<u>2014-15</u>

PHYSICS INVESTIGATORY PROJECT

NAME-HEMANT SINGH RAWAT
CLASS-XII A
TOPIC-TRANSFORMER
SCHOOL-KENDRIYA VIDYALAYA NO.2 COLABA MUMBAI

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DEPARTMENT OF PHYSICS

CERTIFICATE

This is to certify that **HEMANT SINGH RAWAT**, a student of class **XII-A** has successfully completed the research on the below mentioned project under the guidance of MR.RANJEY SHARMA (pgt-physics) during the year 2014-15 in partial fulfillment of physics practical examination conducted by AISSCE, New Delhi.

Signature of external examiner

Signature of physics teacher

ACKNOWLEDGEMENT

In the accomplishment of this project successfully, many people have best owned upon me their blessings and the heart pledged support, this time I am utilizing to thank all the people who have been concerned with project.

Primarily I would thank god for being able to complete this project with success. Then I would like to thank my principal Mrs.Shinny gorge and physics teacher Mr.ranjey sharma, whose valuable guidance has been the ones that helped me patch this project and make it full proof success his suggestions and his instructions has served as the major contributor towards the completion of the project.

Then I would like to thank my parents and friends who have helped me with their valuable suggestions and guidance has been helpful in various phases of the completion of the project.

Last but not the least I would like to thank my classmates who have helped me a lot.

INDEX

11. BIBLIOGRAPHY

INTRODUCTION

The transformer is a device used for converting a low alternating voltage to a high alternating voltage or vice-versa.

A Transformer based on the Principle of mutual induction according to this principle, the amount of magnetic flux linked with a coil changing, an e.m.f is induced in the neighboring coil.

A transformer is an electrical device which is used for changing the A.C. voltages. A transformer is most widely used device in both low and high current circuit. As such transformers are built in an amazing strength of sizes. In electronic, measurement and control circuits, transformer size may be so small that it weight only a few tens of grams where as in high voltage power circuits, it may weight hundred of tones.

In a transformer, the electrical energy transfer from one circuit to another circuit takes place without the use of moving parts.

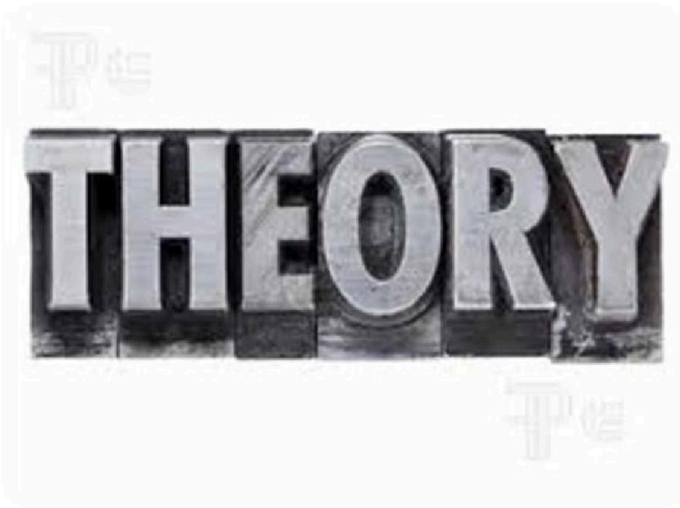
A transformer which increases the voltages is called a step-up transformer. A transformer which decreases the A.C. voltages is called a step-down transformer.

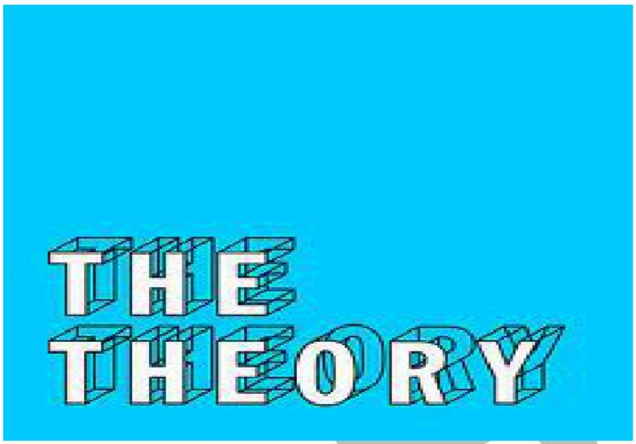
Transformer is, therefore, an essential piece of apparatus both for high and low current circuits.

