DOCUMENT RESUME

ED 394 289 FL 023 685

AUTHOR	Rogers, Angela; Mulyana, Cukup
TITLE	ESP Methodology for Science Lecturers.
PUB DATE	95
NOTE	20p.; Appended materials contain small and broken type.
AVAILABLE FROM	I.A.L.F. in "ESP in S.E. Asia," 1995, P.O. Box 95, Denpasar, Bali, Indonesia (US $10; handouts not included in publication).
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	College Second Language Programs; *Curriculum Development; English (Second Language); *English for Special Purposes; Foreign Countries; Higher Education; *Inservice Teacher Education; *Instructional Design; Physics; Program Descriptions; *Science Instruction; Second Language Instruction; Universities
IDENTIFIERS	Indonesia

ABSTRACT

A program designed to teach university science lecturers in Indonesia how to design and teach one-semester courses in English for special purposes (ESP) is described. The program provided lecturers with training in language teaching methodology and course design. The piloting of the teacher training course, focusing on physics instruction, is detailed. The course covered lesson plans and analyses, need analysis, classroom management, and use of instructional materials. Lesson content emphasized reading skills, vocabulary development, and basic scientific writing, with aspects of grammar thought important for scientific texts. Non-linguistic problems encountered included large classes, lack of equipment, and mixed abilities. Appended materials include ideas for handouts, notes on teaching techniques, a sample test in English for Physics, and a sample lesson plan for a large class. Contains 12 references. (MSE)

ESP METHODOLOGY FOR SCIENCE LECTURERS

by
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Abstract

Universitas Padjadjaran appointed science lecturers to design and teach one-semester courses to help students work with texts in English.
These lecturers needed training in language teaching methodology and course design for ESP. They were concerned that classes should meet students' study needs, which general English classes had not achieved.
The training was given by the language advisor from SUDR-Manggala. This paper will describe the design of the course, its pilot teaching semester and student feedback, taking physics as a sample subject. For ten workshops, lecturers provided suitable texts to be adapted for classroom use. The course covered lesson plans and analyses, needs analysis, classroom management and use of materials. Lesson content emphasised reading skills, vocabulary development and basic scientific writing, with aspects of grammar deemed important for scientific texts. Lessons were observed and consultations held. Some non-linguistic problems discussed were large classes, lack of equipment and mixed ability.
This combination of the expertise of the science lecturer and the language specialist gives science students a solid foundation for future study.

1. Background

1.1 The Situation

This paper springs from the need for science lecturers to help their students study using English, since 95% of textbooks are in English, as are many international journals, bulletins and conferences. All students have learnt English at school and perhaps in private courses, but these general courses do not always meet their study needs. This situation is, of course, far from unique. A description of a similar case can be found in Escorcia (eds. Quirk and Widdowson, 1985), with reference to Latin America, for example.

1.2 The Science Faculty's Proposal

Padjadjaran University is a major Indonesian state university in Bandung, West Java. All first year students are required to learn English for one semester. In 1993, the science faculty proposed that English for scientific study be taught by subject lecturers. This system has some important advantages:

(i) Subject lecturers have successfully studied using English textbooks themselves, and know well which aspects to emphasise.

(ii) Subject lecturers and their students are already familiar with each other.

(iii) There will be no problem of the teacher failing to grasp the content of a text. McDonough (1984) quotes Nolasco as saying students have great faith in their subject teachers and prefer learning the subject and language together. He also quotes Swales on English for Specific Purposes (ESP) as saying how desirable it is for the language teacher to have a knowledge of the subject. In the same work, Abbott is quoted as proposing that scientists be trained to teach ESP.
The disadvantage is that science lecturers might not feel confident to teach English. The SUDR Language Advisor based at this university was therefore called in to train the science lecturers and help them prepare the short ESP courses.

