Learning activities before - Lecture 1

The learning objectives of the session are:

- **Define and distinguish work/energy/power**
- **Distinguish corresponding units**
- **Develop a sense for reasonable quantities**
- **Calculate energy content**

Please prepare yourself in the following way:

Question to make you think:

It is estimated that €1 in every €4 spent on energy in Ireland disappears out of poorly-insulated windows, doors and roofs. What happens to the other €3?

Heat transfer in engineering consists of the **transfer** of enthalpy(Rate of movement) because of a temperature difference(Difference in potential between two points of movement). Enthalpy is the name for **heat** energy, to distinguish it from other sorts, such as kinetic energy, pressure energy, useful work.

What is Work?

Work is said to be done when a body or object moves with the application of external force. We can define work as an activity involving a movement and force in the direction of the force. For example, a force of 30 newtons (N) pushing an object 3 meters in the same direction of the force will do 90 joules (J) of work.

Formula of Work

When we kick a football, we are exerting an external force called F, and due to this force (kick), the ball moves to a certain distance. This disposition of ball from position A to B is known as displacement (Links to an external site.)(d). This work is said to be done and can be calculated as W = F × d

Work = Force × Displacement = **F × d**

Unit of Work

If a force of 5 newtons is applied to an object and it moves 2 meters, the work will be 10 newton-meter. Newton meter in termed and Joules and it is the unit of Work.

What is Energy?

Energy is the ability to perform work. Energy can neither be created nor destroyed. It can only be transformed from one kind to another. The unit of Energy is same as of Work i.e. Joules. Energy is found in many things and thus there are different types of energy.

All forms of energy are either kinetic or potential. The energy in motion is known as Kinetic Energy whereas Potential Energy is the energy stored in an object and is measured by the amount of work done.

Types of energy

Some other types of energy are given below:

- Mechanical energy
- Mechanical wave energy
- Chemical energy
- Electric energy
- Magnetic energy

- Radiant energy
- Nuclear energy
- Ionization energy
- Elastic energy
- Gravitational energy
- Thermal energy
- Heat Energy

Unit of energy

The SI unit of energy is joules (J), which is named in honour of James Prescott Joule.

What is Power?

Power is a physical concept that has several different meanings, depending on the context and the information that is available. We can define power is the rate of doing work. It is the amount of energy consumed per unit time.

Formula of power

As discussed power is the rate of doing work. Therefore it can be calculated by dividing work done by time. The formula for power is given below.

P=W/t

Where,

P = Power

W = Work done

T = Time taken

Unit of Power

As power don't have any direction, it is a scalar quantity. The SI unit of power is Joules per Second (J/s), which is termed as Watt. Watt can be defined as the power taken to do one joule of work in one second. The unit Watt is dedicated in honour of So James Watt, the developer of the steam engine.

Other Power Units

Some of the common power units include ergs per second (erg/s), foot-pounds per minute, dBm, food calories per hour or kilocalories per hour, horsepower (hp), BTU per hour (BTU/h).

Units Of Power Conversions :

Units	Abbreviation	Equivalent Watt Unit
Horsepower	HP	746 watts
Kilowatts	kW	1×10^{3}W
Megawatts	MW	1×10^{6}W
Gigawatts	GW	1×10^{9}W
decibel-milliwatts	dBm	30 dBm = 1 W
British Thermal Unit	BTU	3.412142 BTU/hr = 1 w
Calories per Second	cal/sec	0.24 calories per second cal/sec = 1 W

But in this course we are more interested about the thermal and heat energy .

We always use the hot and cold phrases but have you ever think about it? Physicist Richard Feynman thinks aloud

about atoms and how they 'jiggle', and how we perceive that jiggling as 'hot' and 'cold':

https://www.youtube.com/watch?v=v3pYRn5j7oI&feature=emb_imp_woyt
Then you will ask yourself : What's the difference between Heat and Temperature? Watch the short video about Heat and Temperature to understand the definitions :
https://www.youtube.com/watch?v=LL54E5CzQ-A&feature=emb_imp_woyt
2- If you are interested to understand more about the Ideas of heat and temperature and see some demonstrations about it then watch the interesting video below :
https://www.youtube.com/watch?v=lsJFdOJMXrM&feature=emb_imp_woyt

When Feynman wrote,

“It is important to realize that in physics today, we have no knowledge of what energy is,” he was recognizing that although we have expressions for various forms of energy from (kinetic, heat, electrical, light, sound etc) we seem to have no idea of what the all-encompassing notion of “energy” *is*.

The various forms of energy ($\frac{1}{2}mv^2$, mgh, $\frac{1}{2}kx^2$, qV,mcT, $\frac{1}{2}I^2$, $\frac{1}{2}CV^2$, etc.) are abstractions not directly observable.

We are going to discuss more about work/energy/power and their units in this session.

