Cours de :

Anglais Technique et Terminologie

1ère année Master — Installations énergétiques et turbomachines
Fabrication mécanique et productique
Instrumentation

INTRODUCTION

English is learnt for many reasons which are due to a large variety of professions (academic study, occupational purposes). The need to use English for specific purposes specialties has many characteristics. Science and technology fields are one of the reasons for learning English. As the sciences and technology specialties comprises different branches of engineering; it is necessary to focus on the English course.

The present module is composed of units which are as follows:

Unit Zero: The main tenses
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UNIT ZERO

1-MAIN TENSES

Tense	Construction	Conditions of use	Examples
Present continuous	Auxiliary be in present + verb-ing	- Action in progress - Projects related to the near future	- He is reading now/at the moment. - They are coming next Sunday.
Present simple	- Infinitive without "to" (verbal base) except in the 3rd person singular, add an -s or –es - Negative form: I don't listen – She doesn't listen - Interrogative form: Do you listen? Does she listen?	- Habitual, repeated action - Generality, general truth - Narration, telling a story - Events of a regular schedule	- I work every day. - The sun rises in the east. - Then, she eats dinner and goes to bed. - The train to London leaves at 6.pm.
Simple past	- Regular verbs: verb base + -ed - Irregular verbs: 2nd column - Negative form: I didn't eat - Interrogative form: Did you eat?	- Action dated and completed - Unreal assumptions after "if" - Unreal assumptions after "I wish"	- They lived in Paris in 1996. - If I were there, I would be happy. - I wish I were there now.
Past continuous	Auxiliary be in the past tense (was/were) + verb-ing	- Action that was taking place at a specific time in the past - Action in progress in the past interrupted by another action in the past tense	- He was learning Chinese in 1996. - The secretary was talking on the phone when her boss arrived.
Present perfect simple	Auxiliary have in the present tense + verb in the past participle (-ed for regular verbs; 3rd column for irregular verbs)	- Past action undated or with visible result - Past action with balance sheet value	- I'm tired. I have worked a lot. - I have already been to America.
Present perfect continuous	Auxiliary have in the present tense + been + verb –ing	- Past action not dated or with a visible result but likely to continue (the emphasis is on the duration of the action rather than the result)	- I have a lot of work. I have been studying for three hours now. - I have a lot of work. I have been studying since 3pm.

Past perfect simple	Auxiliary have in past tense (had) + verb in past participle (-ed for regular verbs; 3rd column for irregular verbs)	- Action before the story - Action prior to another action in the past tense	- They had worked all day because she wanted to rest at the weekend. - She had slept before she left home.
Past perfect continuous	Auxiliary have in the past tense (had) + been + verb –ing	- Action prior to another action in the past tense but this first action was likely to be prolonged. (emphasis on duration)	- They had been driving all night long when the car suddenly broke down.
Future simple	- Auxiliary will + verb base	- Prediction about the future - Generality, general truth without future value in scientific English - The present simple has a future value after conjunctions of time (when, as soon as, once, etc.)	- Algerian people will speak better English in the next decades. - The sun will rise in the east. - I will stop working when/as soon as/once bob returns home.
Future continuous	- Auxiliary will + be + verb –ing	- Action that will be taking place at some point in the future	- Tomorrow evening, I will be watching the game at 8.
Future perfect	- Auxiliary will + have + past participle	- Future action prior to a time in the future.	- Next week, she will have finished her project.
Simple conditional	- would + verb base	- Unreal situation of the present (after "if", use of the modal past tense = unrealistic action)	- If I had a car, I would drive there.

2-IRREGULAR VERBS

Irregular verbs

Infinitif	Simple Past	Past Participle	French	Infinitif	Simple Past	Past Participle	French
1To bet	1Bet	1Bet	Parier	To slide	Slid	Slid	Glisser
To burst	Burst	Burst	Eclater	To smell	Smelt	Smelt	Sentir
To cast	Cast	Cast	Jeter	To speed	Sped	Sped	Foncer
To knit	Knit	Knit	Lier	To spell	Spelt	Spelt	Représenter
To cost	Cost	Cost	Coûter	To spend	Spent	Spent	Dépenser
To cut	Cut	Cut	Couper	To spoil	Spoilt	Spoilt	Gâcher
To hit	Hit	Hit	Frapper	To stand	Stood	Stood	Etre debout
To hurt	Hurt	Hurt	Blesser	To stick	Stuck	Stuck	Coller
To let	Let	Let	Laisser	To sting	Stung	Stung	Piquer
To put	Put	Put	Poser	To strike	Struck	Struck	Frapper
To read	Read	Read	Lire	To sweep	Swept	Swept	Balayer
To set	Set	Set	installer	To teach	Taught	Taught	Enseigner
To shut	Shut	Shut	Fermer	To tell	Told	Told	Dire
To spread	Spread	Spread	S'étendre	To think	Thought	Thought	Penser
1To beat	1Beat	2Beaten	Battre	understand	Understood	Understood	Comprendre
1To become	2Became	1Become	Devenir	To win	Won	Won	Gagner
To come	Came	Come	Venir	1To be	2Was	3Been	Etre
To run	Ran	Run	Courir	To bear	Bore	Borne	Porter
1To bend	2Bent	2Bent	Courber	To begin	Began	Begun	Commencer
To bind	Bound	Bound	Attacher	To bid	Bad	Bidden	Ordonner
To bleed	Bled	Bled	Saigner	To bite	Bit	Bitten	Mordre
To breed	Bred	Bred	Elever	To blow	Blew	Blown	Souffler
To bring	Brought	Brought	Apporter	To break	Broke	Broken	Casser
To build	Built	Built	Bâtir	To choose	Chose	Chosen	Choisir
To burn	Burnt	Burnt	Brûler	To do	Did	Done	Faire
To bay	Bought	Bought	Acheter	To draw	Drew	Drawn	Dessiner
To catch	Caught	Caught	Attraper	To drink	Drank	Drunk	Boire
To chide	Chide	Chide	Gronder	To drive	Drove	Driven	Conduire
To creep	Crept	Crept	Ramper	To eat	Ate	Eaten	Manger
To deal	Dealt	Dealt	Avoir affaire	To fall	Fell	Fallen	Tomber
To dig	Dug	Dug	Creuser	To fly	Flew	Flown	Voler
To dream	Dreamt	Dreamt	Rêver	To forbid	Forbade	Forbidden	Interdire
To feed	Fed	Fed	Nourrir	To forget	Forgot	Forgotten	Oublier
To feel	Felt	Felt	Sentir	To forgive	Forgave	Forgiven	Pardonner
To fight	Fought	Fought	Se battre	To freeze	Froze	Frozen	Geler
To find	Found	Found	Trouver	To give	Gave	Given	Donner
To get	Got	Got	Obtenir	To go	Went	Gone	Aller
To hang	Hung	Hung	Pendre	To Grow	Grew	Grown	Croître
To have	Had	Had	Avoir	To hide	Hid	Hidden	Cacher
To hear	Heard	Heard	Entendre	To know	Knew	Known	Savoir
To hold	Held	Held	Tenir	To lie	Lay	Lain	Etre couche
To keep	Kept	Kept	Garder	To mow	Mowed	Mown	Tendre
To lay	Laid	Laid	S'allonger	To ride	Rode	Ridden	Aller cheval
To lead	Led	Led	Conduire	To ring	Rang	Rung	Sonner
To lean	Leant	Leant	Appuyer	To rise	Rose	Risen	Se lever
To learn	Learnt	Learnt	Apprendre	To see	Saw	Seen	Voir
To leave	Left	Left	quitter	To shake	Shook	Shaken	Secouer
To lend	Lent	Lent	Prêter	To show	Showed	Shown	Montrer
To light	Lit	Lit	Allumer	To sing	Sang	Sung	Chanter
To lose	Lost	Lost	Perdre	To sink	Sank	Sunk	Couler
To make	Made	Made	fabriquer	To speak	Spoke	Spoken	Parler
To mean	Meant	Meant	Signifier	To steal	Stole	Stolen	Voler
To meet	Met	Met	Rencontrer	To swear	Swore	Sworn	Jurer
To pay	Paid	Paid	Payer	To swell	Swelled	Swollen	Gonfler
To say	Said	Said	Dire	To swim	Swam	Swum	Nager
To sell	Sold	Sold	Vendre	To take	Took	Taken	Prendre
To send	Sent	Sent	Envoyer	To tear	Tore	Torn	Déchirer
To shine	Shone	Shone	Briller	To throw	Threw	Thrown	Jeter
To shoot	Shot	Shot	Tirer	To wake	Woke	Woken up	Se réveiller
To sit	Sat	Sat	S'asseoir	To wear	Wore	Worn	Porter habit
To sleep	Slept	Slept	Dormir	To write	Wrote	Written	Ecrire

