Answer on Question 58779, Physics, Mechanics, Relativity

Question:

An internal combustion engine uses fuel, of energy content 44.4 MJ/kg, at a rate of 5 kg/h. If the efficiency is 28%, determine the power output and the rate of heat rejection.

Solution:

a) Efficiency is defined as the ratio of useful work done to the heat energy absorbed by the engine:

$$\eta = \frac{Work\ output}{Work\ input} \cdot 100\%,$$

here, $Work\ output$ is the work done by the engine, $Work\ input$ is the heat energy absorbed by the engine.

Let's rewrite our efficiency formula in terms of power:

$$\eta = \frac{Power\ output}{Power\ input} \cdot 100\%,$$

here, $Power\ input$ is the amount of heat that is released during the combustion of fuel, $Power\ output$ is the useful power of the drive shaft of the engine without the power loss caused by gears, transmission or friction, for example.

Let's first calculate the $Power\ input$ by the formula:

$$Power\ input = FC \cdot CV,$$

here, FC is the fuel consumption, CV is the calorific value of kilogram fuel.

Then, the $Power\ input$ will be:

$$Power\ input = FC \cdot CV = 5\ \frac{kg}{h} \cdot \frac{1}{3600}\ \frac{h}{s} \cdot 44.4 \cdot 10^6\ \frac{J}{kg} = 61667\ W.$$

As we know the $Power\ input$, we can find the $Power\ output$ from the efficiency formula:

$$Power\ output = \frac{\eta}{100\%} \cdot Power\ input = \frac{28\%}{100\%} \cdot 61667\ W = 0.28 \cdot 61667\ W = \\ = 17267\ W.$$

b) The rate of heat rejection is equal to the difference of the power input and the power output:

$$Q = Power\ input - Power\ output = 61667\ W - 17267\ W = 44400\ W.$$

Answer:

a) $Power\ output = 17267\ W.$

b) $Q = 44400\ W.$