08-22

AP-9/16/08

Undergraduate Distance Education Review Form

(Required for all courses taught by distance education for more than one-third of teaching contact hours.)

Existing and Special Topics Course

Senate App - 10/07/08

Course: PHYS 101 Energy and Our Environment

Instructor(s) of Record: Stanley Sobolewski

Phone: (724) 357-4590 **Email:** sobolews@iup.edu

Step One: Proposer

A. Provide a brief narrative rationale for each of the items, A1- A5.

1. How is/are the instructor(s) qualified in the distance education delivery method as well as the discipline?

I have taught PHYS 101 Energy and Our Environment for several semesters over the past ten years. This class is a liberal studies non-lab science class; I have taught many other liberal studies classes since I joined the IUP faculty in 1992. These include: SCI 101 Fundamentals of Physics, SCI 105 Physical Science 1, PHYS 105 The Physics of Light and Sound, PHYS 151 Medical Physics Lecture, PHYS 161 Medical Physics Lab, PHYS 111 General Physics I, (both traditional as well as on-line) PHYS 112 General Physics II, and PHYS 122 General Physics Lab II. Before IUP, I had been a high school physics teacher for eight years. I am the course coordinator for the liberal studies physics classes, which includes the selection and administration of lab activities. Hence, I have extensive experience in teaching the non-scientists the ideas of science.

This particular course requires students to read papers on topics pertaining to energy production, consumption and future supplies. After reading these articles, the students write a one-page critique of the article, addressing issues emphasized by the instructor. For the past five offerings of PHYS 101, the articles that the students have read as well as the students submissions of the article review has been administered through WebCT. Students in the class also submit a library research paper, which is collected through the assignment module of WebCT. I make extensive use of Web CT for my traditional class; through out the years I have used every component of the Web CT site, and I am preparing for the migration to the new Course Management Software when the Web CT license expirers in 2010.

The instructor has also taught PHYS 111 General Physics 1 as a distance education class.

2. How will each objective in the course be met using distance education technologies?

The course objectives are as follows

1. To gain knowledge of environmental issue
2. To gain an understanding of the principles and concepts of physics involved in environmental issues.
3. To identify the needs of society which contribute to environmental issues.
4. To write critical reports and make oral presentations on environmental issues.
5. To make educated projections on the outcome of environmental issues under various assumed scenarios.
6. To study expert projections of environmental outcomes made in the recent past and compare them with present day reality to determine events/factors which have affected the outcomes.

Objectives 1 and 3 can be addressed through the reading of the text and other ancillary materials. Objectives 2, 4, 5 and 6 can be addressed through the article reviews and papers written by the students.

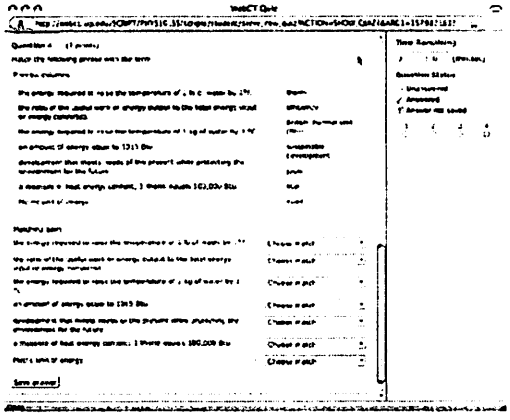
These specific objectives will be addressed in the following manner.

Received
SEP 10 2008
Liberal Studies

1. To gain knowledge of environmental issue

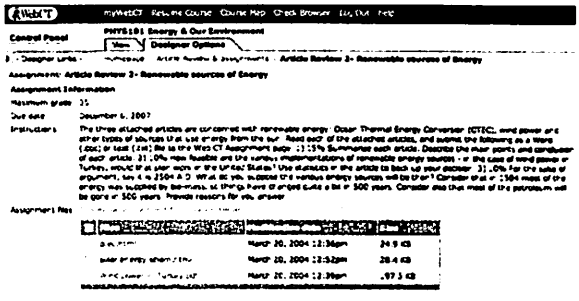
Received
SEP 10 2008
Liberal Studies

The most efficient method to "give students knowledge" is to have the students purchase a textbook and require the students to read the text. There are a few texts on this topic that have adequate depth and breadth for this class. Energy and Problems of a Technological Societyby Kraushaar and Risttinen is a complete text which delves deeply into the topics of this course. Another option is: Energy: Its Use and the Environment, 4th Edition by Roger A. Hinrichsand Merlin H. Kleinbach. This text is not as broad in scope as Kraushaar and Risttinen, but it may be more readable for the students who typically populate this class. This final decision about the text will be decided at a later date. However for either text, I would use Web CT multiple choice quizzes to be sure the students have at least a superficial knowledge of the issues and terminology of energy usage and how that relates to the environment.