UNIT ONE

1-HOW TO WRITE AN E-MAIL

With the development of the technology, the use of e-mails became more frequent. E-mail is extremely convenient, with the click of a mouse, an e-mail can be sent easily. Although you are probably more used to send private e-mails to your friends, you need to learn how to write formal e-mails to your teachers or institutions (you need to remember that you have to be polite and follow almost the same rules as for formal letters).

Look at this example of a formal e-mail:

From: First/LastName@gmail.com
To: Student Registration Service [mailto:SRS@univ-tissemsilt.dz]
Subject: Training day
Dear Mr ……,
Thank you very much for your formal invitation.
I have completed the registry form and I am returning it to you.
If there's anything else, please do not hesitate to contact me.
Yours sincerely,
FisrtName LastName

Here is another example of e-mail (Job Application Letter)

To ……………..

Object: Assistant director position (Company Name)

Dear Manager,

It was with much interest that I read your job position on April 8th for an Assistant Communications Director. Your description of the work responsibilities of Assistant Director closely matches my experience, and so I am excited to submit my resume to you for your consideration.

In my position as an Assistant Communications Director for "Company Name", I wrote articles for the company website, managed the editing and posting of contributing articles, managed their social media presence.

My resume is attached. If I can provide you with any further information on my background and qualifications, please let me know.

I look forward to hearing from you.

Thank you for your consideration.

FisrtName LastName
Address
Email
Phone

2-HOW TO WRITE A CV (resume)

A curriculum vitae, commonly referred to as CV, is a longer (two or more pages), more detailed synopsis than a resume. Your CV should be clear, concise, complete, and up-to-date with current employment and educational information.

- **Personal details and contact information.** Most CVs start with contact information and personal data but take care to avoid superfluous details.
- **Education and qualifications**. Take care to include the names of institutions and dates attended in reverse order; Ph.D., Masters, Undergraduate.
- **Work experience/employment history**. The most widely accepted style of employment record is the chronological curriculum vitae. Your career history is presented in reverse date order starting with most recent. Achievements and responsibilities are listed for each role. More information should be put on more recent jobs.
- **Skills**. Include computer skills, foreign language skills, and any other recent training that is relevant to the role applied for.

Here are some Examples of CV

First/Last Name
ENGINEER
Study Group, Scuba Works
Oran, Algeria

PERSONAL INFORMATIONS

Mailing Address : , Algeria.
Cell Phone : +213 (0)
Email :
Date of birth :
Nationality :
Marital status :

PROFESSIONAL EXPERIENCE

ENGINEER - Study Group, Scuba Works (Oran, Algeria) Jan 2006- Dec 2006
Supervising the renovation of docks (fishing ports).
Redaction of technical notes.

INTERN - Shipbuilding and Repair Company (Oran, Algeria) Sep 2004 - Jun 2005
Computation of the propelling power of vessels for better choices of engines.

EDUCATION

2005 Mohamed-Boudiaf Sciences & Technology University, Oran-Algeria.
Engineer in Ship Equipments

RESEARCH GROUPES

Member of the Applied Mechanics Laboratory

PUBLICATIONS

A.

ADDITIONAL SKILLS

Computer skills : Operating Systems : Microsoft Windows, Linux & Mac OS.
Computation code & related softwares : OpenFoam, Paraview, Tecplot, Matlab.
Microsoft Office, Open Office & LaTeX.
Languages : Arabic / English / French
Associations :
Sports :

Updated 29/06/2021

3-HOW TO WRITE A TRAINING REPORT

Title
Training Report

1. Introduction
A brief introduction about the subject

2. Objective / purpose of the report
(Exp: This report will provide an overview of … and will address attendance, partnership engagement, course feedback and the impact that the training has on practice.)

3. Context

- schemes/graphs/tables/figures
- application of knowledge on practice
- impact of training on practice

4. Conclusion

Basic Structure of a Report

Title of the report
Authors' names, department and university
Date of submission

Summary
Provides a brief overview of the substance of the report:
States the topic of the report

- outlines the most important findings of your investigation
- states the key conclusions

Table of Contents
(The table of contents sets out the sections and subsections and their corresponding page numbers.)

Introduction
The introduction provides the background information needed for the rest of your report to be understood. It includes:

- A clear statement of the purpose of the investigation
- The background of the topic of your report
- A brief outline of the structure of the report if appropriate (this would not be necessary in a short report).

Body of the Report / Context

- presents the information from your research, both in reality and theoretical
- organizes information logically under appropriate headings
- conveys information in the most effective way for communication:
  − uses figures and tables
  − can use bulleted or numbered lists

Incorporating Figures and Tables:

- Refer to each figure and table in the text of the report.
- Give all figures a title.
- The title of a table goes above the table, while the title of a figure goes below the figure.
- Figures must be correctly referenced if necessary. Give the source of the diagram or the data if you have taken them from published sources.

Conclusion
Relates directly back to the aims of the investigation. The Conclusions section provides an effective ending to your report. This section

- states whether you have achieved the aims of your investigation
- gives a brief summary of the key information in your report
- restates the major findings of your investigation.

(EXEMPLE)

UNIT TWO

1- YOUR CAREER AS AN ENGINEER

Engineering is a very broad discipline that addresses the design and the understanding of devices. This increasingly involves the use of computers, but focuses on the design and analysis.
The rapid expansion of the high-tech industry has provided a wealth of professional opportunities for engineers. Although, showing a chronic shortage of qualified engineers, this is one of the fastest growing specialty areas of engineering. A degree in engineering provides great flexibility and can lead to a wide range of career paths. Engineers are inventors, designers, business owners, consultants, teachers, researchers, scientists, executives, politicians, and astronauts. They are addressing many of the world's most serious environmental and social challenges by developing new processes, more efficient resource use, and enhanced communication. Engineering is a profession that uses science, technology, and problem-solving skills to design, construct, and maintain products, services, and information systems.
Engineering program includes more mathematics and science, such as mathematical statistics …
A Bachelor of Science degree in engineering may also serve as a starting point for careers in many other diverse fields, since the problem-solving skills acquired in an engineering program provide an extraordinarily valuable asset. The same skills will equip you to assume leadership roles in your community and in professional circles outside the workplace. A Bachelor of Science program constitutes the full-time formal education for most engineering graduates and is usually undertaken in one field of engineering.
Those of you who will continue studying, those who are interested in advanced design, development and research programs will get a Master's degree (MSc or M.Sc.) and those whose interest is focused on research will pursue a doctoral degree (PhD or Ph.D.).

Task One : write down reasons why you have chosen this field

Task Two : Talk about your future job/employment

2- THE ENGINEERING PROFESSION

What is engineering? It offers solutions for real human problems by the development of application (for machines, materials, tools …), or information (skills, processes, plans, diagrams, formulae, tables, designs …).