OBJECTIVE

To investigate the relation between the ratio of -

1. Input and output voltage.
2. Number of turnings in the secondary coil and primary coil of a self made transformer.





When an altering e.m.f. is supplied to the primary coil plp2, an alternating current starts falling in it. The altering current in the primary produces a changing magnetic flux, which induces altering voltage in the primary as well as in the secondary. In a good-transformer, whole of the magnetic flux linked with primary is also linked with the secondary, and then the induced e.m.f. induced in each turn of the secondary is equal to that induced in each turn of the primary. Thus if Ep and Es be the instantaneous values of the e.m.f.'s induced in the primary and the secondary and Np and Ns are the no. of turns of the primary secondary coils of the transformer and

$d\phi / dt$ = rate of change of flux in each turnoff the coil at this instant, we have

$$E_p = -N_p \, d\phi/dt \quad \text{------------} \quad \text{----} \quad (1)$$ and

$$E_s = -N_s \, d\phi/dt \quad \text{------------} \quad \text{----} \quad (2)$$

Since the above relations are true at every instant, so by dividing 2 by 1, we get

$$E_s / E_p = - N_s / N_p \qquad (3)$$

As E_p is the instantaneous value of back e.m.f induced in the primary coil p_1, so the instantaneous current in primary coil is due to the difference ($E - E_p$) in the instantaneous values of the applied and back e.m.f. further if R_p is the resistance o, p_1p_2 coil, then the instantaneous current I_p in the primary coil is given by

$$I_p = E - E_p / R_p$$

$$E - E_p = I_p R_p$$

When the resistance of the primary is small, $R_p I_p$ can be neglected so therefore

