N5 Engineering Contexts & Challenges

Types of Engineer

Civil Engineer

Civil engineers deal with infrastructure. They plan, design and oversee the construction and maintenance of building structures and facilities such as roads, railways, bridges, dams, irrigation projects, power plants, and water and sewerage systems.

Chemical Engineer

Chemical engineers deal with the chemical properties of materials and how these can be changed or altered for specific jobs. This could be from coating metal with something to make it more water and rustproof, to making plastic from oil.

Electrical Engineer

This branch of engineering can be thought of to include not only electronics but also power generation and distribution, motors and electromechanical devices. It concerns itself with power generation, transmission, utilisation and measurement.

Electronics Engineer

Although the name is similar to electrical engineering, it is different. Electronic engineering is about automatic control and the implementation of it. It encompasses analogue and digital circuits as well as computer programming.

Environmental Engineer

This branch concerns itself with protecting life - from adverse environmental effects such as pollution. Environmental engineers work to improve recycling, water and air quality, waste disposal and public health.

Mechanical Engineer

Mechanical engineers concern themselves with anything that moves. They design and develop mechanical devices to complete specific jobs.

Structural Engineer

Structural engineers analyse, design, plan and research structures, ensuring that a structure is dafe and can support the needed weight. They are trained to understand and calculate the stability, strength and rigidity of a structure, ensuring that it will not collapse under certain loads, forces or conditions.

Impacts of Engineering

Social Impacts

- Are there increased employment or training opportunities created through this engineering project?
- Will there be improved infrastructure because of it?
- Will there be traffic disruption because of its creation?
- Will there be disturbances because of noise?

Environmental Impacts

- Could this provide habitats for wildlife?
- Will there be a risk of damaging animal habitats or ecosystems?
- Will there be a loss of green belt? Will nature be destroyed/damaged because of it?
- Will there be a risk of danger to animals because of this engineering solution?
- Will there be more demand on water or power services?

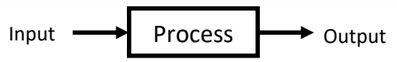
Economic Impacts

- Will this engineering solution bring money into the local area through tourism or other means?
- Will this attract other companies to invest in the area?
- Will this employ more people, meaning more money spent on the local area?

Emerging Technologies

You need to know about emerging technologies that are currently being developed and are not yet commercially available. As technology is always rapidly changing, you should research some emerging technologies in advance of any exams so you are up to date with current developments.

Systems Diagrams



This is a universal system diagram. When creating a universal system diagram for a particular problem, ask yourself the following questions:

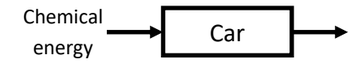
- What inputs need to go into the system to make it work?
- What is the name of the process you are trying to describe?
- What outputs will come out of the system?

Types of Energy

Energy is needed to make things work and it can be converted from one form into another by a suitable process.

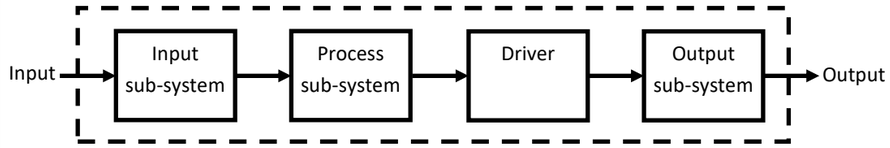
These are the main forms of energy:

Sound	Electrical	Field (magnetic)
Heat	Chemical	Kinetic (movement)
Light	Nuclear	Potential (stored)

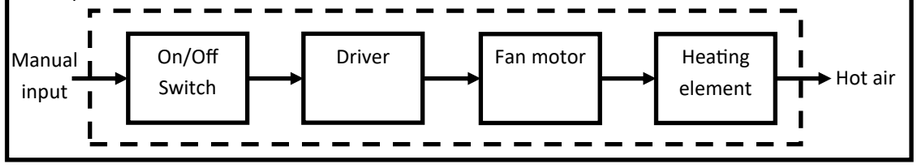


Sub-systems Diagrams

To get a greater understanding of how a system works we need to break it down further than a systems diagram. To do this we use a sub-systems diagram.



