKS - CENGAGE PHYSICS

HEAT AND MECHANICAL ENERGY

Worked Examples

1. A block of copper of weight 2kg falls from a height of 10m into a bucket containing 10 litres of water. Assuming that all the

mechanical energy is used to heat water, find the rise in temperature of water. Given $C_w = 4180 Jkg^{-1}K^{-1}$

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2. Earth receives solar energy at a rate of $1000 Wm^{-2}$. A solar water heater of area $2m^2$ absorbs 50% of incident energy. Find the time required to raise the temperature of 50 litres of water by $50^\circ C$. $\left(C_W = 4180 Jkg^{-1}K^{-1}\right)$

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3. A heat engine is cooled by 10 litres of water. The engine has an efficiency of 50% and delivers 5kW of mechanical power. Find the rise in temperature of water in 1 minute. $\left(C_w = 4180 Jkg^{-1}K^{-1}\right)$

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4. A heat engine of efficiency 40% takes 10kJ of heat energy per second. Find the time required by this engine to lift a weight of

1000kg to a height of 10m from the ground.

(Take $g = 10ms^{-2}$)

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Mandatory Exercise Exercise Set I

1. Can 10J of mechanical energy be converted to 10J of heat? Justify.

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2. Can a heat engine convert 10J of heat into 10J of work ? Justify

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3. Can 10J of mechanical energy produce 15J of heat? Explain.

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4. Can the efficiency of heat engine be 100% ?

Justify

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5. Can the efficiency be greater than 100% ?

Justify

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6. Why do tyres get heated up during the running of a vehicle?

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7. Why does an engine become hot while the vehicle is running?

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8. If heat is absorbed at $T_1(k)$ and rejected at $T_2(k)$. Then it can be shown that $\eta = 1 - \frac{T_2}{T_1}$. What is the most common value of T_2?

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9. What are the changes in forms of energy when petrol is used to run our vehicles?

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10. When a petrol engine doesn't start, we pull the choke button converted to the choke plate of carburettor. What does it do?

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Mandatory Exercise Exercise Set Ii

1. A mixer-grinder becomes hot while grinding. This is because the

A. heat energy is converted to mechanical energy

B. heat energy is converted to electrical energy

C. mechanical energy is converted to thermal energy

D. energy is created

Answer:

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2. Mechanical energy to drive a vehicle is usually obtained by

A. heat energy

B. magnetic energy

C. wind energy

D. geothermal energy

Answer:

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3. Mechanical energy is converted to thermal energy in

A. a steam engine

B. a petrol engine

C. a diesel engine

D. hammering the nail into a plank

Answer:

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4. Spark plug is not present in

A. a petrol engine

B. a diesel engine

C. a gas engine

D. MPFI engine

Answer:

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5. Joule's experiment shows that _____energy and _____energy are equivalent.

A. potential, kinetic

B. electrical, light

C. heat, light

D. mechanical, heat

Answer:

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6. Carburettor is used in

A. a petrol engine

B. a diesel engine

C. a gas engine

D. MPFI engine

Answer:

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Mandatory Exercise Exercise Set Iii

1. (Take $C_w = 4180 Jkg^{-1}K^{-1}$) A block of weight 5kg falls from a height of 5m into a bucket containing 10L of water. If all the mechanical energy of the block is used to heat water, find the rise in temperature of water. Take $g = 10ms^{-2}$

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2. A heat engine of efficiency 40% takes 10kJ of heat energy every second. It is used to lift a weight of 2000kg. Find the height to which

the weight can be raised in 30s. [Take $g = 10ms^{-2}$]

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3. A heat engine absorbs 300J of heat at $627^{\circ}C$ and rejects a part of it at $27^{\circ}C$. Find the work done by the engine.

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4. An engine operates between temperatures 100K and 1000K. If the engine does 5000J of work per minute. How much heat is expelled by the engine?

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5. The efficiency of an engine is 1/2. When T_2 is reduced by $100^\circ C$, the efficiency becomes 2/3. Find T_1

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General Exercise

1. What is a heat engine? Explain the efficiency of a heat engine.

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2. What is a heat engine? Explain the efficiency of a heat engine.