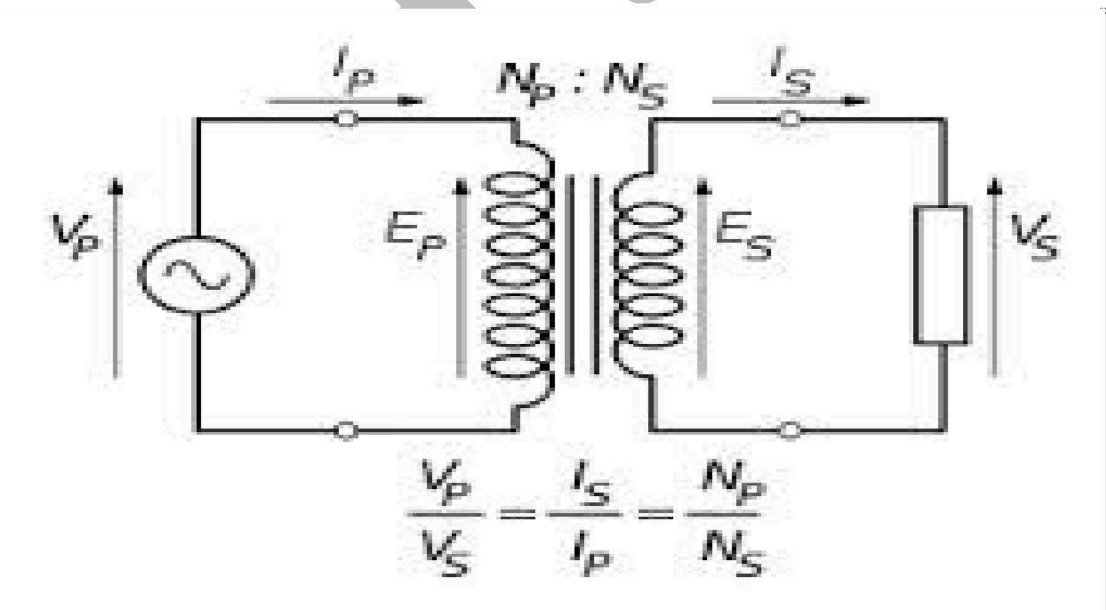
$$E - E_p = 0 \text{ or } E_p = E$$

Thus back e.m.f = input e.m.f

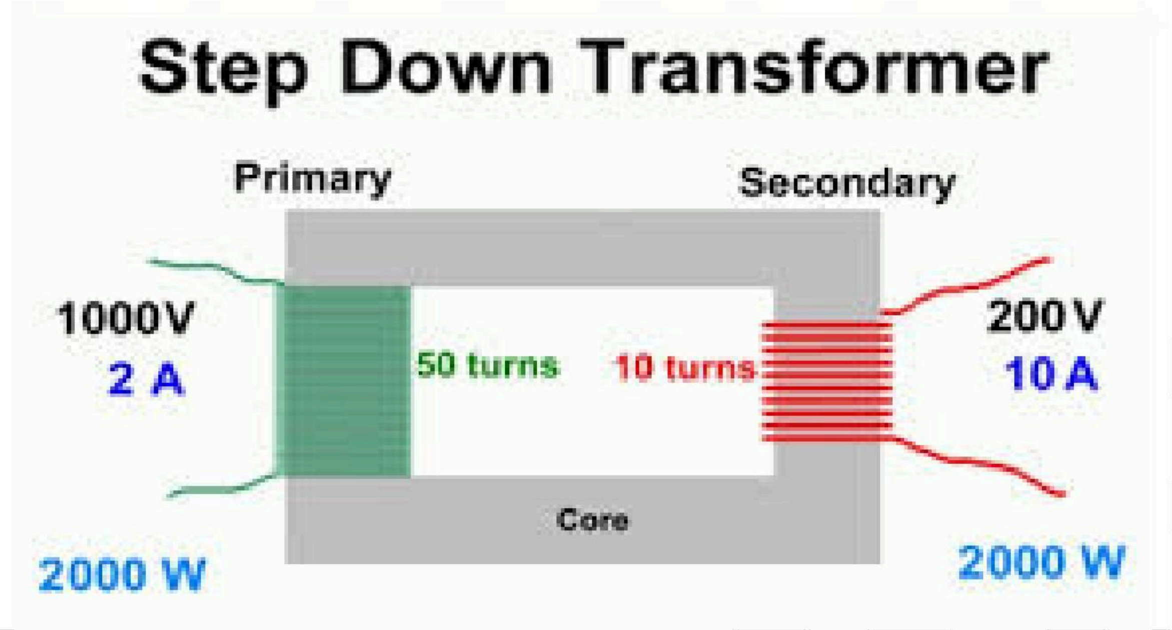
Hence equation 3 can be written as

$$E_s / E_p = E_s / E = \text{output e.m.f} / \text{input e.m.f} = N_s / N_p = K$$

Where K is constant, called turn or transformation ratio.



IN A STEP-DOWN TRANSFORMER



$E_s < E$ so $K < 1$, hence $N_s < N_p$

If I_p = value of primary current at the same instant

And I_s = value of secondary current at this instant, then

Input power at the instant = $E_p I_p$ and

Output power at the same instant = $E_s I_s$

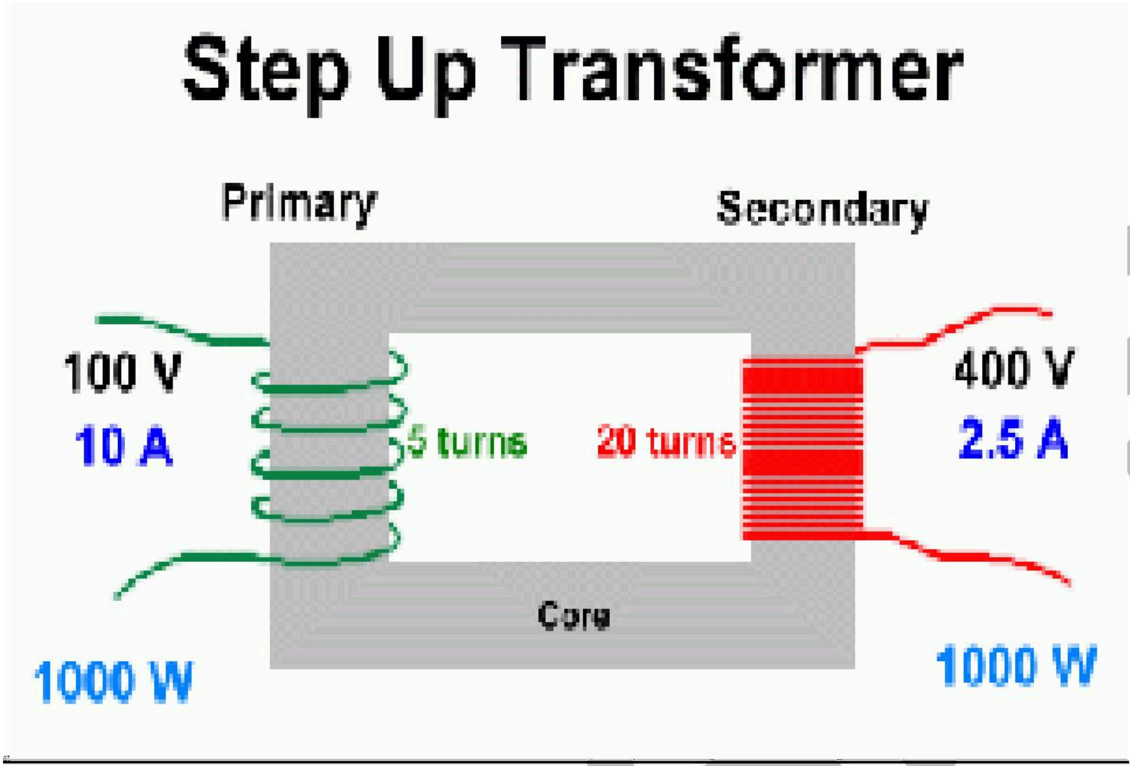
If there are no losses of power in the transformer, then