2. Design and Implementation of the Training Course

2.1 Constraints

A preliminary meeting was attended by one or two lecturers from each of the science departments. It was established that time was very limited. We could have a 3-hour meeting each week for only 10 weeks before the teaching semester started. The students would learn ESP 3 hours per week for only 13 weeks. So it was very important to manage time wisely, and to focus on what was needed most by the lecturers and their students.

2.2 Aims and Needs

Previously, students were taught general English in the hope that it would help them improve their reading skills and write abstracts in English. The problem here was time: it takes a very long course of study to improve all aspects of English. In the 13 lessons allotted, only very little could be achieved. A few grammar points could be practised, a little vocabulary learnt and a few passages translated. The students became frustrated because, although such topics have their uses, the course did little or nothing to improve their studies. So, it seemed to them that there was no connection between physics and English, and that English was not a subject that physicists usually enjoy or find easy.
So, when preparing the new course, we identified the following 3 aims to concentrate on:

1. To help students read physics texts and understand the content rapidly.

2. To help students write brief abstracts in English which could easily be understood, keeping errors to a minimum.

3. To motivate students to continue to learn English independently by making them aware of its importance for their careers.

These aims then led us to identify 4 specific needs in rethinking the whole programme.

First, we needed to design a more appropriate curriculum, based on students' study aims rather than on grammar and general language skills.

Second, we needed to use materials which dealt with Physics, so that the students could see the relevance of the English course to their studies.

Third, we needed to adopt a more active classroom methodology, to motivate students and to give them as much active practice as possible in their English lessons.

Finally, we needed to devise some means of evaluating the course, so that we could adapt it further to satisfy students' aims and needs.

2.3 Student Feedback

When we had prepared the new course, we realised it would be very different from the old course and therefore rather strange to the students. They could not see the reasons for the changes or the rationale behind the new, active classroom methodology. This led to discussions which helped raise their awareness of their study needs and how these were related to the new course. They then understood that the classroom activities would help them to learn how to continue studying independently.

The questionnaires completed at the end of the course showed a very positive attitude to it. Here is a summary of the evaluation data collected so far:

Forty students were given a questionnaire covering six aspects of language study before starting the new ESP course. At the end of the course, the same questions were asked again, and the differences were discussed in class. I will go through the six points and describe what changes occurred.

Point I asked students to rank language skills in order of importance. Before the course, grammar emerged as the highest priority, closely followed by translation and vocabulary learning. Reading ranked as number 6 out of 7 skills. After the course, reading was given the highest priority, still closely followed by translation. Vocabulary ranked fourth, with grammar at the bottom. Students had realised they could grasp the meaning of texts without a detailed knowledge of grammar. However, they still did not feel confident of main ideas if these were not translated into Indonesian.

Point II asked students how many hours of English they needed. Before the course, 2 hours per week was considered sufficient. Afterwards, this rose to 3-4 hours per week. This is closely related to point III which asked how many hours should be spent learning English outside the classroom. Before the course, students answered from 0 to 2 hours per week only. After the course students recommended an average of 7 hours' extra study per week, either alone, with friends or taking another English course. Clearly, they had recognised their need of English for successful study.

Points IV and V covered the usefulness of classroom activities and methods of checking answers. Before the course, it was felt that students should take notes while listening to lectures; pairwork and group discussion were totally rejected. The lecturer was asked to write answers on the blackboard. After the course, pairwork and group discussion in English and Indonesian were given top priority, and the lecturer was asked to move from group

to group and monitor discussion. The active classroom methodology was a great success; students found it both enjoyable and very useful in learning both English and Physics.
Finally, point VI asked what materials should be used in the ESP classes. Before the course, students recommended grammar exercises, vocabulary for memorisation and texts about physics. After the course, discussion of texts on physics was by far the most popular choice. Students added writing exercises to the list, and only a few still wanted to memorise vocabulary.
Results indicate that active participation in class is both useful and enjoyable. Physics and English can be learnt simultaneously, and a mixture of English and the native language can be used. Since most texts are in English, it tends to replace the native language as study of the subject progresses. Students realised their need to continue learning outside the classroom. They may choose the methods which they find most suitable and contact either the subject lecturer or a language specialist whenever they need extra help.

