Department of Electrical Engineering
Assignment
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Course Details

Course Title:	Thermodynamics	**Module:**	02
Instructor:	Mujtaba Ihsan	**Total Marks:**	50

Student Details

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Q1 (A) **State** the following along with their mathematical expressions

1 The ideal gas law

Answer:

State: ”This equation hold for ideal gases.

”R” is the ideal gas constant

Temperature must be in kelvin.

This law allows us to solve for any of the variables affecting a gas.

Mathematically:

Pv = nRt

P = pressure

V = volume

T = temperature

n = number of moles

R = gas constant

(R= 0.0821 if p = atm v= l and T= K)

(R= 8.314 IF P = Pa, v m^3, and T =k)

2 Dalton’s law of partial pressure

Answer:

State: State that the total pressure of mixture of a gases is the sum of the partial pressure of its component. This partial pressure of a gas in a mixture is the pressure that the gas would exert if alone.

Mathematically:

PT= P1+P2+P3+……+Pn

P1= partial pressure by gas 1.

Q1 (B) Explain the Carnot cycle

ANSWER:

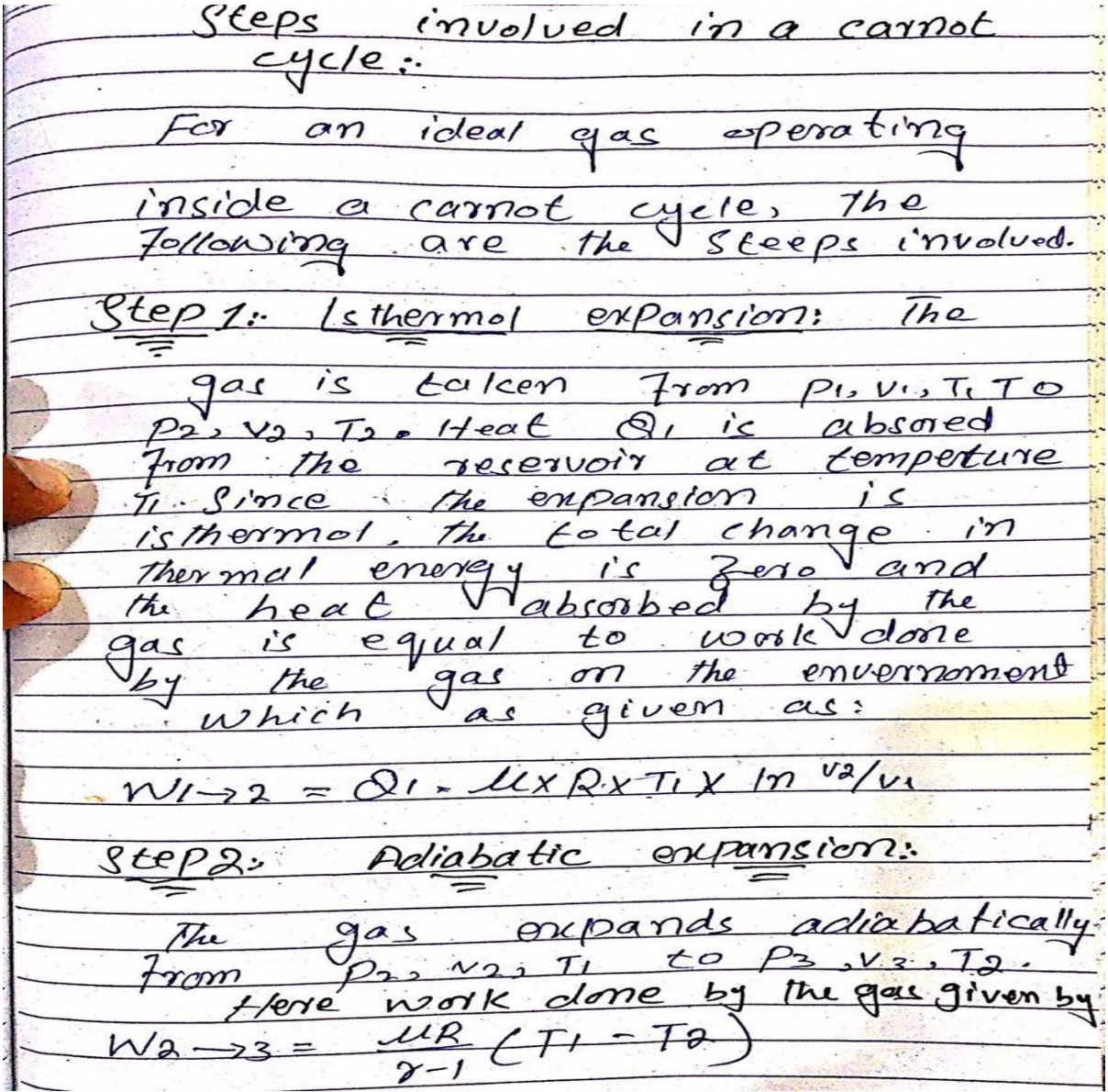
Carnot engine is a theoretical thermodynamic cycle proposed by Leonard Carno.t