Input power = output power Or

$$E_p I_p = E_s I_s \quad \text{Or}$$

$$E_s / E_p = I_p / I_s = K$$

IN A STEP-UP TRANSFORMER



$E_s > E$ so $K > 1$, hence $N_s > N_p$

As, $k > 1$, so $I_p > I_s$ or $I_s < I_p$

i.e. current in secondary is weaker when secondary voltage is higher.

Hence, whatever we gain in voltage, we lose in current in the same ratio.

Similarly it can be shown, that in a step down transformer, whatever we lose in voltage, we gain in current in the same ratio.

Thus a step up transformer in reality steps down the current & a step down transformer steps up the current.

EFFICIENCY

Efficiency of a transformer is defined as the ratio of output power to the input power.

i.e.

$$\eta = \text{output power} / \text{input power} = E_s I_s / E_p I_p$$

Thus in an ideal transformer, where there is no power losses, $\eta = 1$. But in actual practice, there are many power losses; therefore the efficiency of transformer is less than one.

$$\text{efficiency, } \eta = \frac{\text{Output Power}}{\text{Input Power}} \times 100\%$$

$$= \frac{\text{Input Power - Losses}}{\text{Input Power}} \times 100\%$$

$$= 1 - \frac{\text{Losses}}{\text{Input Power}} \times 100\%$$

ENERGY LOSSES

Following are the major sources of energy loss in a transformer:

1. *Copper loss* is the energy loss in the form of heat in the copper coils of a transformer. This is due to joule heating of conducting wires.

2. Iron loss is the energy loss in the form of heat in the iron core of the transformer. This is due to formation of eddy currents in iron core. It is minimized by taking laminated cores.

3. **Leakage of magnetic flux** occurs inspite of best insulations. Therefore, rate of change of magnetic flux linked with each turn of S_1S_2 is less than the rate of change of magnetic flux linked with each turn of P_1P_2.

4. **Hysteresis loss** is the loss of energy due to repeated magnetization and demagnetization of the iron core when A.C. is fed to it.

5. **Magneto striation** i.e. humming noise of a transformer.