2. To gain an understanding of the principles and concepts of physics involved in environmental issues.

The principals and concepts of physics involved can be addressed with the textbook, much as above. In addition to reading the text, students will have access to on line articles and resource, through the Web CT assignment module. As per the syllabus, students have required assignments where they read articles provided by the instructor. The figure to the right is a page from such an assignment



3. To identify the needs of society which contribute to environmental issues.

This objective will be met primarily through the use of the student research paper that is the terminating activity for the class. The term paper allows the student to express a position of his or her own which may or may not agree with any of the authors used in the course. The student selects a topic from any of those listed in the syllabus and write a position paper on this topic. Since the student is not an "expert" the student is expected to refer to those who are to support their position. The topics for the paper will deal with the needs of society, and a portion of the paper will be dedicated to how this topic relates to environmental issues. At least three different authors should be cited.

The paper requirements are summarized as follows: The student paper will provide a description of the problem(s) or condition(s) involved in the topic. This typically involves the factors, which affect the condition or problem. This portion may make up the bulk of your paper. The student will state their view or your position on this topic or problem or situation. The student will offer a projection of outcomes that will occur if no action is taken. The student will offer corrective actions that can be realistically taken to positively affect the outcomes of this problem/situation.

4. To write critical reports and make oral presentations on environmental issues.

This objective will be met first through the papers and article summaries that have been described above. The oral presentation objective will be met with the use of the Wimba Online classroom utility. Students will be able to make oral presentations to the class over the Internet. The only extra equipment a student might need would be a microphone, and these are inexpensive.

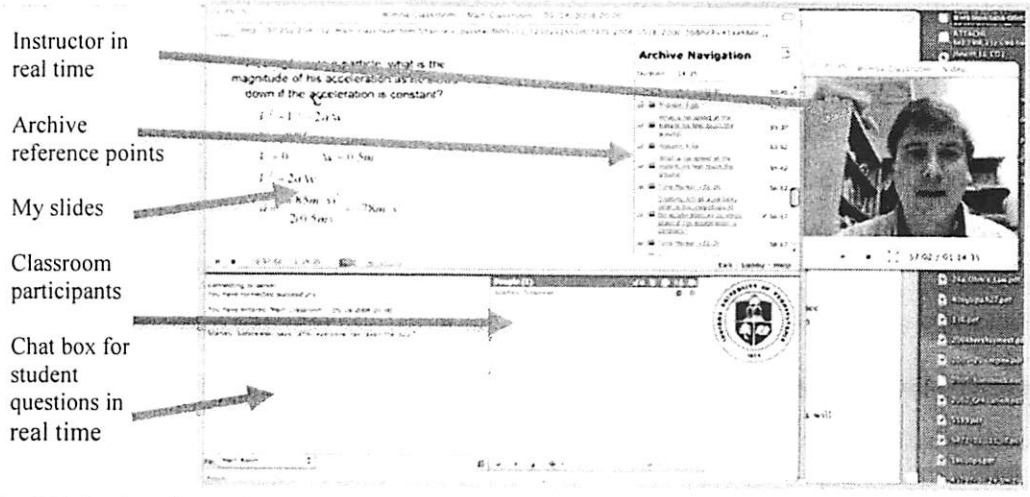
5. To make educated projections on the outcome of environmental issues under various assumed scenarios.

As with objective 2, students will be explicitly asked to make predictions in the article reviews. See the figure in the discussion of objective 2. The following text is from that assignment:

> The three attached articles are concerned with renewable energy: Ocean Thermal Energy Conversion (OTEC), wind power and other types of sources that use energy from the sun. Read each of the attached articles, and submit the following as a Word (.doc) or text (.txt) file to the Web CT Assignment page. 1) 15% Summarize each article. Describe the main points and conclusion of each article. 2) 10% How feasible are the various implementations of renewable energy sources - in the case of wind power in Turkey, would that plan work in the United States? Use statistics in the article to back up your decision. 3) 10% For the sake of argument, say it is 2504 A.D. What do you suppose the various energy sources will be then? Consider that in 1504 most of the energy was supplied by bio-mass, so things have changed quite a bit in 500 years. Consider also that most of the petroleum will be gone in 500 years. Provide reasons for you answer.