The dashed line around the outside of the sub-systems is known as a systems boundary. Anything inside the line is part of the system and anything outside is part of the “real world”. Below is an example for a heater.

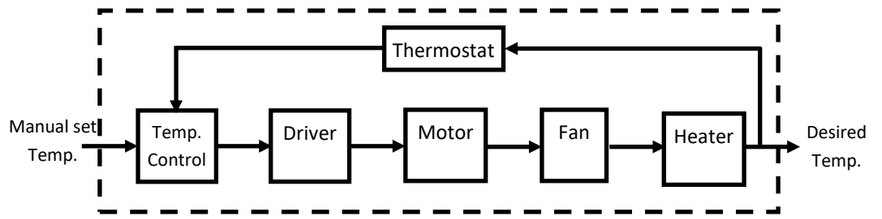


Open-loop Control

The system above is known as Open-loop control as it has no form of feedback.

Closed-loop Control

Closed-loop control does have feedback which constantly monitors the set level with the actual level to adjust the output of the system.



Mrs Gault

Energy

Types of Renewable Energy

Energy Type	How it is harnessed	Advantages	Disadvantages
Wind power	Wind tur-bines	Free energy No harmful gasses produced	Weather is unpredictable May spoil views Dependant on the wind: no wind, no electricity
Wave power	Wave-energy converter	Free energy No harmful gasses produced	Only suitable at certain locations May block fishing/travel routes Will affect marine-life ecosystem
Tidal power	Tidal-energy generator	Free energy No harmful gasses produced	Only suitable at certain locations with a strong tidal flow Will affect marine-life ecosystem
Hydro-electric	Dam and turbine	Free energy No harmful gasses produced	Only suitable at certain locations Will affect local habitat due to flooding of area behind dam
Solar	Solar panels, solar collectors or photocells	Free energy No harmful gasses produced	Weather is unpredictable Dependant on the sun: no sun, no electricity

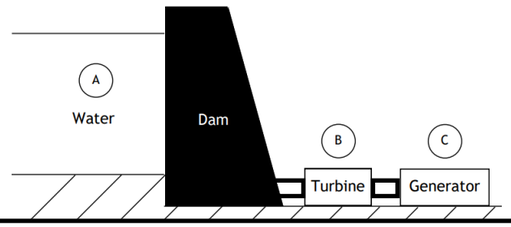
Energy Calculations

Work Done	$E_{WD} = F \times d$	Energy (J)	Force (N)	Distance (m)	
Weight	$W = m \times g$	Weight (N)	Mass (kg)	Gravity (9.8 ms^{-2})	
Power	$P = \frac{E}{t}$	Power (W)	Energy (J)	Time (s)	
Electrical Energy	$E_e = ItV$	Energy (J)	Current (A)	Time (s)	Voltage (V)
Kinetic Energy	$E_K = \frac{1}{2}mv^2$	Energy (J)	Mass (kg)	Velocity (ms^{-1})	
Potential Energy	$E_P = mgh$	Energy (J)	Mass (kg)	Gravity (9.8 ms^{-2})	Height (m)
Heat Energy	$E_h = cm\Delta T$	Energy (J)	Specific Heat Capacity ($Jkg^{-1}K^{-1}$)	Mass (kg)	Change in temperature (°C)
Efficiency	$\eta = \frac{E_{out}}{E_{in}} \times 100\%$ $\eta = \frac{P_{out}}{P_{in}} \times 100\%$				

Energy Transfer & Loss

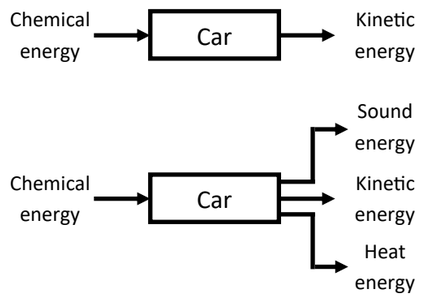
The rule of conservation states that energy cannot be created or destroyed, it can only be transformed from one energy type to another.