What is the work of an engineer? An engineer designs, operates, or maintains equipment, deals with the practical application of theoretical findings. Engineers apply the principles of science and mathematics to develop economical solutions to technical problems. Their work is the link between social needs and commercial applications.

Today's engineers require at least a three- or five-year university course in order to graduate and to get a degree in engineering and become specialists in their fields. This does not mean that, taking their degree, the education is finished. Continuing education, or as it has been called lately lifelong learning, is critical for engineers wishing to enhance their value to employers as technology evolves. They have to cover different fields, incorporate their ideas into the real world, listen to the needs, and be familiar with the global economic situation.

Therefore, when engineers start developing a new product, they have to consider many factors. For example, in developing an industrial robot, engineers precisely specify the functional requirements; design and test the robot‘s components; integrate the components to produce the final design; and evaluate the design‘s overall effectiveness, cost, reliability, and safety. This process applies to the development of many different products, such as chemicals, computers, gas turbines, ...

In addition to design and development, many engineers work in testing, production, or maintenance. These engineers supervise production in factories, determine the causes of component failure, and test manufactured products to maintain quality. They also estimate the time and cost to complete projects. Some move into engineering management or into sales. In sales, an engineering background enables them to discuss technical aspects and assist in product planning, installation, and use. Supervisory engineers are responsible for major components or entire projects.

Engineers use computers extensively to produce and analyze designs; to simulate and test how a machine, structure, or a system operates. Many engineers also use computers to monitor product quality and control process efficiency.

Most engineers specialize. Numerous specialties are recognized by professional societies, and the major branches of engineering have numerous subdivisions. Some examples include structural and transportation engineering, which are subdivisions of civil engineering; and ceramic, metallurgical, and polymer engineering, which are subdivisions of materials engineering. Engineers also may specialize in one industry, such as motor vehicles, or in one type of technology, such as turbines or semiconductor materials.

Task One: fill in the blank spaces with the corresponding engineering profession:

1) a person whose job involves designing and building of houses, roads, bridges is a ________________ engineer

2) a person who designs and builds machines and systems that use or produce electricity is an ______________ engineer

3) a person whose job is to design, build and repair machines is a ________________ engineer

4) a person who writes computer programs is a ________________ engineer

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Task Two : discuss with your mates the following points (oral discussion)

1. What is engineering?

3. What is the difference between today's engineers and those in the past?

4. Why is continuous education an imperative for engineers?

6. What do engineers use computers for?

7. Where would you like to work?

8. What would you like to specialize in?

Task One:

Task Two

UNIT THREE

1- DRAWINGS

Drawing types and scales In engineering, most design information is shown on drawings. Today, drawings are generally not drawn by hand. They are produced on computer, using CAD (computer-aided design) systems.

A key factor on a drawing is the scale - that is, the size of items on the drawing in relation to their real size. When all the items on a drawing are shown relative to their real size, the drawing is drawn to scale, and can be called a scale drawing. An example of a scale is 1:10 (one to ten). At 1:10, an object with a length of 100 mm in real life would measure 10 mm on the drawing.

Most engineering designs consist of a set of drawings (a number of related drawings):

- **General arrangement (GA)** drawings show whole devices or structures, using a small scale. This means objects on the drawing are small, relative to their real size (for example, a 1:100 drawing of an entire building).
- **Detail** drawings show parts in detail, using a large scale, such as 1:5 or 1:2. Small parts are sometimes shown in a detail as actual size (1:1), or can be enlarged to bigger than actual size (for example, 2:1).

For electrical circuits, and pipe and duct networks, it is helpful to show designs in a simplified form. In this case, schematic drawings (often referred to as schematics) are used. An everyday example is the map of a train network.

Types of views used on drawings Technicians are discussing different views shown on drawings (looking at components from above, from the side, etc.), as they search for the information they require.

Exp:

"We need a view from above showing the general arrangement of all of the roof panels - a plan of the whole area."

"According to this list, there are elevations of all four sides of the machine on drawing 28. So one of those should show the front of the machine."

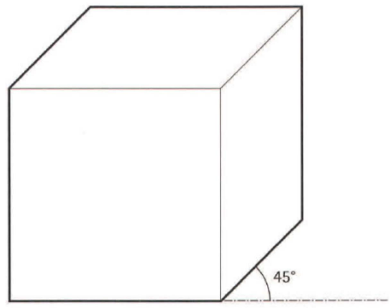
"There should be a section through the pipe, showing the valve inside, on drawing 36."

"We need an exploded view of the mechanism, showing the components spaced out."

"It's hard to visualize this assembly, based on two-dimensional elevations and sections. It would be clearer if we had a three-dimensional view, as either an oblique projection or an isometric projection."

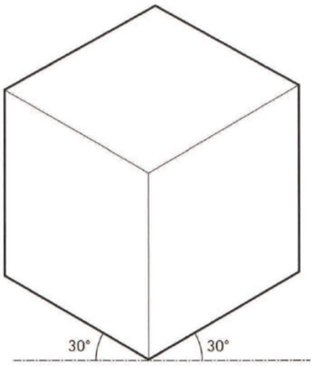
Three-dimensional drawings

An **oblique** projection shows an object with one of its faces at the front. The 3D shape of the object is shown by lines at 45 degrees from the horizontal.



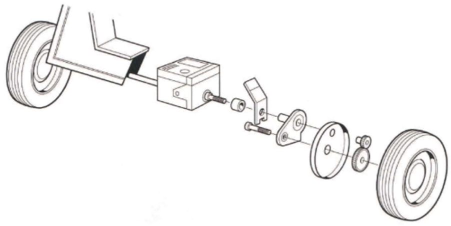
An oblique projection

An **isometric** projection shows an object with one of its corners at the front. The 3D shape of the object is shown by lines at 30 degrees from the horizontal.



An isometric projection

An **exploded** view shows an assembly with its components spaced out, to show how the components fit together.



An exploded view showing part of a lawn mower

A- Complete the sentences.

1 Enlarged drawings show components larger than their ....

2 For engineering drawings, 1:5 is a commonly used ....

3 Whole machines or structures are shown on .... drawings.

4 Electrical drawings don't usually show sizes. They're shown as ....

5 A .... of drawings for a large project can consist of hundreds of pages.

6 Most drawings are produced on computers, using .... software.

B- Match the descriptions (1-6) with the names of views used on drawings (a-f).

1 a 2D view of the side of an object	a a plan
2 a 2D view inside an object, as if it is cut through	b a section
3 a 2D view, looking down on top of an object	c an isometric projection
4 a 3D view, showing an assembly taken to pieces	d an oblique projection
5 a 3D view, with the 2D face of the object at the front	e an exploded view
6 a 3D view, with a corner of the object at the front	f an elevation

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C- Complete the sentences, taken from conversations about drawings, using the words and abbreviations in the box.

1 We need a .... through the bridge, showing the profile of the deck.

2 The only drawing we have is the ······-······················· , which is 1:100, so it obviously doesn't show things in detail.

3 On drawing 12, there's a large .... of the entire top deck of the ship.

4 This is the .... showing the front face of the tower.

5 Modern CAD systems can produce .... drawings that look almost as realistic as photographs.

6 We don't need dimensions and positions at this stage. We just need a .... showing how many branches come off the main supply pipe.

7 We don't have a proper drawing. We've just got a rough sketch, which is not to

8 The fixings aren't shown on the 1:50 general arrangement. But there's a ...., at 1:5, on drawing 42.

A-

B-

C-

2- DESIGN DEVELOPMENT

Initial design phase A structural engineer from a firm of consulting engineers has sent an email to a more senior colleague, with an update on a project for a new airport terminal.