2.4 Lecturers' Preparation Course

Aims and constraints led to the following decisions regarding the lecturers' preparation course:

1. make use of the materials already available to the Language Advisor and in local libraries

2. take students' subject textbooks and adapt them to focus on specific language and study skills

3. produce materials where necessary

4. make sure that all classroom tasks are relevant and useful

To take the emphasis off translation, which is far too time-consuming for study, the lecturers were encouraged to use English as the medium of instruction for at least part of the time. Books consulted to assist with classroom language were Willis (1981) and Doff (1988). Other books available for self-access included dictionaries (monolingual, bi-lingual and scientific), grammar reference works and textbooks which focus on scientific reading (e.g. Morrow (1980), Baudoin et al (1988), Cooper (1979)).

The lecturers discussed the use of pairwork and groupwork to maximise levels of individual student participation. Discussion of the content of scientific texts, using English, was offered as an alternative to translation. This helped break down the barrier between science and the language used to describe it. This has been recommended by various writers.

Lawton (1987), for example, says:

> "Science will no longer be seen as an isolated subject ... Teachers can no longer isolate themselves behind subject barriers, but have to integrate their subject matter into the whole curriculum."

Barnes (1982) found evidence from psychology that learning progresses well when put into a context familiar to the learner:

> "... coping with problems embedded in a familiar context is very much easier. ... the learners can contribute much more to the thinking when the issue discussed is embedded in their own first-hand experience ..."

So, students could be asked to discuss an aspect of their subject, using English as far as possible, as a way of increasing language. acquisition. New words and expressions are learnt within familiar concepts, and are therefore easier to grasp and to recall. This appears to be more interesting and effective for ESP students than formal grammar and translation lessons. Yalden (1987) quotes Corder's suggestions that language acquisition is better through getting one's meaning across than through formal learning. This can be incorporated into groupwork with crossgroup reporting. Within their own subjects, students are most likely to have something to express, which is also a motivating factor. Such use of schema, or concepts already clear to the learners, is also recommended by Widdowson (1984) when describing types of language activity considered to be suitable for scientists.
During their preparation period, the lecturers were encouraged to discuss the pros and cons of various ideas and to make their own decisions. This is vital because such a short course cannot cover all the possibilities; trainees must continue to train themselves afterwards. This also applies to the students of the ESP courses. In both cases, independent decision-making and autonomous

learning will be essential. In this matter, then, the lecturers are in a similar position to that of their students. Woodward's (1991) concept of 'loop input', or 'popping down' into the shoes of the learners, applies in this situation.

2.5 Materials for the ESP Course

A selection of ESP course books was available, but most of the texts used were taken from books which students use in their studies. We will be looking at some examples later. This had 3 advantages:

1. Students were motivated and encouraged by the familiarity and relevance of the materials.

2. Course content was useful and relevant for both language and subject learning, helping to break down the barrier between the two.

3. Students could be asked to bring their science textbooks to use in the English class. Questions and exercises could be written on the board. This again blurred the demarcation line between subject and language study and enhanced the perceived relevance of the English classes, as well as keeping spending to a minimum.

Each week, about half of the lecturers' training session was devoted to materials development and course design. They worked alone or in pairs, and described and discussed their work with each other and with the SUDR Language Advisor. It was up to them to ensure the relevance of texts to their students, as well as the most appropriate order in which to use them. Some aspects of language which commonly cause confusion in scientific texts were identified as:

a. <u>mass and unit</u> e.g. "a little time" vs "a few times"; words like "apparatus" and equipment" with a singular verb but meaning more than one item

b. <u>passive voice</u> commonly used to describe standard procedures, and meanings of modal passives such as must be, shouldn't be, etc.

c. <u>present perfect tense</u> to indicate a prior action, <u>e.g</u> "when it has been heated, it is safe to use".

d. <u>use of articles</u> e.g. the difference between "take the water" and "take some water", or "fill the test tube" and "fill a test tube".