APPARATUS REQUIRED

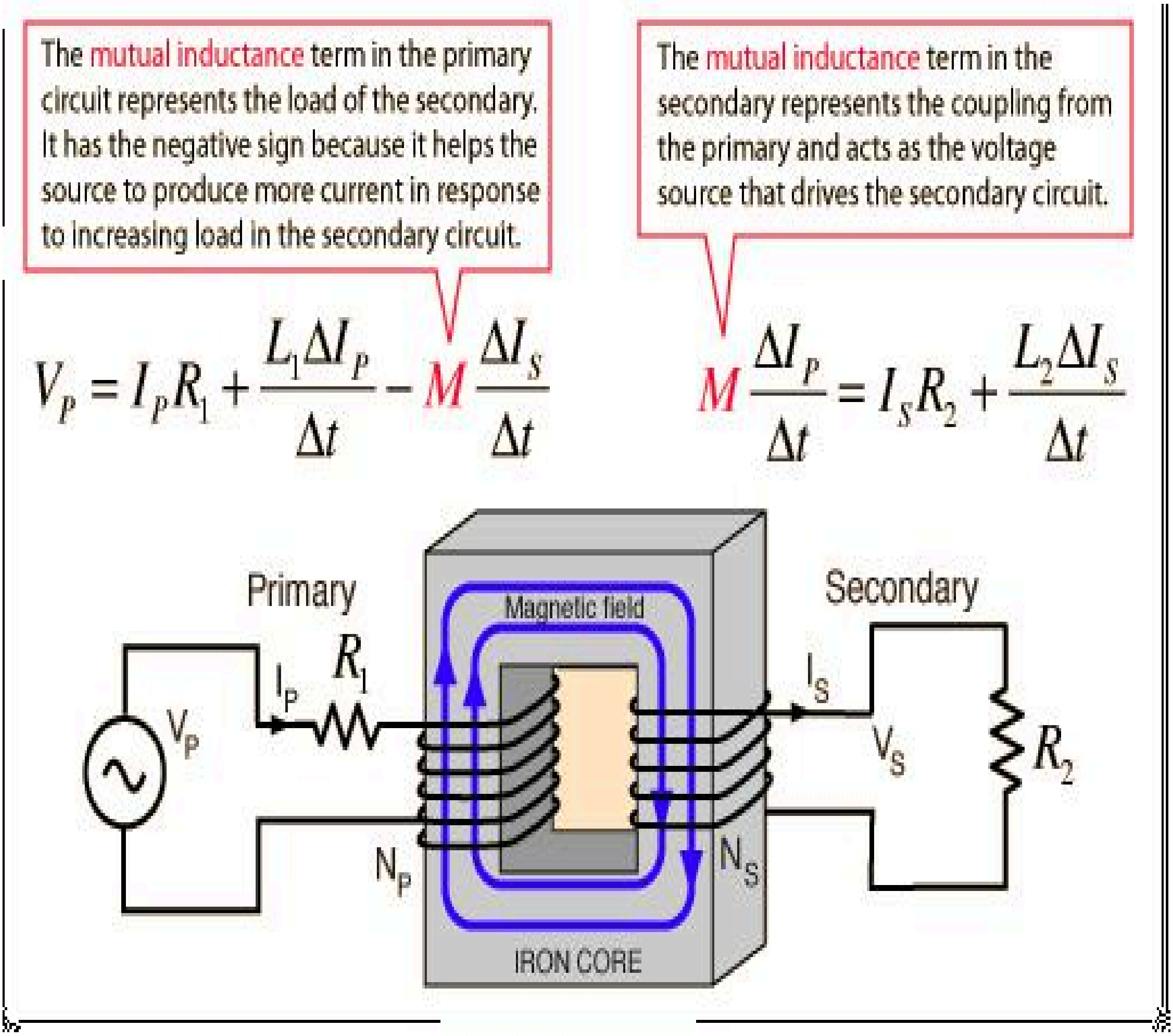
IRON ROD

COPPER WIRE

VOLTMETER

AMMETER

CIRCUIT DIAGRAM



PROCEDURE

1. Take thick iron rod and cover it with a thick paper and wind a large number of turns of thin Cu wire on thick paper (say 60). This constitutes primary coil of the transformer.

2. Cover the primary coil with a sheet of paper and wound relatively smaller number of turns (say 20) of thick copper wire on it. This constitutes the secondary coil. It is a step down transformer.

3. Connect p1, p2 to A.C main and measure the input voltage and current using A.C voltmeter and ammeter respectively.

4. Similarly, measure the output voltage and current through s1and s2.

5. Now connect s1and s2to A.C main and again measure voltage and current through primary and secondary coil of step
up transformer.

6. Repeat all steps for other self made transformers by changing number of turns in primary and secondary coil.

USES OF TRANSFORMER

A transformer is used in almost all a.c. operations-

In voltage regulator for T.V., refrigerator, computer, air conditioner, etc.

A step down transformer is used for welding purposes.

A step down transformer is used for obtaining large current.

A step up transformer is used for the production of X-Rays and NEON advertisement.

Transformers are used in voltage regulators and stabilized power supplies.

Transformers are used in the transmissions of a.c. over long distances.