Stefan,
We had our first design meeting with the airport authority and the architect yesterday. As you know, the client just gave the architect a short list of essential requirements for the terminal, so the design brief was pretty open. As a result, the ideas he's come up with form quite an adventurous concept. However, things are still at an early stage - there are no scale drawings yet, just eight sketches showing roughly what he wants the building to look like. So it wasn't possible to assess the design in detail. The next step is for the architect to develop the sketches into preliminary drawings. These are due at the end of April.

Collaborative development

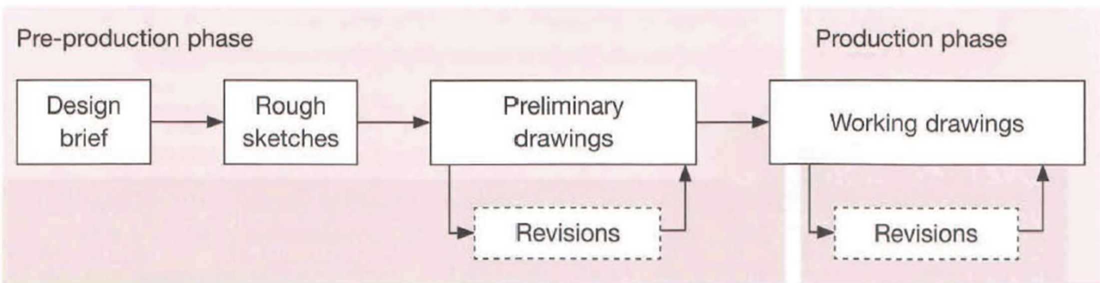
When a design team consists of engineers and consultants from different organizations, the design development process needs to be carefully coordinated.

Before the first draft (version) of a drawing is sent to members of the team, a decision is made about who needs a copy. Sometimes, a drawing will only be issued to certain specialists in the team. Sometimes, it will be circulated to all the team members.

After team members have received a drawing, they can comment on it, and may ask for the design to be changed. Following these comments, the drawing will be revised - that is, drawn again with the requested changes made to it. Every drawing is numbered, and each time a drawing is amended (revised), the letter next to the drawing number is changed. Therefore drawing 110A, after a revision, becomes 110B. When revision B is issued, it becomes the current drawing, and A is superseded. With each new revision, written notes are added to the drawing. These describe the amendments that have been made.

When engineers revise drawings during the early stages of the design process, they may have to go back to the drawing board (start again), and redesign concepts completely. For later revisions, the design should only need to be refined slightly.

After a preliminary drawing has been finally approved (accepted), a senior engineer can sign off (authorize) the drawing as a working drawing - that is, one that the production or construction team can work to. However, this does not always mean the drawing will be final. Often, working drawings go through more revisions to resolve problems during production.



A- Find words with the following meanings.

1 a description of design objectives

2 a rough, hand-drawn illustration

3 an initial diagram, requiring further development

4 an overall design idea

A-

B- Put the words in the box into the table to make groups of verbs with similar meanings.

Amend circulate redesign revise supersede approve issue

refine sign off

1	**2**	**3**	**4**
Change improve	send out distribute	Accept agree	Replace

B-

C- Choose the correct words from the brackets to complete the sentences about drawings.

1 Has the drawing been revised, or is this the first (draft/refine)?

2 This has been superseded. It's not the (current/preliminary) drawing.

3 Has this drawing been signed off? Can they (circulate/work) to it in the factory?

4 I still need to (comment/note) on the latest set of drawings.

5 Construction can't start until the first (current/working) drawings have been issued.

C-

D- Complete the email using the correct forms of the words in the box.

amendment current draft issue note revision supersede work

There seems to be a problem with dwg 1120, which you (1) **issued** yesterday. The drawing is marked as (2) .... C, but there are no (3) .... in the right-hand column detailing the (4) .... .made. And on the actual drawing, there are no visible differences from the first (5) .... Has the (6) .... version (1120B) been sent accidently, incorrectly labelled as 1120C, instead of the new drawing? Please advise asap, as we are assuming this is not the (7) .... drawing, and I have therefore told the fabrication team not to (8) .... to it until we receive clarification.

D-

3- DESIGN SOLUTIONS

Design objectives The web page below is from a manufacturing company's intranet.

Company design procedure - the design brief

A design brief for the **proposed** product should be **drawn up** by the project engineer. This should consist of a detailed list of technical objectives which the design team must work to, in order to produce a **design solution**.

Key elements of the brief are:

- **function** - the product's intended use (what it is **designed to** do), including performance targets (strength, power, durability, etc.)
- **constraints** - limits on the design (for example, it must not **exceed** a maximum size or weight limit)
- comparative targets - how well the product should perform, compared with **existing models** (competing products already on the market. Or the current model that the new product will replace)
- design **features** - specific things the new design must have (for example, rechargeable batteries, or a lid with a lock)
- **budget** - the cost limits that must not be exceeded, in order to make the design **cost-effective**.

Design calculations

Design information is shown on drawings, and written in specifications - documents which describe the materials, sizes and technical requirements of components. In order to specify this detailed information, an engineer must evaluate - that is, identify and calculate – the loads (forces) that key components will have to carry. To do this, the engineer needs to determine (identify) the different loads, then quantify them - that is, calculate them in number form. Usually, each load is quantified based on a worst-case scenario - in other words, the engineer will allow for the maximum load, such as an aircraft making a very hard landing, or a bridge being hit by extremely high winds.

After maximum loads have been quantified, an engineer will apply a factor of safety. This is an extra margin to make the component strong enough to carry loads that are higher than the worst-case scenario. For example, a factor of 1.5 increases the load a component can carry by 50%. After this has been factored in, the engineer will then size the components - that is, calculate their required size.

Engineers are sometimes criticized because they overdesign things (add excessive factors of safety), which increases costs. However, according to Murphy's Law, “Anything that can go wrong, will.” This suggests that belt and braces - an expression often used in engineering, based on the safest method of holding up trousers - is a sensible approach.

A- Complete the sentences from technical conversations using the words in the box.

budget constraint cost-effective designed exceed existing

feature function proposed

1 Of couse, money is limited. Coast limitations are always a .... But some finance is available. A .... has been allocated for the preliminary design phase - a total of 35.000$. But we mustn't .... that amount.

2 Obviously, if we have to spend 80€ on components for each appliance, and the appliances are sold for 70€, that's not a .... design solution.

3 The .... of this detector is to locate underground cables by giving audio feedback. Since it's .... to be used in noisy environments, the earphone is an important ....

4 Are these already on the market - are they .... products? Or are we talking about .... products that are still under development?

A-

B- Choose the correct words from the brackets to complete the sentences.

1 The types of loads that will be encountered must be (designed I determined).

2 Maximum loads are based on predicted (specifications I worst-case scenarios).

3 On top of maximum loads, additional safety margins are (factored in I sized).

4 For cost reasons, components shouldn't be (overdesigned I quantified) .

5 The practice of overdesigning components can be described as the (belt and braces I factor of safety) approach.

6 (Quantifying I Sizing) components means calculating their dimensions.

B-

C- Replace the underlined words and expressions with alternative words and expressions.

Most engineering designs (I) make provision for excessive or abnormal operating conditions. The critical question is, how much of a (2) percentage of extra size or capacity should be applied without (3) adding too much of a margin? To (4) calculate an amount for this figure, it is critical to assess the consequences of a technical failure. Where the stakes are high, in applications such as aviation, designing for (5) the most extreme situations is clearly critical on safety grounds. On the face of it, the result of this may seem costly. But where the human implications and expense of failure are serious, a high level of expenditure aimed at accident prevention can be considered (6) financially viable.