The university authorities required mid-tests and final tests to be made for these courses. Texts for these tests were based on readings from the students' subject areas, with questions checking overall comprehension and identification of main ideas. Various question formats were discussed, bearing in mind that students' real-life study needs should be reflected. Popular question formats involved drawing, correcting or completing a diagram based on a text, and open-ended comprehension questions, usually placed before the text to help students focus on the important points before starting to read. Some examples of these are included in our handouts for you to discuss later.

Some basic practice in writing abstracts was included in the ESP courses. Sample abstracts were studied and criticised. Good organisation with clarity of meaning were considered to be the most important criteria of good writing.

3. The Pilot Teaching Semester

3.1 Consultation

After the 10-week training course, during the 13-week ESP course, consultations and observations took place. It was up to the lecturers to decide how to use this service. Further discussion led to developments in non-linguistic areas, discussed below.

3.2 Non-linguistic Problems: Large Classes, Lack of Equipment and Mixed Ability

The use of pairwork and groupwork aimed to keep every student actively engaged all of the time. This was not easy to organise in such large classes. In one case, 200 students studied in a room with poor acoustics and a board visible to less than half of the class. In this extreme case, students were organised into study groups of 7 people who lived close to each other. Each group chose a monitor who was responsible for liaising between the group members and the lecturer, noting down queries, organising photocopying, collecting handouts for absentees, etc. It is hoped that the cooperation begun here will continue among the students in future. This system helped the lecturers identify students who had problems with English and give them help and advice. Students could re-group on grounds of ability or for other reasons by agreement with the lecturer.

Lack of equipment and funds led to the use of wallposters for questions and answer keys, shared materials within groups, and frequent use of subject-based textbooks.

Our hand-outs include a lesson plan prepared to minimise these problems; you may wish to discuss it later.

4. Conclusion

The participatory style of the English classes began to spill over into the Physics lectures, and the students began to cooperate more in their own time in both areas. Some Physics classes are now given partly in English, and the demarcation line between the two subjects is gradually fading away.

Language specialists are consulted on language problems which cannot be solved or understood, and give lessons in writing, spoken English and presentation, and other areas as the need arises, but scientific reading is now the responsibility of the science lecturers.

Our recommendation is that science lecturers break down the barrier between a subject and its expression in English. Science students should be encouraged to be more active, co-operative and autonomous learners so that they can continue to increase their knowledge and skills in all relevant subjects after they leave university. Science lecturers should incorporate scientific reading in English into their science curriculum.

Acknowledgements

The following lecturers also participated in this programme and made important contributions:

Ade Moetangad (Agricultural Engineering), Abubakar Sidik (Chemistry), Eddy Djohari and Harapan Tobing (Mathematics and Statistics), Lien Darmawan (Physics), and Tuti Otong (Biology).

Thanks also to our secretary, Ms. Bayu Indrawati, for her invaluable assistance in this programme.

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HANDOUTS

You may wish to select one or two of these handouts for discussion, depending on your interests:

I Language Points

II Extracts from Physics Book Adapted for ESP

III Sample Test in English for Physics

IV Sample Lesson Plan for Large Class

The summary of student feedback is also reprinted here for quick reference:

Summary of Students' Priorities Before and After the ESP Course

Point	Before	After
I most important language skills	- grammar - translation - vocabulary - little reading	- reading - translation - little vocabulary and grammar
II hours of English classes needed	two	three/four
III hours of additional English study needed	zero - two	Seven: alone, with friends, another course
IV most useful classroom activities	- listening to lectures and taking notes - no pairwork - no group discussion	- pairwork - group discussion in English and Indonesian
V what lecturer should do	- give lectures - write answers on board	- move from group to group and monitor discussion
VI best types of materials	- grammar exercises - vocabulary lists - texts about physics with comprehension questions	- texts about physics with discussion questions - writing exercises - some vocabulary lists