Carnot cycle: “A Carnot cycle is defined as an ideal reversible closed thermodynamic cycle in which there are four successive operations involved and they are isothermal expansion, adiabatic expansion, isothermal compression, and adiabatic compression”. During these

operations, the expansion and compression of substance can be done up to desired point and back to initial state.

Following are the four processes of Carnot cycle:

- In (a), the process is reversible isothermal gas expansion. In this process, the amount of heat absorbed by the ideal gas is q_{in} from the heat source which is at a temperature of T_h. The gas expands and does work on the surroundings.
- In (b), the process is reversible adiabatic gas expansion. Here, the system is thermally insulated and the gas continues to expand and work is done on the surroundings. Now the temperature is lower, T_l.
- In (c), the process is reversible isothermal gas compression process. Here, the heat loss, q_{out} occurs when the surroundings do the work at temperature T_l.
- In (d), the process is reversible adiabatic gas compression. Again the system is thermally insulated. The temperature again rise back to T_h as the surrounding continue to do their work on the gas.


Steps involved in a carnot cycle:-

For an ideal gas operating inside a carnot cycle, the following are the steeps involved.

Step 1:- Isthermal expansion: The gas is taken from P_1, V_1, T_1 to P_2, V_2, T_2. Heat Q_1 is absored from the reservoir at temperture T_1. Since the expansion is isthermal, the total change in thermal energy is zero and the heat absorbed by the gas is equal to work done by the gas on the envernment which as given as:

$$W_{1\to2} = Q_1 = \mu \times R \times T_1 \times \ln V_2/V_1$$

Step 2:- Adiabatic expansion:-

The gas expands adiabatically from P_2, V_2, T_1 to P_3, V_3, T_2. Here work done by the gas given by

$$W_{2\to3} = \frac{\mu R}{\gamma - 1}(T_1 - T_2)$$

Step 3: Isthermal compression:

The gas is compressed isthermally from the state (P_3, V_3, T_2) to (P_4, V_4, T_2)

Here, the work done on the gas by the environment is given by:

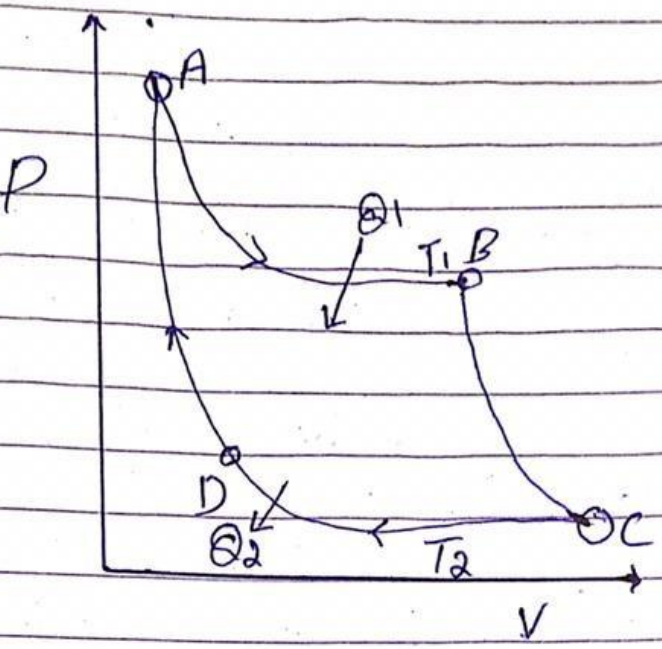
$$W_{3 \to 4} = \mu R T_2 \ln \frac{V_2}{V_4}$$

Step 4: Adiabatic compression:

The gas is compressed adiabatically from the state (P_4, V_4, T_2) To (P_1, V_1, T_1)

Here, the work done the gas by the environment is given by:

$$W_{4 \to 1} = \frac{\mu R}{\gamma - 1}(T_1 - T_2)$$



Hence: The Total work done by the gas on the envernoment is one complete cycle. is given by:

$$W = W_{1\to2} + W_{2\to3} + W_{3\to4} + W_{4\to1}$$

$$W = \mu R T_1 \ln \frac{V_2}{V_1} - \mu R T_2 \ln \frac{V_3}{V_4}$$

net effeciency = $\frac{\text{Net work done by the gas}}{\text{Heat absorbed by the gas}}$

$$= \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q_1} = 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_1} \frac{\ln V_3/V_2}{\ln V_2/V_4}$$

Since the Step 2→3 is an adiabatic process, we can write $T_1 V_2^{\gamma-1} = T_2 V_3^{\gamma-1}$

OR

$$\frac{V_2}{V_3} = \left(\frac{T_2}{T_1}\right)^{1/\gamma-1}$$

Similarly, for the process 4->1, we can write

$$\frac{V_1}{V_2} = \left(\frac{T_2}{T_1}\right)^{\frac{1}{\gamma-1}}$$

$$\frac{V_2}{V_3} = \frac{V_1}{V_2}$$

So, the expanse expression for net efficiency of carnot engine reduces to:

$$\text{Net efficiency} = 1 - \frac{T_2}{T_1}$$

Q2 (A) You need to buy a refrigerator for your home. Outline the key factors that you will consider while buying the refrigerator.

ANSWER

Consider When Buying a Refrigerator

Buying a new refrigerator is a big decision. Not only is the refrigerator a centerpiece among your collection of kitchen appliances, it's a gathering place for preparing family meals. You rely on it to keep your food fresh. Even when it becomes an eye sore (hello, avocado green!), or an energy hog that's ratcheting up your energy bill, you might be inclined to put off replacing it. Besides, the moment you walk into a store or begin your online shopping, you will encounter seemingly endless decision points – from sizes and configurations to features and more. But the time is now. Follow these easy tips, and you'll be well on your way to big savings**.**

Look for the ENERGY STAR

ENERGY STAR is the simple choice for saving energy, saving money and helping to protect the climate. After heating, cooling, and hot water, the refrigerator is probably the next largest energy user in your home. Thanks to recent improvements in insulation and compressors, today's refrigerators use much less energy than older models. In fact, a 15 year old refrigerator uses 33% more energy as a new ENERGY STAR certified model. You could save more than $200 and reduce your carbon footprint by 4,900 pounds of CO2 over the 12-year lifetime of the product**.**

Consider a Refrigerator with a Top-Mounted Freezer

Refrigerators are sold in many configurations including top freezer, bottom freezer, and side-by-side. Your new refrigerator doesn't have to be the same configuration you had before, so long as you account for proper sizing as discussed below. A top-freezer refrigerator that has earned the ENERGY STAR uses less energy than a 60-watt light bulb. Top freezer models tend to use the least energy of all refrigerator configurations and are affordably priced