C-

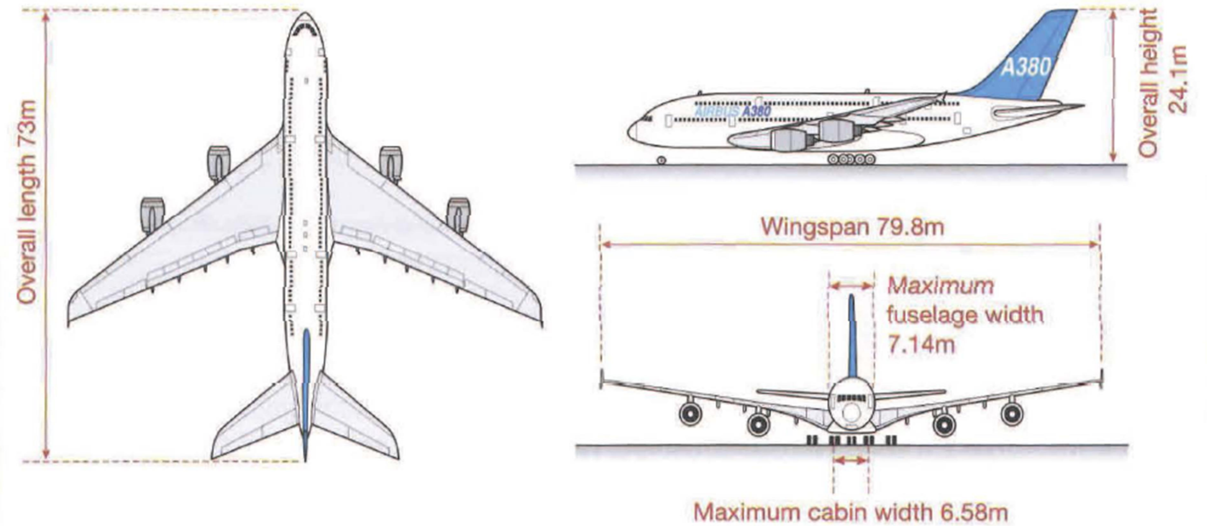
UNIT FOUR

1- HORIZONTAL AND VERTICAL MEASUREMENTS

Linear dimensions

The web page shows the key dimensions of the Airbus A380 in meters, and the explanations below it describe how they are measured. In the explanations, the word plane means an imaginary surface (not an aeroplane). On drawings, planes are shown as lines that indicate where dimensions are measured from and to, and are positioned to strike (touch) the faces (edges or surfaces) of components. Often, they are either horizontal planes or vertical planes.

Airbus A380 dimensions:



Overall length is a measurement of how long the aircraft is in total. The measurement is taken between the two points that are furthest apart (the front and rear extremities), along the length of the aircraft. The length is measured along a horizontal plane. It is the distance between a vertical plane striking the front of the nose, and a vertical plane striking the rear of the tail.
Wingspan is the total distance spanned by both wings. The span is measured as a straight line between the two wingtips.
Overall height measures how tall the aircraft is. The dimension is measured vertically between the underside of the wheels and a horizontal plane striking the top of the tail.
Maximum fuselage width is the external width of the aircraft's body - how wide it is, measured horizontally between vertical planes striking the outside faces of the fuselage.
Maximum cabin width states the maximum internal width, measured between the inside faces of the fuselage. The measurement is equivalent to the external width, less the thickness of the fuselage at each side of the aircraft.

Level and plumb

If a surface is described as being level, this means it is both horizontal and flat (smooth).
However, a surface which is flat is not necessarily horizontal. A flat surface may be vertical, or inclined (sloping at an angle to the horizontal or vertical plane).
Faces that are vertical, such as those of the walls of buildings, are described by engineers as being plumb. Structures that are slightly inclined from vertical are said to be out of plumb.

A- Complete the key dimensions of the Millau Viaduct, using the words in the box.

height overall thickness span width

(1) .... length: 2,460 m

(2) Maximum .... between supports: 342m

(3) .... of tallest support (ground to deck): 245m

(4) .... of deck: 32m

(5) .... of deck: 4.2 m

A-

B- Decide whether the sentences about the viaduct are true or false, and correct the false sentences.

1 The height of the towers is measured horizontally.

2 The overall span is measured along the width of the bridge.

3 The tops of the towers are at different levels, so a horizontal plane striking the top of one tower will not strike the tops of all the others.

4 The highest point of the structure is the top extremity of the highest tower.

5 The thickness of each tower decreases towards the top, so the faces of the towers are plumb.

6 The greatest thickness of each tower is its internal thickness at its base.

B-

C- Circle the correct words to complete the text about extra-high voltage (EHV) power lines.

On EHV transmission lines, cables - called conductors - (1) incline / **span** between pylons, which are described as supports. The conductors are suspended from the supports by rods, called insulators. On straight sections of line, the insulators are (2) level / plumb, hanging vertically from the supports. At supports where the direction of the line changes, pairs of insulators are used. In this situation, the insulators are (3) inclined / striking from the vertical plane, as they are pulled (4) plumb / out of plumb by the conductors pulling in different directions.

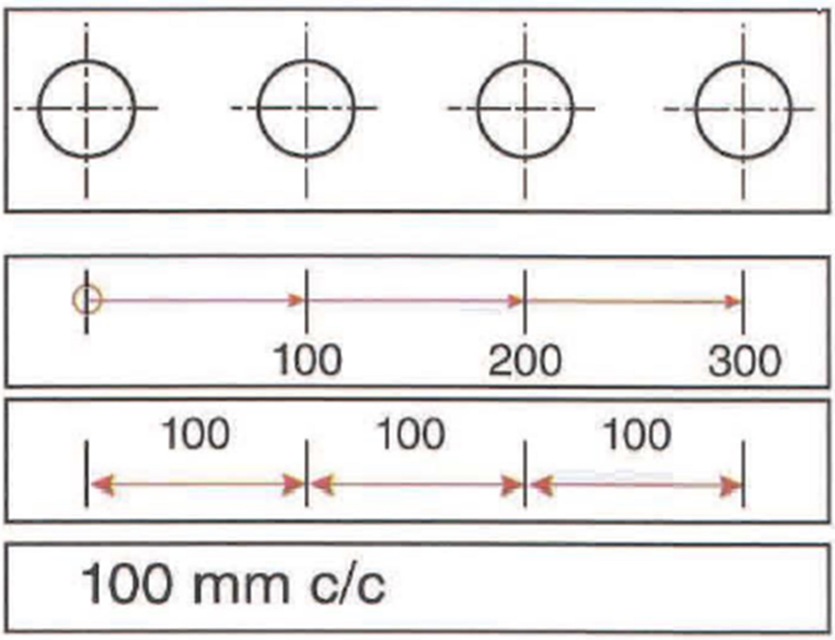
The higher the voltage being transmitted by the line, the greater the required distance between the conductor and the support, in order to provide effective insulation. The (5) length / width of insulators therefore varies, depending on the voltage. Higher voltages also mean that conductors must be located at a greater minimum (6) height / thickness above the ground, for safety. This distance is measured between the ground and the lowest point of the cable.

C-

2- LOCATING AND SETTING OUT

Centerlines and offsets

The drawing below shows the position of some holes for bolts. The distances between the holes can be shown as running dimensions or as chain dimensions. In both cases, the centerline (CL) - a line through the center of the hole - is marked (drawn), and the distances between the centerlines are given. Distances between centerlines are called center-to-center (c/c) dimensions. The holes below are at 100 mm centers.