ESP METHODOLOGY FOR SCIENCE LECTURERS

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HANDOUT I: LANGUAGE POINTS

The following four points arose during the lecturers' preparation course as aspects of language which commonly cause confusion to readers of scientific texts.

a. mass and unit e.g. "a little time" vs "a few times"; words like "apparatus" and "equipment" with a singular verb but meaning more than one item

b. passive voice commonly used to describe standard procedures, and meanings of modal passives such as must be, shouldn't be, etc.

c. present perfect tense to indicate a prior action, e.g. "When it has been heated, it is safe to use".

d. use of articles e.g. the difference between "take the water" and "take some water", or "fill the test tube" and "fill a test tube".

Questions

1. How could these four points best be clarified and practised in class?

2. Are there other language points which you would also prioritise?

3. Should language points be prioritised in advance or dealt with as they arise?

ESP_METHODOLOGY_FOR_SCIENCE_LECTURERS

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HANDOUT II: EXTRACTS FROM PHYSICS BOOK ADAPTED FOR THE ESP COURSE

1.1 What Is Physics?

Before reading this, can you write your own definition of 'physics'? What should be included in the study of physics, and what should not be included ? Are there any topics which are a part of physics and of another subject - if so, what are these topics ?

Definition :

Topics included :

Topics not included :

Topics which overlap with other subjects :

Compare answers with your neighbours.
Now read 1.1 and see if you agree with it.

The word *physics* comes from a Greek term meaning *nature*; and, therefore, physics should be a science dedicated to the study of all natural phenomena. In fact, until early in the nineteenth century, physics was understood in this broad sense and was called "natural philosophy." However, during the nineteenth century and until very recently, physics was restricted to the study of a more limited group of phenomena, designated by the name of *physical phenomena* and loosely defined as processes in which the *nature* of the participating substances does not change. This somewhat imprecise definition of physics has been gradually discarded, returning to the broader and more fundamental concept of previous times. Accordingly, we may say that *physics is a science whose objective is to study the components of matter and their mutual interactions. In terms of these interactions the scientist explains the properties of matter in bulk, as well as the other natural phenomena we observe.*

In progressing through this course, the student will witness the way this program is developed from basic and general principles and applied to the understanding of a large variety of phenomena, apparently unrelated but obeying the same fundamental laws. Once these great principles are clearly understood, the student will be able to attack new problems with great economy of thought and effort.

Text 1.3 discusses fundamental particles.
Read it to find answers to these questions :

1. What are the three most important fundamental particles ?
2. Why are others less important ?
3. Why are pions important ?
4. What are different varieties of atoms called, and about how many are there ?
5. Can you name some molecules with only a few atoms, and some with a large number of atoms ?
6. What does plasma consist of ?
7. What is protoplasma ?
8. What are the 4 main atoms of the human body ?
9. About how many stars are there in the universe ?

1.3 Our View of the Universe

At present we consider matter to be composed of a handful of fundamental (or elementary) particles and all bodies, both living and inert, to be made up of different groupings or arrangements of such particles. Three of these fundamental particles are especially important because of their presence in many common phenomena: *electrons, protons*, and *neutrons*.

There are a few other fundamental particles; but they have a transient life, being continuously created and destroyed (anu thus are termed unstable); and apparently they do not participate directly in most of the phenomena we observe around us (Fig. 1-1). Their existence is made manifest only by means of rather elaborate observational techniques, and their role in the general scheme is not yet completely understood. Some of these, such as the *pions*, are vital because of the role they play in the interactions between protons and neutrons. Fundamental particle research is of great importance today in obtaining some clue to the structure of the universe.