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3. Why does our palm become warm when we rub them together?

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Challenging Exercise

1. The earth receives solar energy at the rate of 1000 Wm^{-2}. A solar water heater of area $4m^2$ absorbs 60% of incident energy. Find the time

required to rise the temperature of 100L of water by $40^{\circ} C$

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2. A heat engine operates between a cold reservoir at tempreture $T_2 = 300K$ and a hot reservior at tempreture T_1. It takes $200J$ of heat from the hot reservior and delivers $120J$ of heat to the cold reservior in a cycle. What sould be the minimum temperature of the hot reservior ?

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Olympiad And Ntse Level Exercises

1. A Carnot engine working between K 300 and 600 K has work output of 800 J per cycle. What is amount of heat energy supplied to the engine from source per cycle

A. 1800J/cycle

B. 1000J/cycle

C. 2000J/cycle

D. 1600J/cycle

Answer:

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2. An ideal gas heat engine operates in a Carnot's cycle between $227^\circ C$ and $127^\circ C$. It absorbs $6 \times 10^4 J$ at high temperature. The amount of heat converted into work is

A. $4.8 \times 10^4 J$

B. $3.5 \times 10^4 J$

C. $1.6 \times 10^4 J$

D. $1.2 \times 10^4 J$

Answer:

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3. An engine is supposed to operate between two reservoirs at temperature $727^\circ C$ and $227^\circ C$. The maximum possible efficiency of such an engine is

A. $1/2$

B. $1/4$

C. $3/4$

D. 1

Answer:

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4. If a Carnot's engine functions at source temperature $127^\circ C$ and at sink temperature $87^\circ C$, what is its efficiency

A. $10\ \%$

B. $25\ \%$

C. $40\ \%$

D. $50\ \%$

Answer:

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5. Two Carnot engines A and B are operated is succession. The first one A receives heat from a source at $T_1 = 800K$ and rejects to a sink at

T_2K. The second engine B receives hence rejected by the first engine and rejects the another sink at T_3=300K. If the efficiencies of two engines are equal, then the value of T_2 is

A. 100K

B. 300K

C. 550K

D. 700K

Answer:

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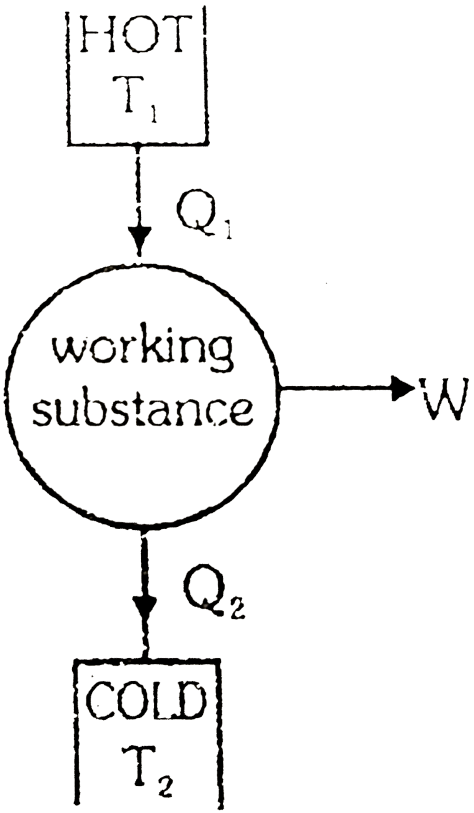
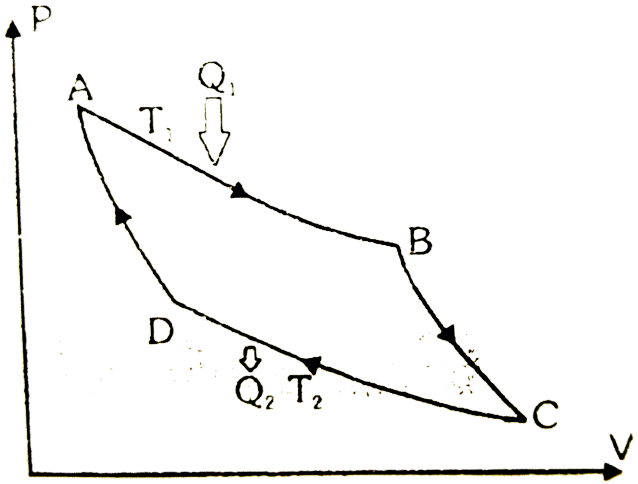
6. The efficiency of a heat engine is defined as the ratio of the mechanical work done by the engine in one cycle to the heat absorbed from the high temperature source . $\eta = \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q_1}$ Cornot devised an ideal engine which is based on a reversible cycle of four operations in succession: isothermal expansion , adiabatic expansion. isothermal compression and adiabatic compression.