Purchase an Appropriately Sized Refrigerator

Generally, the larger the refrigerator, the greater the energy consumption. The most energy-efficient models are typically 16-20 cubic feet. When you replace an old refrigerator with a new one, do not keep the old refrigerator for extra cold storage. If your refrigeration needs absolutely cannot be met by a single refrigerator, make sure that the second refrigerator or freezer is an energy efficient model that is no bigger than what you need. Be certain to recycle your existing second refrigerator from your garage or basemen

Consider the Features that are Most Important to You

Which features do you need in your new fridge? Think about whether you'll want an icemaker, through-the-door ice, or hot water, so that you only pay for what you use – both in the initial purchase price and over the lifetime of the product. For example, through-the-door ice adds about 84 kWh of energy, or $10 per year to your utility bill. Peruse the ENERGY STAR Product Finder to compare features among energy efficient refrigerator models and optimize your purchase.

Recycle Your Old Refrigerator

Recycling old refrigerators is another important way to help prevent global warming. Not only does it prevent energy-wasting units from ending up in someone else's home, but it avoids the release of harmful materials. Keeping all that old refrigerant and foam from getting into the environment could prevent 4,900 pounds of greenhouse gas emissions! Learn how to Flip Your Fridge and save.

Take Advantage of Utility Rebates

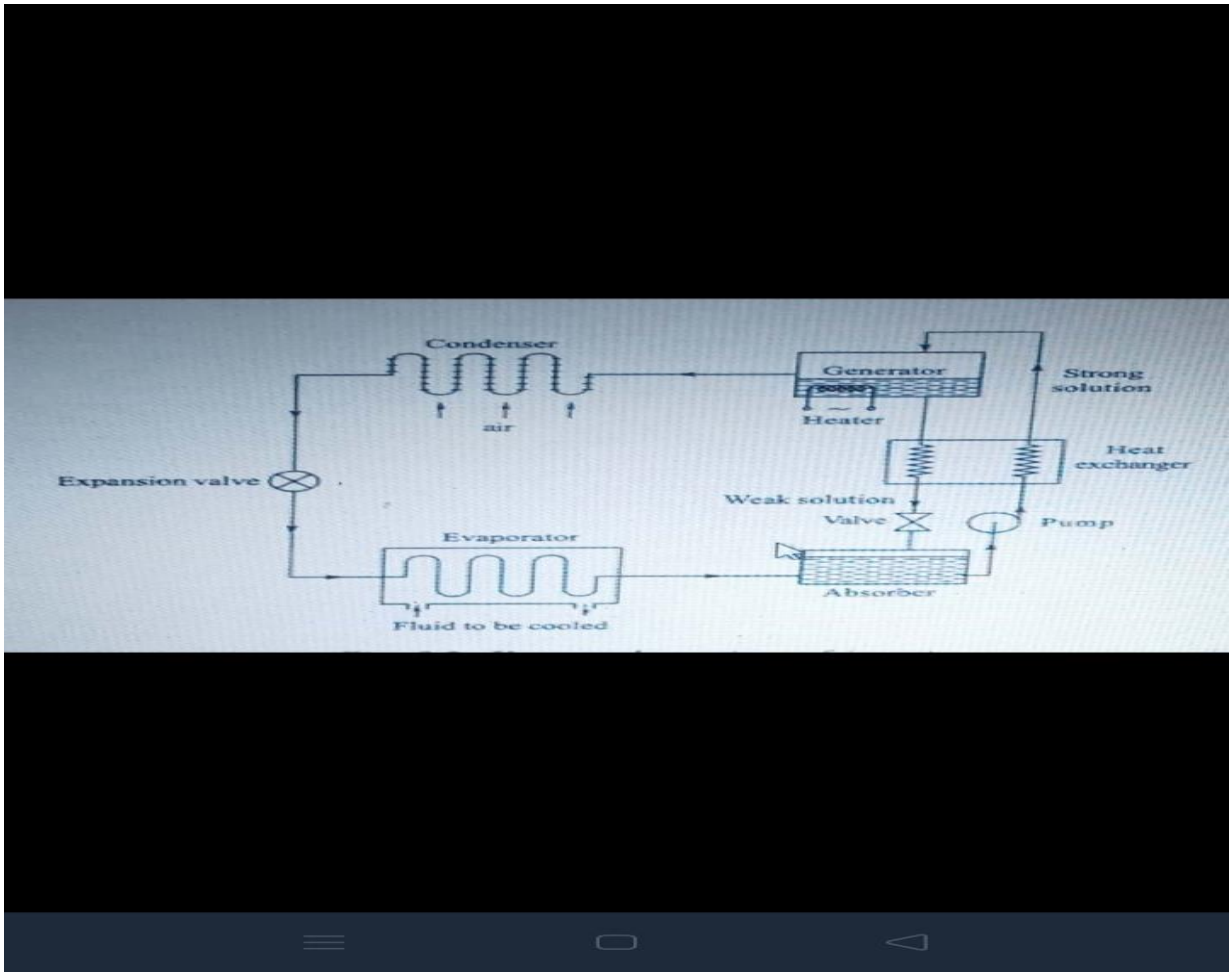
Be sure to visit the ENERGY STAR Rebate Finder to check for special offers from your local utility on purchasing a new refrigerator and/or recycling an old one.