Using an oversimplified language, we may say that the three particles—electron, proton, and neutron—are present in well-defined groups called *atoms*, with the protons and neutrons clustered in a very small central region called the *nucleus* (Fig. 1-2). About 104 distinct "species" of atoms have been recognized (see Table A-1); but there are about 1300 different "varieties" of atoms, called *isotopes*. Atoms, in turn, form other aggregates called *molecules*, of which several thousand different kinds are known to exist. The number of different molecules is extremely large, and more and more new molecules are synthesized every day in chemical laboratories. Some molecules contain just a few atoms; e.g., hydrochloric acid molecules are formed of one atom of hydrogen and one atom of chlorine (Fig. 1-3); other molecules, such as those of proteins, enzymes, and nucleic acids [DNA and RNA (Fig. 1-4)] or some organic polymers such as polyethylene or polyvinylchloride (PVC), may have several hundred atoms. Finally, molecules group together forming bodies (or matter in bulk) appearing to us as solids, liquids, or gases (Fig. 1-5) although this classification or division is not a rigid one. Another state of matter is the *plasma*, consisting of a gaseous mixture of positive and negative ions (or charges particles). Most of the matter in the universe is in the form of a plasma.

A particularly important kind of body is the living body or *living matter*, called *protoplasm*, in which molecules appear in a highly organized pattern and exhibit properties and functions apparently distinct from those of inert matter. The human body, which is the most developed of all living bodies, is composed of about 10^{28} atoms; most of these are carbon, hydrogen, oxygen, and nitrogen atoms.

The solar system is an aggregate of several huge bodies, called planets, which rotate about a star, called the sun. One of the planets is our earth, which contains about 10^{51} atoms. The sun is composed of about 10^{57} atoms. The solar system is, in turn, a small part of a large aggregate of stars which form a galaxy called the Milky Way, composed of about 10^{11} stars or 10^{68} atoms and having a disk shape, with a diameter of about 10^{21} m, or about 100,000 light years, and a maximum thickness of about 10^{19} m. Many galaxies similar to ours have been observed (Fig. 1-6), the closest being about two million light years, or 2×10^{22} m, from us. The universe may contain about 10^{20} stars, grouped in about 10^{10} galaxies and containing a total of about 10^{80} atoms in a region whose radius is of the order of 10^{26} m, or 10^{10} light years.

Now, cover the text. Working with a partner, try to answer the questions again. After you have tried, check the text again.

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HANDOUT IV: SAMPLE LESSON PLAN FOR LARGE CLASS

5 minutes	: Organise the room, collect homework, take the register
10 minutes	: Introductory activity ('warmer')
90 minutes	: CORE LESSON
10 minutes	: Closing activity ('cooler')
5 minutes	: Sum up lesson, set homework

Here are some notes on a core phase of a lesson:

Materials : 3 subject-based texts (length according to class ability)

Constraints: If copies are limited, distribute thus:

Text I : One copy between 3
OR
One copy on the OHP or board
+
Several copies stuck on the walls around the room, large enough to be read by several students at once

Text II : One copy between 3

Text III : One copy between 3

Aims : 1. Students should identify the main idea(s) of the texts, comparing and discussing their answers.

2. Students should practise important vocabulary for their studies

Preparation: Before the lesson, you should write the main idea(s) on several pieces of paper, and/or on the board or OHP, for students to see after they have tried (or copy them for everyone if possible).
Make a list of the important vocabulary, with definitions in English, plus an Indonesian translation if necessary. You are the best person to decide which words they need to know, since you are a subject lecturer. Do not waste time on words they will rarely meet.
Words needed to understand the main idea(s) can be taught before the reading phase, but leave most of them until after reading, to let students practice guessing meaning from context. This vocabulary can be conveyed as main ideas above, if copies are limited.

Homework : Students could make their own sentences with the new words. They could write the main idea(s) of another text (you could make use of textbooks they already have). Ask them to reread the texts studied in class several times, until they can understand them without reference to the vocabulary list. Seeing the new words in context will help them remember what they mean and how to use them in a sentence.