For carnot cycle $\frac{Q_1}{T_1} = \frac{Q_2}{T_2}$. Thus $\eta = \frac{Q_1 - Q_2}{Q_1} = \frac{T_1 - T_2}{T_1}$ According to carnot theorem "No irreversible engine can have efficiency greater than carnot reversible engine working between same hot and cold

reservoirs".



A carnot engine whose low temperature reservoir is at $7^\circ C$ has an efficiency of $50\,\%$. It is desired to increase the efficiency to $70\,\%$. By how many degrees should the temperature of the high temperature reservoir be increased?

A. 273K

B. $\frac{1120}{3}K$

C. 140K

D. None of these

Answer:

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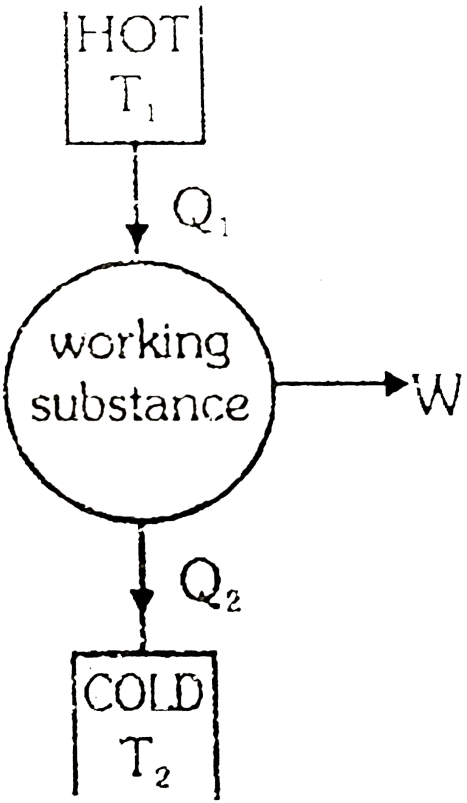

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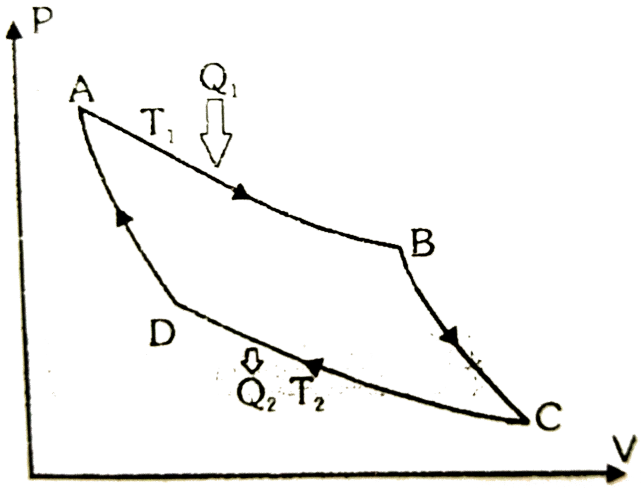

Efficiency of a carnot's cycle change from $\frac{1}{6}$ to $\frac{1}{3}$ when source temperature is raised by $100K$. The temperature of the sink is-

A. $\frac{1000}{3}K$

B. $\frac{500}{3}K$

C. 250K

D. 100K

Answer:

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