Running dimensions

Chain dimensions

A written note

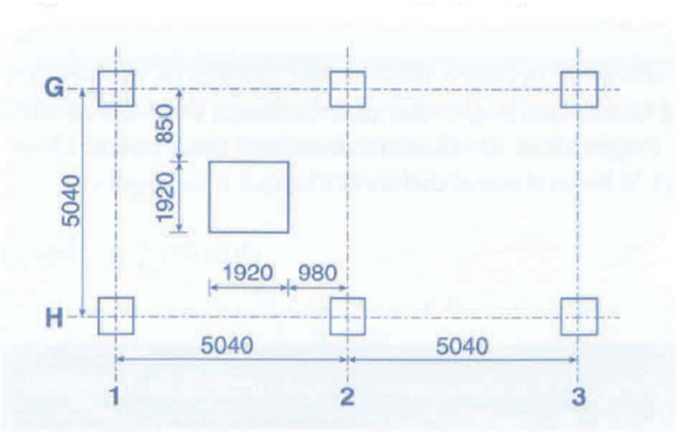
Centrelines are often used as reference points. These can be measured from, in order to locate - that is, give the position of - points on components. The measurements are offset from the centreline - each is at a certain distance from it, and the offsets are measured at a right-angle to the centreline (at 90 degrees to it).

Grids

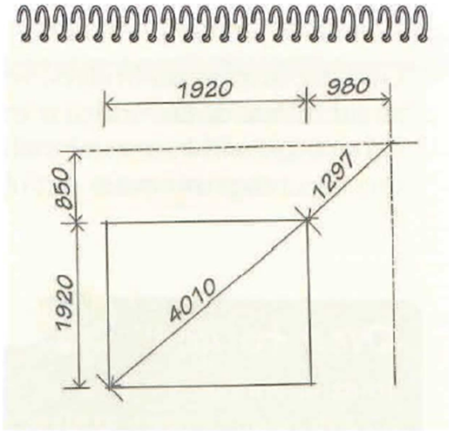
In large designs, notably those of structures, grids are used for horizontal positioning. The gridlines have numbers and letters. All numbered gridlines are parallel with one another - that is, they are straight, and are regular distances apart. Lettered lines also run parallel with one another, and are perpendicular to (at a right-angle to) the numbered lines.

The plan below shows part of the floor of an office building. The perpendicular gridlines intersect at (cross at) the centers of columns. An opening (hole) in the floor is shown using coordinate dimensions. These allow the site engineer to set out (mark the position of) the opening by squaring off the gridlines - marking lines that run at a right-angle to them - and then measuring along these lines using a tape measure.

A theodolite - an optical device used for measuring angles - can be used to square off gridlines accurately. To double-check dimensions - that is, carry out an extra check - diagonal measurements can be used, as in the engineer's sketch below. The length of diagonals can be calculated using Pythagoras's Theorem.



Drawing



Site engineer's sketch

A- Look at the sentences about the design of a ship. Replace the underlined words and expressions with alternative words.

1 The handrail is fixed by 115 brackets, which are <u>175 mm apart, between their centers</u>.

2 The dimensions are measured from the <u>line down the middle</u> of the ship.

3 How far is the widest point of the ship <u>located away</u> from the centerline?

4 Are the adjacent lengths of handrail <u>at 90 degrees</u> to each other?

5 These dimensions allow you to <u>establish the position</u> of the hole.

A-

B- Look at the extracts from technical discussions on a construction site. Complete the sentences using the words in the box.

gridline intersect parallel perpendicular set out square off

1 According to this drawing, ... 8 runs along the external wall of the structure.

2 The positions were marked accurately – they were .... by our site engineer.

3 The external wall funs along gridline 1, and the internal corridor wall runs along gridline 2, so the walls are .... with each other.

4 I’ve marked a cross on the concrete floor, showing where the two gridlines ....

5 We need to show the position of the corner of the staircase with coordinate dimensions. There should be two .... dimensions, taken from two gridlines.

6 We’ll use the theodolite -to .... the. gridline and mark a ninety-degree offset.

B-

C- Match the two parts of the sentences to complete the extract from a training manual.

In civil engineering, the following precautions can help to prevent costly setting-out mistakes.

(1) Always use a steel tape measure (never a plastic one)

(2) Check that both diagonals of rectangular shapes are equal

(3) Measure dimensions in two directions, from parallel gridlines,

(4) Add up chain dimensions to give running dimensions

a) to check that corners are right-angles. b) to ensure it does not stretch under tension.

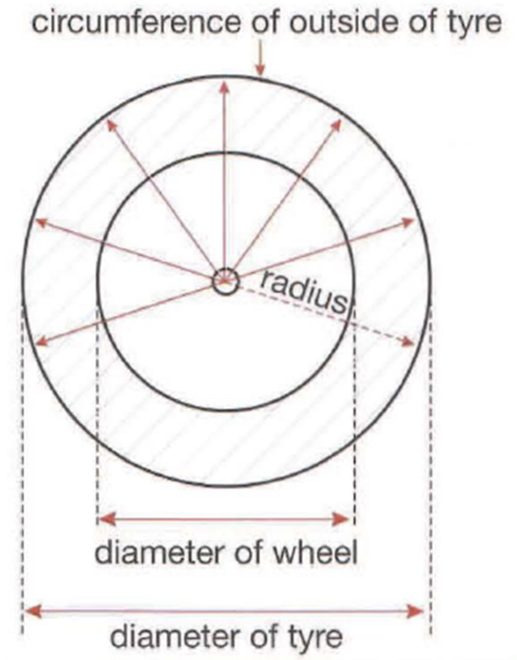
c) to prevent slight errors being multiplied. d) to double-check your measurements.

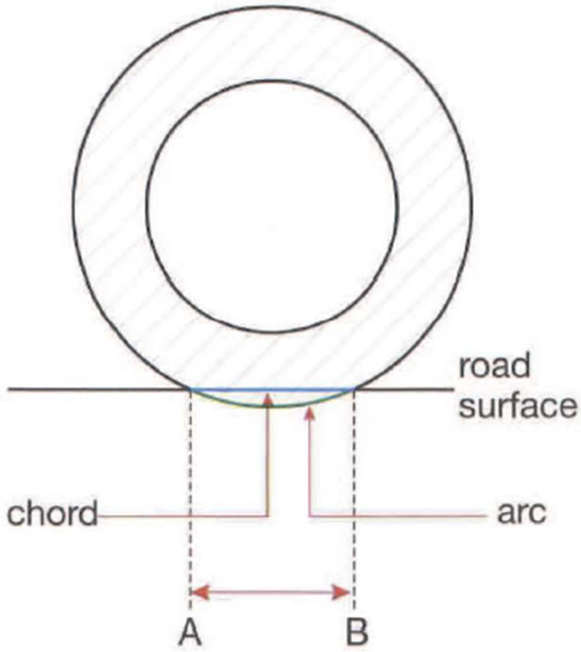
C-

3- DIMENSIONS OF CIRCLES

Key dimensions of circles

An engineer is giving a training course to a group of technical sales staff who work for a tyre manufacturer. During the talk, he mentions a number of dimensions relating to circles.

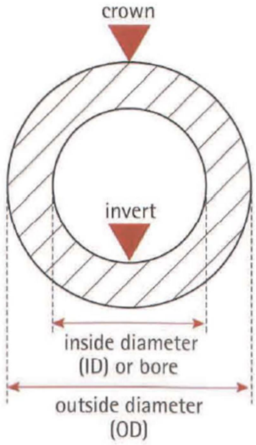




“Obviously, the outside edge of a tyre forms a circle, as you can see in this simple diagram. The outer circle in the diagram is the outside of the tyre, and the inner circle - the circle with the smaller diameter - represents both the inside of the tyre and the outside of the wheel. And, clearly, the inner circle is right in the middle of the outer circle - it's exactly in the center. So because it's central, that means the inside and outside of the tyre form concentric circles. And as the tyre is circular, simple geometry tells us that measurements of the radius, taken from the center of the circle to different points on its edge - points on the circumference - are equal. All the radii are the same. In other words, the tyre has a constant radius.”