Lesson Plan for the Core Phase:

5 minutes you address the class	Distribute Text I. Explain that they will look for the main idea(s) in groups of 3, and then compare their answers with those of other groups before you give them the final solution.
5 minutes students work alone	Give them only five minutes to find the main idea(s). Tell them when they have one minute left. Train them to skim-read, not to linger over new words or details.
10 minutes students work in groups	Ask them to compare and discuss their answer(s) with the other 2 people in their group, and then compare again with a neighbouring group of 3.
10 minutes you address the class (they may remain sitting in groups)	Give your solution. Explain which words or sentences in the text led you to this, and ask them to underline these main points. Let one member of each group refer to the solutions nearest them if they cannot all see the board or OHP. It is important to make sure they are all clear about the correct answer. Weaker students may then study the text more slowly at home. Include important vocabulary with the solution.
5 minutes you address the class	Now distribute the other 2 texts. Explain that each half of the class will have a different text. Give Text II to those on the left, Text III to those on the right. Tell them to keep working in small groups, and each group has to identify and write down the main idea(s) and underline any new words they think are important.
15 minutes students work in groups and co-operate with other groups	Give them 15 minutes for this task. Tell them if they finish early, they should compare their answers with other groups who have the same text. The main idea(s) should be written clearly on a piece of paper.
15 minutes you address the class and then they work in groups (preferably newly-formed groups)	Now they exchange sheets of paper containing main ideas with the other half of the class. While they are doing this, you distribute Text II to those who have read Text III, and vice versa. If practical, ask them to work with 2 <u>different</u> partners for this group activity. They have to correct the main idea(s) written by the other half of the class. Whether they decide they are right or wrong, they have to justify their decision by referring to the text.
10 minutes you address the class; they find the correct solutions to both texts	Now tell them to find the model answers you made (on the board, OHP or walls if not enough copies are available). Let them argue among themselves if they wish. These thought processes are an important part of developing the skill of skimming.
15 minutes you address the class	This is a quieter phase. Let them ask questions if they have any. Accept any plausible alternative answers. Use the remaining time to give them the remaining important vocabulary. If they have a lot of questions, omit your closing activity.

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HANDOUT III: SAMPLE TEST IN ENGLISH FOR PHYSICS

The energy crisis

If present trends continue, the world will face a major crisis by the end of this century: insufficient cheap, convenient energy. For without such energy, industrial production will fall, agricultural output will drop, transport will be restricted, and standards of living in developed countries will plummet .

At present, almost all our energy comes from fossil fuels (oil, coal and natural gas). The Earth's reserves of fossil fuels have been formed from organic matter subjected to enormous heat and pressure for millions of years. But such reserves are finite . Because power demand is increasing very rapidly, fossil fuels will be exhausted within a relatively short time. We can estimate the amount of recoverable fuel under the surface of the Earth, and we know the rate at which it is being extracted. Fairly simple calculations can therefore determine its remaining life . If present trends continue, gas and oil reserves will be exhausted by the middle of the 21st century – about 70 years from now. Similar estimates for coal reserves suggest a projected supply of 250–300 years. Of course, long before fossil fuels are exhausted, demand will greatly exceed supply.

For too many years, the world has consumed fossil fuels with little thought for the future. In fact , world energy consumption increased almost 600% between 1900 and 1965, and is projected to increase another 450% between 1965 and the year 2000. Crude oil has been pumped out of the ground for about 100 years, but over one-half of it has been consumed in the past 18 years. Coal has been mined for over 800 years, but over one-half of it has been extracted in the past 37 years. In sum, most of the world's consumption of energy from fossil fuels throughout all history has taken place within living memory.

Most of this energy is consumed by the industrial countries of the world. In fact, with only 30% of the world's population, they consume 80% of the world's energy – and this gap is expected to widen. The USA alone (with 5% of the world's population) accounts for over 32% of the world's annual consumption of energy. In contrast , India (with about 15% of the world's population) consumes only about 1·5% of the world's energy. Each year, 215 million Americans use as much energy for air conditioning alone as 970 million Chinese use for all purposes. And Americans *waste* as much energy as 116 million Japanese consume for all purposes.