Notes – Lecture 1:

Work, Energy and Power

Questions to make you think

It is estimated that €1 in every €4 spent on energy in Ireland disappears out of poorly-insulated windows, doors and roofs.
What happens to the other €3?

What *is* energy?

Bottom line; nobody *gets* energy because there's nothing to *get*. Energy is not tangible (it is 'an indirectly observed quantity'); you can't hold it in your hand, you can't weigh it on an electronic balance, you can't see it, touch it, smell it etc. Yet when the universe was first created there was a certain amount of this put in to the mix (actually now that I think about it the mix itself was energy (with perhaps just a little dash of time)), and it's all still there today. Its form can change, but the energy itself can't ever disappear.

All right, let's listen to Richard Feynman give his take on it.

There is a fact, or if you wish, a law governing all natural phenomena that are known to date. There is no known exception to this law – it is exact so far as we know. The law is called the conservation of energy. It states that there is a certain quantity, which we call "energy," that does not change in the manifold changes that nature undergoes. That is a most abstract idea, because it is a mathematical principle; it says there is a numerical quantity which does not change when something happens . . . it is a strange fact that when we calculate some number and when we finish watching nature go through her tricks and calculate the number again, it is the same. It is important to realize that in physics today, we have no knowledge of what energy "is." We do not have a picture that energy comes in little blobs of a definite amount. It is not that way. It . . . does not tell us the mechanism or the reason for the various formulas.
The Feynman Lectures on Physics Vol I, p 4-1

When Feynman wrote,
"It is important to realize that in physics today, we have no knowledge of what energy is," he was recognizing that although we have expressions for various forms of energy from (kinetic, heat, electrical, light, sound etc) we seem to have no idea of what the all-encompassing notion of "energy" *is*.
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2007 *American Association of Physics Teachers*

Now with that interesting bit out of the way, let's go see what we need to know for the exam.

Work is defined as the product of *force* and *displacement*.

Work = Force × displacement*

$$W = F \times s$$

The unit of work is the Joule (J).

Energy is the ability to do work.

The amount of energy something has is also the amount of work it can do.
Because work is a form of energy it follows that **the unit of energy is also the Joule.**

Work-Energy Principle

The change in the energy of an object is equal to the work done on the object

Different Forms of Energy

Kinetic energy is energy an object has due to its motion.

Formula for kinetic energy:

$$E_K = \tfrac{1}{2} mv^2 *$$

Potential energy is the energy an object has due to its position in a force field.

The formula for potential energy:

$$E_P = mgh$$

Any time work is done energy is transferred*

The Principle of Conservation of Energy*

states that energy cannot be created or destroyed but can only be converted from one form to another.

Loss in Potential Energy = Gain in Kinetic Energy for a freely falling object*

Collisions: Kinetic Energy and Momentum

When two objects collide, momentum is conserved provided no external forces act on the system.
Kinetic energy however is not conserved.
This is because some of the kinetic energy gets converted to sound and heat energy.

Power

Power is the rate at which work is done.

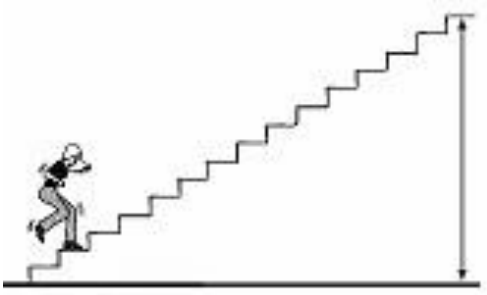
Or

Power is the rate at which energy is converted from one form to another.

The unit of power is **the Watt (W).**

$$\textbf{Power} = \frac{\textbf{Work\_Done}}{\textbf{Time\_Taken}}$$

To estimate the power developed by a person running up a flight of stairs



1. Calculate the work done in going up the stairs.
   This will be the same as your potential energy at the top (mgh),
   where m is your mass (you will need a bathroom scales).
2. Time how long it takes to run up a flight of stairs.
3. Divide the work by the time taken.

How does your power (kept up for a few seconds) compare with that of a horse over a working day (550 W)?

Did you know that the average brain uses 12 Watts of power (less than a laptop)?
For some of you this may be a bit optimistic.

Learning activities after - Lecture 1

You have joined the first Lecture of our E&H course. Below you will find some activities that will help you to bring your learning into practice and/or to learn more about the topics that were addressed.

Work, Power and Energy Questions

Try to think and find out the answers for below questions :

1. What is the relationship of work energy and power?
2. What happens to the energy as work is done?
3. What is the difference between work energy and power?
4. Is energy transferred the same as work done?
5. How does work affect an object's energy?
6. How is work energy and power related to each other?
7. How are force energy and work related?
8. What is the formula of work energy and power?
9. How do you calculate energy from power?
10. Can force be converted into energy?