“But when a tyre is fitted to a vehicle, it's compressed against the road surface. That means its geometry changes. So while the wheel - the inner circle - obviously remains round, the circumference of the tyre - the outer circle - changes shape. It deforms. Before deformation, this part of the tyre forms an arc of the circle, between points A and B. So, as you can see in this diagram, it's not a straight line - it's a curved line. But after deformation, it's no longer a curve. The tyre becomes deformed between points A and B. It becomes a chord of the same circle, forming a straight line between A and B. However, the length of a chord and the length of an arc, between the same two points on a circle, are different. So the design of the tyre has to allow for this change in shape - from a rounded edge to a straight edge.”

Pipe dimensions



Specific terms are used to describe the circular dimensions of pipes. The width of the inside of a pipe is called the inside diameter (ID). It can also be called the bore. The outside width is called the outside diameter (OD). When pipes are laid horizontally, the top of the outside of the pipe is called the crown, and the bottom of the inside of the pipe is called the invert.

Shapes

The nouns and adjectives can be used to describe the shapes of components and assemblies.

2D shapes

Noun	Adjective	
square	square	
rectangle	rectangular	
triangle	triangular	
hexagon	hexagonal	
octagon	octagonal	
pentagon	pentagonal	
circle	circular	
semicircle	semicircular	
spiral	spiral	

3D shapes

Noun	Adjective	
cube	cubic	
cylinder	cylindrical	
tube	tubular	
sphere	spherical	
hemisphere	hemispherical	
dome	dome-shaped	
cone	conical / cone-shaped	
pyramid	pyramidal / pyramid-shaped	
helix	helical	
wedge	wedge-shaped	

A- Complete the notes, made by a salesperson attending the engineer's talk, using the words in the box.

arc chord circular circumference constant curved

deformed diameter radius

Before tyres are fitted to vehicles :

- shape is round – outside edge is perfectly (1) ....

- distance from center of wheel to edge of tyre = (2) ....

- total distance across tyre = 2 x radius = (3) .... ot tyre

- all measurement from center to points around tyre's (4) .... are equal – tyre has (5) .... radius

- bottom of tyre (6) .... of a circle

When fitted to vehicle, bottom of tyre is compressed and (7) .... – change from (8) .... line to straight line. straight line (9) .... of a circle.

A-

B- Find words and expressions with the following meanings. One question has two possible answers.

1 the highest point of a horizontal pipe

2 the lowest point of the inside of a horizontal pipe

3 the maximum overall external width of a pipe

4 the maximum internal width between the pipe walls

B-

C- Change one word in each of the sentences below to correct them.

1 The distance travelled by the vehicle each time its wheels turn completely is equal to the radius of one of its tyres.

2 The diameter of the tyre is measured from the center of the wheel to the outside edge of the tyre.

3 The radius of the curve in the motorway is constant, so the edges of the road follow chords of a circle.

4 The curve in the motorway has a constant radius, so the inside and outside edges of the road are arcs of two deformed circles that have the same center.

5 The invert is on the circumference of the external face of the pipe, and therefore cannot be in contact with the liquid flowing inside the pipe.

6 The thickness of the wall at the bottom of the pipe, plus the distance between the invert and the crown of the pipe, is equal to the inside diameter of the pipe.

C-

UNIT FIVE

1- ENERGY

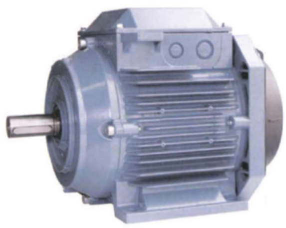
Forms of Energy The effects of energy can be seen, felt or heard in different ways, depending on the form of energy in question. The main forms are listed below:

- kinetic energy : energy in the form of movement – a type of mechanical energy
- thermal energy : energy in the form of heat
- electrical energy : the energy of an electric current
- sound energy : energy in the form of noise
- light energy : for example, light emitted from the sun or from a light bulb
- chemical energy : energy within substances that can produce a chemical reaction
- nuclear energy : energy from an atomic reaction.

Energy cannot be created or destroyed, only converted from one form to another. For example, in a torch powered by batteries, chemical energy stored in the batteries is converted to electrical energy, and the electrical energy is converted to light energy.

Mechanical energy can be stored as potential energy. An example is a load, lifted by a crane and suspended at a high level. The weight has the potential (in the future) to be released and allowed to fall, becoming kinetic energy. Energy can also be stored when a component is elastically deformed. This is called strain energy. An example is the spring in a watch, which is wound up, then progressively unwinds.

Energy efficiency Machines often convert an energy source, such as electricity, to another form of useful energy. For example, a motor converts electrical energy (the energy source) into kinetic energy (useful energy). But it also converts some energy into heat and noise. As this will be dissipated into the air, and not used, it is waste energy.



A motor: electrical energy
- useful kinetic energy
- wasted thermal and sound energy

If a machine converts a high percentage of energy into useful energy, it is efficient. For example, if a motor converts 75% of the electrical energy it consumes into kinetic energy, and wastes 25% as thermal and sound energy, it is seventy-five percent efficient. Improving efficiency (making efficiency gains) is a key focus in engineering.

Work and power The amount of energy needed to do a task (for example, lifting a load to a certain height by crane) is called work. The amount of energy converted in order to perform tasks (the amount of work done) is measured in joules (J). If a force of one newton is required to keep an object moving, the work required to move that object over a distance of one meter is equal to one joule.

The speed, or rate, at which work is done is called power, and is measured in watts (W). One watt is one joule per second. Power, in watts, is often referred to as wattage. A powerful motor will have a higher wattage than a less powerful one.

A- Make word combinations with energy using words from the texts above. Then match the combinations with the descriptions (1-8).

1 …............................ energy= energy stored within the liquids or solids in a battery

2 …............................ energy = mechanical energy in the form of movement

3 …............................ energy = potential energy stored in a deformed material

4 …............................ energy= energy converted to the form required for a purpose

5 …............................ energy= energy converted to a form that cannot be used

6 …............................ energy = the form of energy that shines, and can be seen

7 …............................ energy= the form of energy that can be heard

8 …............................ energy= energy that results in an increase in temperature

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B- Complete the article about electric and diesel-electric locomotives using the following words.

Chemical – convert – dissipate – efficiency – efficient – electrical – form – gain – joules – kinetic – power – powered – powerful – source – stored – thermal – useful – waste – wattage – work.

▲ An electric locomotive

An electric locomotive is one that is (1) …............................ by an external energy (2) …............................ , most often via overhead electric lines. This differs from a diesel-lectric locomotive, which has an onboard fuel tank and a diesel-powered generator to provide electricity for its motors. Purely electric power has numerous advantages over diesel-electric power, explaining the choice of electric locomotives for use in high-speed trains.

Firstly, an electric locomotive needs to carry neither a generator nor fuel. Its mass is therefore lower than a diesel-electric equivalent. This results in a significant efficiency (3) …............................ ,as the electric locomotive‘s smaller mass means less (4) …........................... . is done – measured as a total number of (5) …............................ – on a given journey. For a comparable rate of acceleration, its motors are also required to provide less (6) …............................ . As they use a lower (7) …............................ , this means less (8) …............................ motors can be used, making them smaller, thus further reducing weight and improving (9) …............................. In addition, electric locomotives use only (10) …............................ energy.

This means there is no need to (11) …............................ energy from one (12) …............................ to another on board the train (electricity can be generated more efficiently in power stations). In a diesel-electric unit, the energy conversion process starts with (13) …......................... .. energy, which is (14) …............................ within the hydro-carbon compounds of diesel. This fuel is burned to produce (15) …............................ energy, and the heat is then converted by the engine into (16) …............................ energy, which provides the movement to drive the train. This process is a very long way from being 100% (17) …............................ – only a small percentage of the initial chemical energy is converted to the (18) …............................ energy that is actually used to drive the train, with a significant percentage being (19) …............................ into the air in the form of heat, constituting (20) …............................ energy.