6. To study expert projections of environmental outcomes made in the recent past and compare them with present day reality to determine events/factors that have affected the outcomes

3. How will instructor-student and student-student, if applicable, interaction take place?



I have used Wimba Classroom, and will use that again for this class. The picture to the left is a captured session for PHYS 111 from the summer of 2008. This is a screen shot of my Mac Book, which has the necessary technology built in. At the designated time of the "lecture" I open up the classroom, and the students will click on the Wimba icon in Web CT, to join the lecture.

With the ability of students to see slides, see and hear the instructor, as well as ask questions of the instructor in real time, it will be similar to an in-person lecture. The students will also be able to communicate through e--mail.

4. How will student achievement be evaluated?

On-line WebCT quizzes -the items will be multiple choice, free response and calculation questions. The students will write article reviews, critiques and a library research paper.

5. How will academic honesty for tests and assignments be addressed?

5. **How will academic honesty for tests and assignments be addressed?**

In the case of the on-line quizzes, the multiple-choice items will be rotated to provide a different quiz for each student. The calculation questions will have new values generated for each items. All of the students written work will be submitted to the Turnitin web site, (http://turnitin.com/static/home.html) which checks for plagiarism between the students, as well as papers from the internet. The instructor has used this before, and has caught several (3 or 4 per semester) students who cut and pasted their papers.

B. Submit to the department or its curriculum committee the responses to items A1-A5, the current official syllabus of record, along with the instructor developed online version of the syllabus, and the sample lesson. This lesson should clearly demonstrate how the distance education instructional format adequately assists students to meet a course objective(s) using online or distance technology. It should relate to one concrete topic area indicated on the syllabus.

Step Two: Departmental/Dean Approval

Recommendation: X Positive (The objectives of this course can be met via distance education)

☐ Negative

[signature]	9-3-08
Signature of Department Designee	Date

Endorsed:

[signature]	9/11/08
Signature of College Dean	Date

Forward form and supporting materials to Liberal Studies Office for consideration by the University-wide Undergraduate Curriculum Committee. Dual-level courses also require review by the University-wide Graduate Committee for graduate-level section.

Step Three: University-wide Undergraduate Curriculum Committee Approval

Recommendation: ☒ Positive (The objectives of this course can be met via distance education)

☐ Negative

[signature]	9/18/08
Signature of Committee Co-Chair	Date

Forward form and supporting materials to the Provost within 30 calendar days after received by committee.

Step Four: Provost Approval

☑ Approved as distance education course ☐ Rejected as distance education course

Signature of Provost 9/24/08 Date

Forward form and supporting materials to Associate Provost.

Scanned Syllabus of Record

PY 10
Energy and Our Environment
Course Syllabus

I. Description

A study of man's effect on the environment from a scientific/physics point of view, and in particular, man's use of energy and natural resources to provide a living for the global community and its effect on the land, sea, and air. The text and outside readings and text references are used as the information base.

II. Course Objectives

1. To gain knowledge of environmental issues

2. To gain an understanding of the principles and concepts of physics involved in environmental issues.

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III. Suggested Course Outline

A. Energy Fundamentals
   1. Basic concepts
   2. Forms of energy
   3. Energy consumption

B. Energy from fossil fuels
   1. Sources / Production/ Technology
      a. Petroleum
      b. Natural gas
      c. Coal
   2. Marginal sources
   3. Environmental issues concerning Production

C. Energy Conversion
   1. Efficiency
   2. Laws of energy conversion
   3. Electricity
   4. Efficiencies of coal fired and nuclear power plants
   5. Cogeneration

D. Nuclear Energy
   1. Basic physics of nuclear energy
   2. Structure of nuclear Power Plants
   3. Types of reactors

E. Environmental Issues / Safety
   1. Radioactivity / health science
   2. TMI
   3. Chernobyl
   4. Waste Storage
   5. Coal fired power plants
   6. Relative Risks