Q 2 (B): VAPOUR ABSORPTION REFRIGERATION:

PRINCIPLE: Here the heat energy is utilized to achieve the refrigeration. An electric heater or steam is used to add the heat to the refrigerant for its evaporation. Also an absorber, a pump and a generator are used to complete the cycle.

Construction:

Here a throttle valve is connected between an evaporator and a condenser. One pump is connected between an absorber and a separator. Water is filled in the absorber and it is connected to the evaporator. The evaporator is kept in the storage room. The separator is connected to the condenser. Both the condenser and evaporator consists of pipes in coil form to provide more contact surface area for the refrigerant. Arguments are made to circulate the cold water around the condenser and in the absorber. An electric heater is housed in the separator. Trays may be positioned to collect the exit water near by the absorber and condenser. A receiver is connected in between the condenser and the throttle valve



Q3. Distinguish between water tube & fire tube boilers.

Answer:

Distinguish between water tube & fire tube boilers.

These are most efficient boilers- water runs is the tube the hot gas surround it, hence the heat transfer area is low value.

Boiler Accessories:

Some of the boilers are given below.

1. **Economizer:** It's used for hesting feed water, thus utilize the heat an exhaust flow gasses.
2. **Super Heater**: It's used for super heating of wet stream.
3. **Feed Pumps**: It pumps water it desired pressure to the boiler.
4. **Injector:** It's used for pumping water tube to a vertical or a locomotive boiler to a low pressure boiler.
5. **Air Pre-Heater**: It is used for Pre-heating of air.
6. **Steam Trap:** It's used to drain off water resulting partial condensation steam from steam pipes.
7. **Team Separator:** It's used for splitting water particles steam.
8. **Pressure Reducing Value:** It's used to maintain desired steam pressure.
9. **Induced Draft Fan (ID):** It's used to exhaust flow gasses boiler and discharge them into chimneys.
10. **Force Draft Fan (FD):** it's used to supply air for combustion.
11. **Primary Air Fan (PF):** It's Used to supply air for palavering fuel and carrying it to the furnace.

Q 4: State the meaning of the word "stroke" & describe the working of a 04 stroke engine?

Answer

Stroke: "A stroke is movement of the piston from top dead. Centre (T.D.C) to bottom dead Centre (B.D.C) or from B.D.C to T. D. C".

Cycle: "IT is a series of event that repeat themselves."