For example in a hydro electric power station, the water stored behind the dam has **potential** energy. As the water it is released into the penstock, it changes into **kinetic** energy. As it flows through the turbine, turning it, the energy is converted from **kinetic** energy to **electrical** energy in the generator.



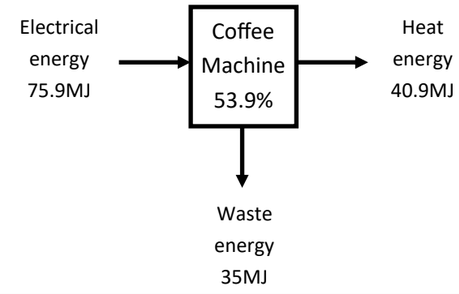
Energy Losses

Energy losses in a system usually come in the form of heat or sound from any moving part in the system, usually due to friction.



Energy Audits

In an energy audit we need to consider how efficient a system is, what the input and output energies are and if there are any losses. We often need to calculate the values for these energies and the efficiency of the system.



11. (continued)

At the start of the ride, 6.2 m above the ground, the carriage and rider have a combined potential energy of 13 kJ.

(b) (i) Calculate the combined mass of the carriage and rider. 3

$E_p = mgh$

$13 \times 10^3 = m \times 9.8 \times 6.2$

$m = \frac{13000}{9.8 \times 6.2}$

$m = 213.9566$

m = **210 kg (2 sf)**

(ii) Calculate the kinetic energy of the carriage and rider when released and travelling at a velocity of 2.7 ms^{-1}. 2

$E_k = ½\ mv^2$

$E_k = ½ \times 210 \times 2.7^2$

$E_k = 765.45$

E_k = **770 J (2 sf)**

The washing machine's heating element is tested using 8.6 kg of water.

(e) Calculate the heat energy when the water temperature is raised by 15 °C. 2

$E_h = cm\Delta T$

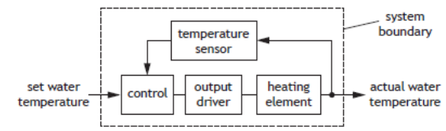
$E_h = 4180 \times 8.6 \times 15$

$E_h = 539220$

E_h = **540 kJ (2 sf)**

A washing machine is shown.

A sub-system diagram showing the control of the water temperature in the washing machine is shown below.



(a) Describe the reason for including a system boundary in a sub-system diagram. 1

To separate they system from the real world/ to show what goes in/ out of a system/to contain all the sub-systems that are in a system

(b) Describe, with reference to the sub-system diagram above, the control of the water temperature. 3

The water temperature is set . . .

The temperature sensor (detects the actual temperature and) sends a signal to the control.

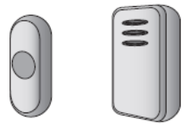
The control will compare the set temperature with the actual temperature.

If the water is too cold the heater will switch on.

OR

If the water is at/above the set temperature the heater will switch off.

1. The parts of a doorbell, consisting of a button and speaker, are shown.



button speaker

(a) Complete the system diagram shown below for the doorbell by adding the missing output. 1

user input → doorbell → Sound

The doorbell operates without the use of feedback.

(b) State the type of control that uses feedback. 1

Closed Loop Control

6. A drill uses a 1.5 A, 18 V rated battery.

(a) Calculate the electrical energy supplied by the battery when the drill is used for 160 seconds. 2

$E_e = ItV$

$E_e = 1.5 \times 160 \times 18$

$E_e = 4320$

E_e = **4.3 kJ (2 sf)**

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