F. Alternate Energy Sources
   1. Solar
      a. domestic applications
      b. large systems / electricity
   2. Hydroelectric
   3. Wind
   4. Ocean / Tides
   5. Geothermal
   6. Storage of energy

G. Energy Usage
   1. Space heating / insulation
   2. Efficiency of appliances
   3. Waste heat recovery
   4. Recycling / Waste disposal / Incineration

H. Plant and Food Production
   1. Photosynthesis
   2. Feeding the world's population
   3. Fuel from Biomass

I. Transportation
   1. System needs, fuels, people, freight
   2. System efficiencies: routing, mass transit
   3. Trucking, railroads, and air transport

J. Production of Land, Air, and Water pollutants and their Effects
   1. Carbon Monoxide
   2. Nitrous oxide
   3. Photochemical smog
   4. Sulfur dioxide
   5. Carbon dioxide
   6. Global warming

IV Evaluation Methods

The course grade will be determined by the following evaluation instruments and weightings

1. Article reports (4)	40%
2. Papers with references (2)	40%
3. Oral presentation/discussions (daily attendance required)	20%

Written materials should by typed / word processed.

Text: Krauskopf / Rischtimer
Energy and Problems of a Technological Society
Second Edition 1989

PHYS 101 Energy and Our Environment ON Line Syllabus

Catalog Description: An overview of the areas of energy, transportation, and pollution. These topics are approached via the relevant concepts of physical science and physics. A non-laboratory course for Liberal Studies requirements.

Course Syllabus

I. Description

A study of man's effect on the environment from a scientific/physics point of view, and in particular, man's use of energy and natural resources to provide a living for the global community and its effect on the land, sea, and air. The text and outside readings and text references are used as the information base.

II. Course Objectives

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  - 1. Efficiency
  - 2. Laws of energy conversion
  - 3. Electricity
  - 4. Efficiencies of coal fired and nuclear power plants
  - 5. Cogeneration
- D. Nuclear Energy
  - 1. Basic physics of nuclear energy
  - 2. Structure of nuclear Power Plants
  - 3. Types of reactors
- E. Environmental Issues / Safety
  - 1. Radioactivity / health science
  - 2. TMI
  - 3. Chernobyl
  - 4. Waste Storage
  - 5. Coal fired power plants
  - 6. Relative Risks
- F. Alternate Energy Sources
  - 1. Solar
    - a. domestic applications
    - b. large systems / electricity
  - 2. Hydroelectric
  - 3. Wind
  - 4. Ocean / Tides
  - 5. Geothermal
  - 6. Storage of energy
- G. Energy Usage
  - 1. Space heating / Insulation
  - 2. Efficiency of appliances
  - 3. Waste heat recovery
  - 4. Recycling / Waste disposal / Incineration
- H. Plant and Food Production
  - 1. Photosynthesis
  - 2. Feeding the world's population
  - 3. Fuel from Biomass
- I. Transportation
  - 1. System needs: fuels, people, freight
  - 2. System efficiencies: routing, mass transit
  - 3. Trucking, railroads, and air transport
- J. Production of Land, Air, and Water pollutants and their Effects
  - 1. Carbon Monoxide
  - 2. Nitrous oxide
  - 3. Photochemical smog
  - 4. Sulfur dioxide
  - 5. Carbon dioxide
  - 6. Global warming

IV Evaluation Methods

The course grade will be determined by the following evaluation instruments and weightings

Additional Information

1. Article reports (4)	30%
2. Paper with references	30%
3. Live Classroom Discussions (daily attendance required)	10%
4. On-line Quizzes on text and class information	30%

Written materials must be word processed – and submitted online

Tentative Text: Kraushaar / Risttinen Energy and Problems of a Technological Society

Description of on-line operation.

The class will operate much like a traditional lecture. There will be a two-hour "Wimba Classroom" lecture on the following days. The lecture will be in the afternoon, from 1:00 to 3:00 P.M. It is required that students be present for the on line lecture. On the occasional situation where the student cannot be near a computer at this time, a recorded version of the lecture may be observed instead.

For each chapter, there will be an on-line web ct quiz. The quiz will consists of multiple choice, calculation and fill in the blank questions. The quizzes are timed, and must be taken by the deadline indicated on the WebCT quiz page. Each chapter quiz will be available for approximately 48 hours. They will open approximately 24 hours before the corresponding on line lecture is given and close 24 hours after the lecture has been completed.