A-

B-

2- RENEWABLE ENERGIES

Renewable energy originates from resources that are practically inexhaustible in relation to human needs. The sun, as the source of solar will continue to shine for long (and most other forms of renewable energy). The term "renewable" is not correct, as energy can neither be consumed nor renewed (according to the law of the conservation of energy), the total energy of a closed system remains constant. Using renewable energy therefore means partly redirecting natural energy flows to make them usable for human purposes.

Fossil fuel reserves like coal, petroleum and natural gas are limited in their future availability. Moreover, their use makes many countries dependent on imports. They are also associated with significant CO_2 emissions and thus contribute to global warming. An increase in the use of renewable energy as a proportion of total energy use is therefore planned in worldwide.

Renewable energy, also referred as sustainable energy, saves resources and protects the climate. However, some forms of it are not available for energy generation on a steady basis, but are instead subject to considerable fluctuations depending on the time of day, season and region: the sun does not always shine, nor does the wind always blow. Only renewable biomass and geothermal energy can be used to supply base load power continuously.

In the future, renewable energy will contribute significantly to the energy mix. It will be important to combine those forms of renewable energy that fluctuate in availability, like solar and wind power, with resources capable of supplying base load power. So-called hybrid power plants, which make use of various energy resources, might be a feasible solution. Such power plants may work with solar thermal energy during the day and with geothermal energy during the night. It may also be possible to combine this with biomass power. When the wind isn‘t blowing and the sun isn‘t shining, renewables like solar and wind aren‘t producing electricity. What happens during that time when we need energy? We need something more reliable, something that produces electricity all the time and that we can rely on.

Task One : complete the following sentences using words from the list

Energy mix- solar- renewable energy- subject- baseload- hybrid- closed- emissions- fossil fuels- biomass- wind

1- CO_2 …………………………..contribute to global warming.

2- In the future, renewable energy will contribute to the country‘s………………..

3- A term sometimes used for sustainable energy is………………………………

4- Some forms of energy such as the wind blowing or the sun shining are………..to high fluctuations.

5- The term…………………………refers to the constant load needed by a system to cover minimum needs.

6- The text states that only……………………..or geothermal energy can be used to supply the base load.

7- ……………………power plants make use of various energy forms.

8- According to the laws of energy, in a ……………system energy is neither produced nor lost.

9- Neither………………..nor………………………energy is constant enough to provide for the baseload.

10- The main or sole use of……………………..makes many countries dependent upon the import of energy sources.

Task Two : identify the type of energy or resource in the following statements

__________________a. This type of energy is from ancient swamps and is mined to produce the most amount of electricity.

___________________b. This type of resource uses materials that were living (organic material) and changes it by fermentation, conversion of gas and bacterial decay.

_________________c. This type of energy uses photovoltaic cells to produce electricity.

__________________d. This type of energy uses the heated water from the earth's core.

________________e. This type of energy uses the air in motion from the uneven heating of the earth to heat or produce electricity.

_______ ________f. This type of energy uses the kinetic energy of the water.

_________________g. This type of energy is a fossil fuel and is refined from crude oil making types of fuel and thousands of products.

_______________h. This type of energy is found by itself, or in petroleum or coal beds.

_______________i. This type of energy involves the nucleus of an atom.

Task One:

Task Two :

3- HEAT AND TEMPERATURE

Changes of temperature and state

The two extracts below are from a basic technical training course for the customer service staff of a manufacturer of heating boilers.

As you know, temperature is measured in degree Celsius (°C). But heat is energy, so it's measured in joules. To calculate the amount of energy needed to raise the temperature of a substance, you need to know the mass of the substance being heated, and also its specific heat capacity - in other words, the amount of energy, in joule, required to raise the temperature of one kilogram of the substance by one degree Celsius.

What happens when substances change state? Well, heat energy is needed to make a solid melt and become a liquid. It's also needed to turn liquid into vapor - it takes energy to make a liquid boll, so that it evaporates (or vaporizes) and becomes a gas. That's because melting and evaporation are endothermic processes. That means they take in heat energy - they need to absorb heat from a heat source, such as a flame. And it's the opposite when a substance cools. As a gas condense to become a liquid, or as a liquid solidifies to become a solid, the process is exothermic - heat is emitted. The amount of energy absorbed or emitted while a substance changes state, in joules per kilogram, is called latent heat. During melting it's called latent heat of fusion, and during vaporizing it's called latent heat of vaporization.

Heat transfer

To help understand heat transfer, homes provide everyday examples. The heating systems in homes often have electric convector heaters. These heat the air and make it circulate, so that it moves in a circle- first rising, then cooling and sinking before rising again. This is called convection, where warm gas or liquid moves around and dissipates heat, transferring it to the rest of the gas or liquid.


An electric convector heater

Alternatively, the heating system in a home may circulate hot water through radiators. The radiators act as heat exchangers - devices that transfer heat -in this case, from the hot water inside to the cooler air outside. This happens by conduction- heat transfer through solid material. After the heat has been conducted through the metal of the radiator, the heat is dissipated by convection.

The third way that heat is transferred is by radiation. This is heat that travels as electromagnetic waves. An example is the heat from the sun. So the radiators that circulate water have a misleading name, as they don't really function by radiation.

A- Complete the sentences about water using text above. Sometimes there is more than one possible answer.

1 When the temperature of ice reaches 0 °C, it changes .... – it .... to become water.

2 At 100 °C, water ....

3 When water is .... to 0 °C or below and .... to become ice, it is said to freeze.

4 In gas form, water is called .... or ....

5 Between 100 °C and 374 °C water is a .... because it is below its critical temperature.

6 Extremely hot water vapour is called ....

B- Match the two parts to make correct sentences.

radiation / coolant / heat sink / thermal inertia / heat exchanger.

1 A liquid pumped onto a workpiece that is being machined, to stop it overheating, is called a

2 The form of heat transfer that occurs with infrared heat- a form of electromagnetic wave - is called

3 The metal fins (plates) around air-cooled engines, intended to maximize the surface area of the hot engine that is in contact with the cooler air, are designed to act as a

4 Thick, dense, internal walls inside an energy-efficient house, which are intended to absorb heat energy during the day and store some of it to be emitted at night, function as a

5 The soil and rocks on the surface of the earth remain warm at night in summer, due to the principle of

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C- Circle the correct words to complete the article about condensing boilers. Look at A and B opposite to help you. The first one has been done for you.

Condensing boilers are becoming increasingly popular in homes, as they use up to 40% less gas than traditional boilers. How do they work? By exploiting the fact that when a liquid condenses, due to the principle of latent heat of (1) fusion/**vaporization**, the process is (2) endothermic/exothermic. This means heat is (3) absorbed/emitted, and can thus be (4) circulated/conducted via the water inside the radiators in the home.

A condensing boiler burns natural gas (hydrocarbon fuel) to (5) heat/cool water, just like a conventional boiler. However, it achieves greater efficiency by recovering energy from water vapour. This is present in the hot, waste gas that's produced when natural gas is burned. In a traditional boiler the (6) heat/temperature energy from the gas, which is at a (7) heat/temperature of 180 °C or more, would be (8) dissipated/radiated into the atmosphere by (9) conduction/convection, and the water vapour within it would condense in the outside air. But in a condensing boiler the hot gas passes through a (10) heat/temperature exchanger. This allows the heat from the gas to be (11) absorbed/emitted by the cool water that's returning to the boiler after passing through the radiators in the home's (12) cooling/heating system - heat transfer takes place from hot gas to cool water by (13) conduction/radiation through the metal of the heat exchanger. In addition, when the temperature of the gas has fallen to a certain point, the water vapour within it (14) condenses/solidifies. And it is this process that enables significant amounts of heat to be transferred, due to the principle of (15)1atent/specific heat.

A-

B-

C-