Small transformers are used in Radio sets, telephones, loud speakers and electric bells etc

SOURCES OF ERROR

1. Values of current can be changed due to heating effect.
2. Eddy current can change the readings.

CONCLUSION

1. The output voltage of the transformer across the secondary coil depends upon the ratio (Ns/Np) with respect to the input voltage
2. The output voltage of the transformer across the secondary coil depends upon the ratio (Ns/N p) with respect to the input voltage
3. There is a loss of power between input and output coil of a transformer.

PRECAUTIONS



1. Keep safe yourself from high voltage.
2. While taking the readings of current and voltage the A.C

should remain constant.

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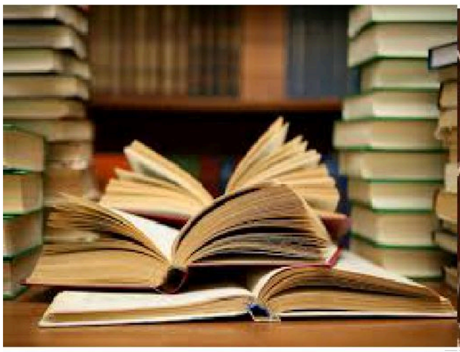
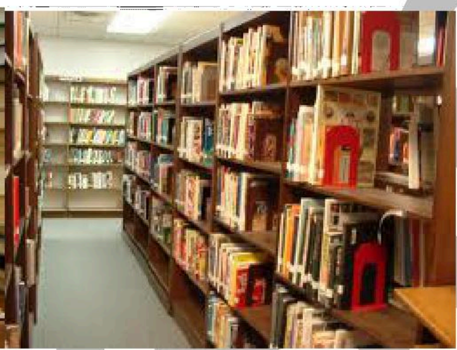

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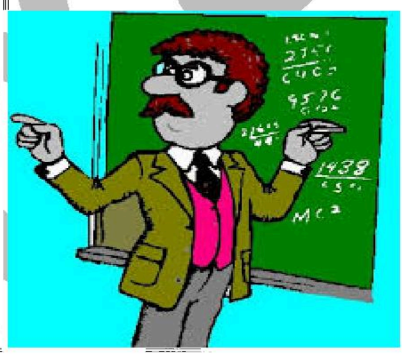

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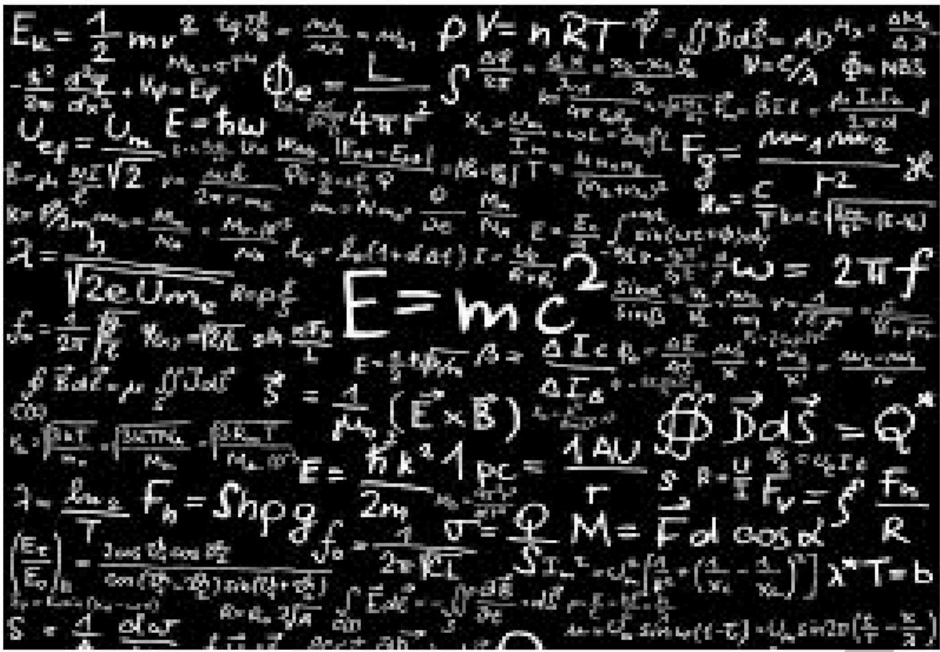
$E = mc^2$
$pV = nRT$
$\omega = 2\pi f$
$E_k = \frac{1}{2}mv^2$


PHYSICS


THANK
YOU!