Four times during the semester, an article from a journal will be given to each student. The student must read the article and write a short review of the article, addressing issues presented by the instructor. These article reviews are submitted on line through the assignment module of IUP's WebCT server. See "Article Review Standards" below

Tentative Class Schedule

Class	Date	Topic for Class	Read Chapters	Assignment Due
1	12/15 Monday	Introduction • Work and Energy	1	
2	12/16 Tuesday	Exponential Growth • Fossil Fuels	2	
3	12/17 Wednesday	Types of Coal, Coal Production• Scientific Notation	2	
4	12/18 Thursday	Thermodynamics	3	
5	12/19 Friday	Cogeneration	6	Article 1 review
6	12/20 Saturday	Solar Energy	7	
7	12/22 Monday	Other sources of Energy • especially Hydroelectric	8	
8	12/23 Tuesday	Energy Conservation	9	Article 2 review
9	12/26 Friday	Food Production	10	
10	12/27 Saturday	Transportation	12	Article 3 due at the beginning of class
11	12/29 Monday	Air Pollution	13	
12	12/30 Tuesday	Water Pollution	14	
13	01/02 Friday	Noise Pollution	15	
14	01/03 Saturday	Nuclear Energy / the Atom		
15	01/04 Sunday	Environmental aspects of nuclear energy	4	Article review 4 due
16	01/05 Monday	Radiation and Man	5	
17	01/06 Tuesday	Energy and the future? Can these problems be solved.	11	

Article Reports and Paper Standards

Article Review Standards

Article Reports should include the following:

1. The name of the source/article, name of the periodical, issue date and name of the author.

2. A brief description of the authors background/credentials as evidence for the credibility of his position taken in the article.

3. A brief description of the purpose, theme, claim, or position taken by the author of the article.

4. Discussion of the variables or factors that are involved in the theme of the article.

5. Major arguments for and against the authors position.

6. Conclusions/recommendations made by the author.

7. A personal statement of agreement or disagreement with the authors position and why.

Paper Standards

Your "Papers" allow you to express a position of your own which may or may not agree with any of the authors used in the course.
You may select a topic from any of those listed in the syllabus and write a position paper on this topic. Since you are not an "expert" you are expected to refer to those who are to support your position. At least three different authors should be cited.

Lastly your paper should include the items 3 through 6 listed in the above standards for article reports where you are the "author".

Quotes or paraphrases of an authors argument that you use are to be denoted by a superscript number which refers to an article listed at the end of your paper i.e. (^{1}) would refer to the first article listed in your bibliography.

You are expected to type your article reports and papers, using complete sentences in order to convey your thoughts clearly.

Successful article reports and papers depend on how clearly, completely, and well substantiated you make your position.

The "Paper" is to be written on some aspect of (or problem involved in) the topics covered in the course (listed in the syllabus under "III. Suggested Course Outline")

I. You are to title your paper

II. You should provide a description of the problem(s) or condition(s) involved in the topic. This typically involves the factors, which affect the condition or problem. This portion may make up the bulk of your paper.

III. You should state your view or your position on this topic/problem/situation.

IV. You should/may offer a projection of outcomes that will occur if no action is taken.

V. You should/may offer corrective actions that can be realistically taken to positively affect the outcomes of this problem/situation.

VI. Items 2, 4 and 5 above should be supported by "expert" sources, listed in a bibliography at the end of your paper. Quotes or paraphrases of an authors argument that you use are to be denoted by a superscript number which refers to an article listed at the end of your paper i.e. ([1]) would refer to the first article listed in your bibliography.

VII. Your references may include Scientific American, Biology, Chemistry, or Physics Journals, Science, the Text, or any respectable Ecology/Environmental Science Journal.

SAMPLE LESSONS *Note for conversion to DE course review process: The student would download this Word document; fill in the blanks, and then return the assignment to the instructor*

Chapter 5

A well-insulated house

Instructions: With your text and a calculator at hand, follow the instructions on these pages. Type your answers in the spaces, and up-load the Word file in the WebCT assignment module. *Please understand* this is partly an exercise in **estimation**! Your answer only needs to be close to be marked as correct. You have two days to complete and submit the assignment. Once you have submitted your answers, I will provide you with my answers.