The average increase in consumption of fossil fuels is 6% per year. Write an equation based on paragraph 2 (lines 9-17) to calculate when there will be no more fossil fuels.

Draw a graph based on paragraph 3 (lines 18-26) to show the increase in energy consumption.

Draw a bar chart to illustrate the information in paragraph 4 (lines 27-35).

Complete the following, based on the text:

MECHANICAL

POTENTIAL (1) ______________

(3) ______________ (2) ______________

Coal and oil produce (4) ____________ energy,which is a kind of (5) ______________ energy.

Uranium produces (6) ______________ energy which produces (7) ______________.

Complete the description of figure 45.

At A the water has __________ energy. At A + B the energy produced by the water to turn the turbine is __________ energy. A + C the __________ energy of the turbine is changed into ______________ energy by the dynamo.

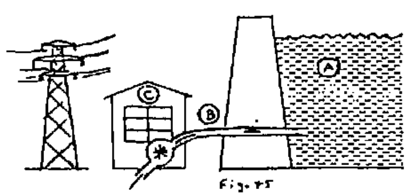

Fig. 45

BEST COPY AVAILABLE

Energy is one of the most important things in life. It is that which enables us to do work. Work in physics means such things as changing the position of an object by lifting it up or changing its speed, raising the temperature of somthing, changing the shape of an object or a material and providing light.

We need energy to move about and to do the activities of a normal day. We obtain the energy necessary for this from food and, more particularly. form the starch and sugars of our diet, the CARBOHYDRATES, which the body uses as 'fuel' in much the same way as a steam engine might burn coal or oil.

Imagine a man doing a simple piece of work. He is pulling on a rope over a pulley to raise a load. The fact that he uses some energy in doing this will be felt by the man. When he has raised the load to the top, he might fasten the end of the rope he has been pulling to a box. Provided that the box is lighter than the load,the load would then run down and pull the box up. To do this the load must have some energy. This energy has actually been given to the load by the man: he has TRANSFERRED some energy. When the load is at the top of the distance it has been pulled up, it has gained POTENTIAL energy: it has the ability to do some work but it is not yet using this ability. It is only when the load is moving downwards that it is doing work in pulling the box up. When the load is moving, it has KINETIC energy - energy due to motion.

There are various forms which energy can take. Potential and kinetic energy can be grouped together as MECHANICAL energy. Sound energy is a special form of kinetic energy since it is obtained from the movement of molecules. Chemical energy is a special form of potential energy, the energy 'locked up' in fuels such as coal and oil which is released as heat when the fuel is burnt. Nuclear energy is produced when particles are thrown out from radioactive atoms of materials like uranium and plutonium which are used in atomic piles, yielding great heat.

All energy is measured in a unit called the joule (J). This is the energy transferred when a force of one newton moves through a distance of one matre.

It takes a force of 1N to lift a mass of 0.1 Kg at the surface of the Earth. If the mass is raised 1 metre it will gain 1 joule of potential energy.

Heat energy is also measured in joules, and it may be difficult to see how a unit which involves a force moving through a distance can be used to measure heat. Kinetic and potential energy can be converted into heat, however. If a piece of lead is hammered on a block of wood it becomes flattened as a result but it will also be found to have become quite warm in the process. The potential and kinetic energy of the hammer blows have been converted into heat energy. Kinetic energy is converted into electrical energy by a dynamo and electrical energy is readily converted into heat energy by an electric fire, iron or kettle. One unit of energy, the joule, is therefore all that is needed to measure all forms of energy.

It is of great importance that the energy we obtain from fuels like oil and coal is used with the least possible waste. Oil and coal are fossil fuels formed millions of years ago from the remains of animals and plants. There is only a limited amount of these fuels contained in the Earth's surface and, once this is used up, it can never be replaced. Only quite recently has it been realised that our supply of this form of energy is running low. There is much work now being done to see how other forms of energy, obtained from the wind, tides and the sun, might be used for producing the electrical energy we need.