Four – stroke Engine: Four – stroke cycle engine works on four stroke principle i.e there are four stroke in one cycle of such engine. Four –stroke cycle engine is also called "four engine or " Otto cycle engine.

There are four stroke of Otto cycle engine are

1 Intake stroke:

On the intake stroke, the piston is moving darn due to which a partial vacuum is produced inside the cylinder. The intake valve is open, therefore, atmospheric pressure pushes the fresh air fuel mixture in the cylinder through the intake valve.

2 Compression Stroke:

When the piston reaches the B.D.C on the intake stroke, the intake valve closes. Ten piston moves up on the compression stroke. During this stroke, both the valves are closed, therefor, no air-fuel mixture can enter or goes out of the cylinder. Therefore, when the piston moves up “the” mixture inside the cylinder is compressed. In modern engine it is compressed to one- eight or one- ninth of the original volume. The amount to which the air-fuel mixture is compressed is called “the mixture ratio”.

If the mixture is compressed to one-eighth of the original volume, the compression ratio is “8” to “1” (8:1).

3. Power Stroke:

During the compression stroke, the piston moves of which it get near T.D.C, the spark plug reduce a spark which ignite the compressed air-fuel mixture. Due to which thr temperature and the pressure of gas rises. The pressure becomes about 600 psi which push the piston down. As during this stroke, we obtain power therefor it is called “power stroke”.

The piston transmit this power through connecting rod to the rank due to which the crankshaft rotates this rotatory motion is carried through shafts and gears to thr car wheels due to which wheel turns and car moves.

4. Exhaust Stroke.

During the power stroke is the piston reaches B.D.C, the exhaust valve open then the piston moves of on exhaust stroke. When piston moves up, it push, out the bunt gasses

from the cylinder through exhaust valve. When the piston reaches I. D.C, the exhaust valve close and intake valve opens for the second cycle.

Q5 (A) Outline the differences between a petrol engine & a diesel engine.

Answer

A. Differences between a petrol engine & a diesel engine

Petrol Engine

- Petrol engines are internal combustion engines which have spark-ignition. They run on relatively volatile fuels such as petrol.
- In these engines, air and fuel are generally mixed post-compression.
- Petrol engines work on the Otto cycle, which consists of two isochoric processes and two isentropic processes.
- In petrol engines, air and petrol are usually mixed in a carburetor before being introduced to the cylinder.
- Once the air and petrol are compressed, the fuel is ignited via an electric spark.

Diesel Engine

- The Diesel engine is also an internal combustion engine which is also known as the compression-ignition engine. It is named after Rudolf Diesel.
- In these engines, the fuel is injected into a combustion chamber and is then ignited by the high temperature of the air in the chamber.
- The high temperature of the air in the cylinder is due to the adiabatic compression. These engines only compress the air and not the fuel.
- When injected into the combustion chamber, the Diesel fuel undergoes spontaneous ignition.
- These engines work on the Diesel cycle, which consists of a constant pressure process, a constant volume process, and two isentropic processes.

B. Several provincial governments in Pakistan have banned the use of 02 stroke engines in auto rickshaws. Identify the causes behind this decision.

(b). Causes behind the banned decision of 02 stroke engines in auto rickshaws

Lahore City District Government imposed ban on plying of two-stroke rickshaws on The Mall, in pursuance of Punjab Governments' decision aimed at phasing-out exit of smoke-emitting vehicles from the City. According to sources, 40 percent of the total auto rickshaws were plying illegally on City roads, as they were not registered with the government. No rickshaws had been registered from January 2005 onward but the manufacturing could not be stopped which resulted into continuous addition of polluting three wheelers. According to an estimate, there are about 150,000 auto rickshaws plying on City roads out of which 20,000 are not registered. In addition to auto rickshaws, 75,000 motorcycle rickshaws were contributing to polluting the surrounding environment. All these rickshaws are plying illegally as they are registered as motorcycles and not as three wheelers.