You are going to estimate the heating costs of a sample house. In each section, you calculate a value that will be used in the final equation. **Essentially you are doing the example on page 141**

Degree Day

Use the data in figure 5.8 to determine the ***approximate*** number of heating degree days there are in this part of the country (pick the closest place to Indiana, or a place that has similar weather.)

Ans.: _____ °F • day *This number will be used in the "Energy to Heat the House: Q" below*

Insulation R-value

Next, pick insulation for the house:

Now, refer to table 5.1 You need to meet the current FHA minimum insulation recommendations. Even though the recommendations are different for ceilings and wall, use the same R value for all the surfaces. So here, insulate the walls and ceilings the same. It will be easier to calculate a final answer.

List building materials and amounts: See Table 5.2 on page 134. (You don't have to fill all of the lines)

Material	R value
_____	_____
_____	_____
_____	_____
_____	_____

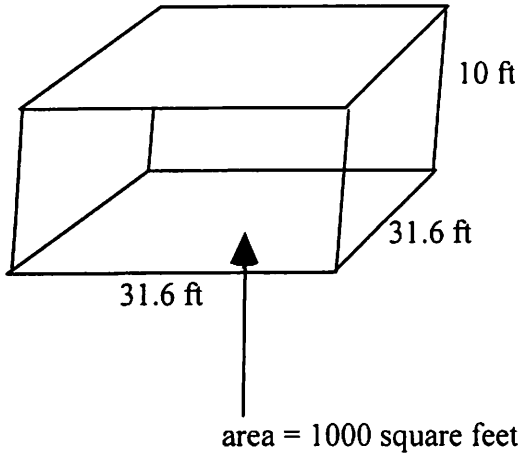
_____ _____

_____ _____

Add up the R values

ANS: Total R = _____ *This number will be used in the "Energy to Heat the House: Q" below*

Area of the House A



(Ignore the floor) If we assume that our house has 10 ft high ceilings, is a one-story box, then the floor area of 1000 ft^2 gives us a side of 31.6 ft along the ground.

Each of the **four** walls has an area of 31.6 ft x 10 ft = 316 ft^2

The ceiling would have an area of 1000 ft^2. So the total area is **Area = A =** _____ **ft^2**

This number will be used in the "Energy to Heat the House: Q" below

---

Energy to Heat the House: Q

Now we need to calculate how much energy we need to heat this house. Use

$$Q_{total} = \sum\left(\frac{1}{R} xA\right) x(24\,h/day) x(\text{degree days})$$

we have only one value for R and A, so we can ignore the summation

See example on page 142 - You can approximate to make the math easier.

$$Q_{total} = \frac{1}{\_\_\_\_\_} x \_\_\_\_\_ x \frac{24hr}{day} x \_\_\_\_\_$$

Ans.: _____ $\frac{Btu}{}$ per year

Cost to heat the house $$$

Assume that we are using natural gas. From the information on page 143, gas costs $6.00 per 100,000 Btu
You can assume efficiency similar to that in the text, or pick your own.

Final Answer $ _____ per year.

As per the *example* on page 143 in regards to Buffalo, New York, calculate how much it would cost to heat **this** house with electricity:

1 kWh = 3413 Btus

Need _____ kWh of electricity which costs $0.07 per kWh

Answer $ _____ per year

CO_2 in the atmosphere

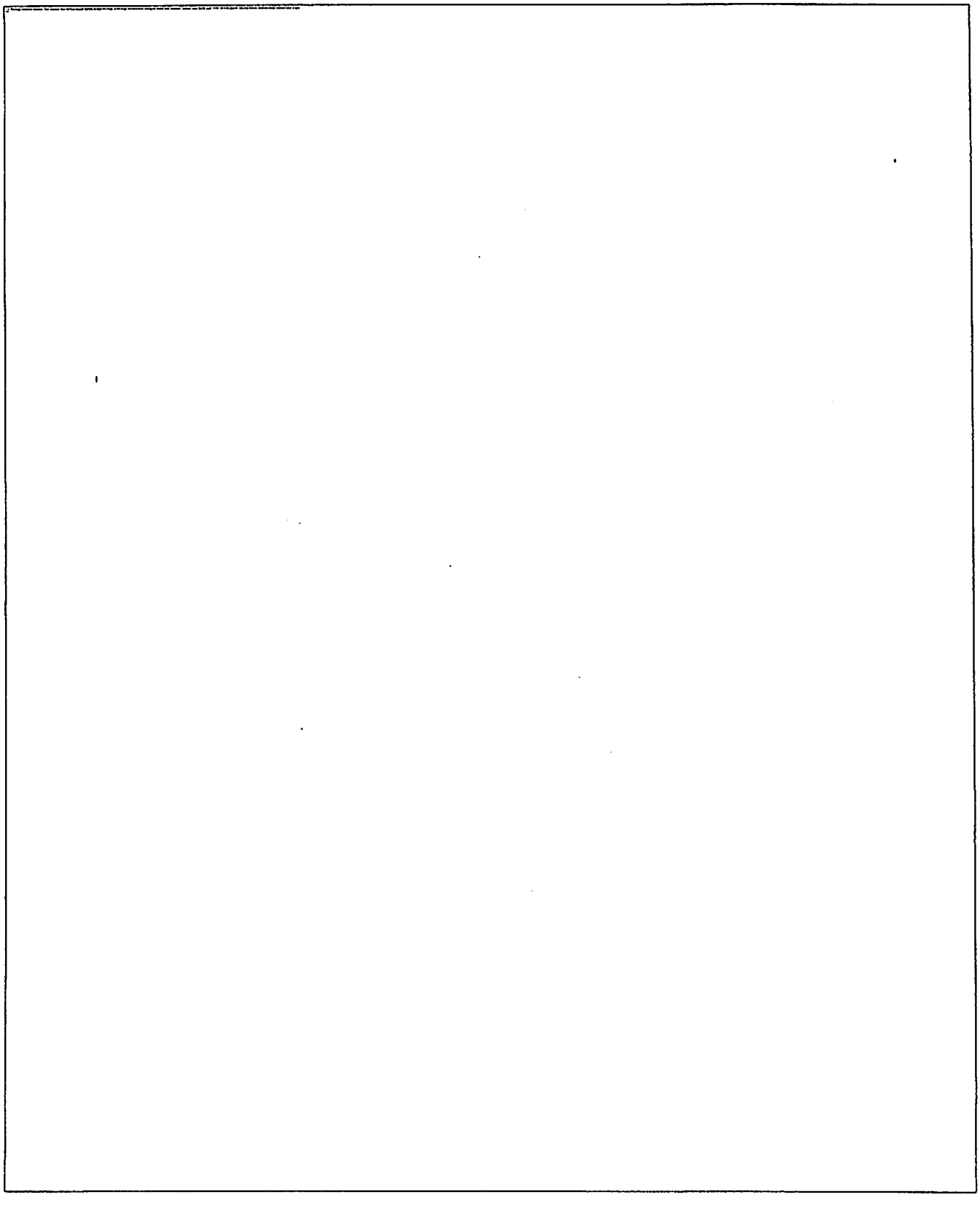
As per Table 9.3, 100,000 Btu's of Natural gas use emits 12 lbs of carbon dioxide, and 1Kwh of electricity from burning coal produces 2 lbs of carbon dioxide.

How many pounds of CO_2 are emitted in a year heating this house

with natural gas? _____ lbs CO_2

with electricity from coal? _____ lbs CO_2

Power point slides to be used with a Wimba Live Classroom Session



Energy from the Sun

Chapter 6

All energy, except for Nuclear Energy is ultimately from the sun.

Direct Energy from sun

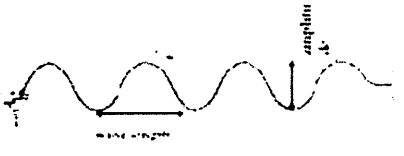
- 0.077% of energy consumption is from solar
- I would guess the number may be higher - direct solar heating is not in this figure.
  - When you open the curtains on a cool sunny day, the sun provides energy

US Energy Flow 2000

Need to know about light

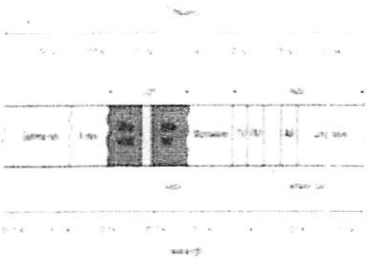
- Light is a wave
  - Light has frequency, amplitude and wavelength
- Classically, the energy of the wave corresponds to the amplitude
- The frequency corresponds to the color
- The wavelength is related to the frequency and speed by
  - $V = \lambda \nu$

A wave showing, amplitude and wavelength



A light wave might look like this

- A light wave is a crossed electric and magnetic field



Light is also a particle

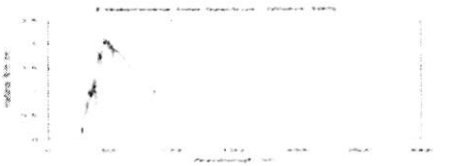
- Light is made up of energy bundles called photons
- The frequency of light gives each photon its energy
- High frequency light (violet) has photons of higher energy than lower frequency light (red)

Light from the sun to produce energy

- Obviously, there are problems such as night, clouds, and seasons that affect the quality of sun light we can use for energy. Even in the best situation, we need to know the nature of sun light.

Sunlight is not "white"

- Most light is at the 500 nm wave length



Where does this energy come from?

- Fusion in the sun
  - Mass becomes energy
- Light energy travels from sun to earth
  - Photons in space
- Light energy hits the earth
  - Only some reaches earth and

All sun light doesn't hit the earth

- 25% Direct Solar
- 10% absorbed by atmosphere
- 35% scatters back into space
- 30% scatters down towards earth
  - adapted from table at left

Tuesday, September 9, 2008 **Name**_____

Chapter 6

Class assignment: Energy from the sun

Read the following discussion and answer the questions or solve the problem as indicated. You may work in groups no larger than five; you may use calculators and the text. As with other aspects of this course, there are correct answers and incorrect answers, however, there is a wide range of "correct" answers. Each person must turn in a paper showing work.

One of the possible new energy sources is solar energy. In this discussion, we will start from "primary energy source" that is the fusion in the sun, and see how this energy is could be used for electricity. We have seen how the law of conservation of energy tells us that energy cannot be created nor destroyed; most of the energy that we use, including fossil fuel, wind power, hydroelectric power and biomass, ultimately came from the sun. In this activity, you will calculate how much of the sun's energy can be used to generate electric energy.

Part 1 • Energy generated by the sun

The Sun converts mass to energy at the rate of 4 million tons *per second*. Express this mass in kilograms

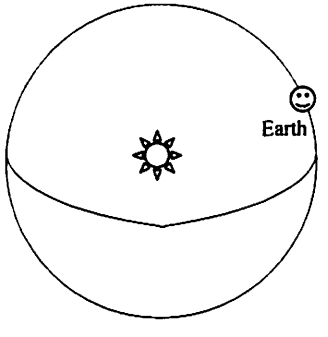
_____

Next, use $E=mc^2$ to determine the energy equivalent of this much mass ($c= 3 \times 10^8$ m/s)

_____Joules

How much power does this represent? (This is easy, look at the first line again)

_____Watts



This energy radiates out from the sun in all directions. The power per square meter is total power output of the sun divided by the surface area of a sphere where the radius is the mean distance from the sun to the earth. In case you forgot, the surface area of a sphere is $4\pi r^2$ and the sun to earth distance can be found in the text.
Area of sphere with sun at the center and earth at surface

= _____

Solar power incident upon the earth in Watts per m^2 = _____ ☆[1]

Look through the textbook and find estimates of this same value. _____

Is the value from the text higher, lower or the same as your answer? _____

What assumption or assumptions did you not consider in the calculation of <u>your</u> ☆[1] value of "Solar power incident upon the earth" that contributes to the difference between these two values?

_____

_____

_____

Part 2 • Useful solar energy

One of the assumptions that needs to be considered can be found from the table below

	Mars	Earth	Venus
distance from sun (Earth=1.0)	1.52	1.0	0.72
albedo	0.22	0.3	0.8
effective radiating temperature	213K	255K	220K
surface temperature	218K	288K	730K
greenhouse effect (or "atmosphere effect")	5K	33K	510K

al·be·do *n: the fraction of incident light that is reflected by an object, especially the Earth or another planet reflecting the Sun's light*

What percentage of the sun's energy is reflected off the earth? _____
What percentage of the sun's energy is left to be absorbed by earth? _____

How much power per area (fraction of ☆[1]) is reflected off the Earth?

_____

What quantity of ☆[1] is left over to be absorbed by the earth? _____ ☆[2]

Examine figure 6.3 on page 165 of the text. List in the table below the various parts of the earth / atmosphere system that absorb the energy calculated for ☆[2]

Energy absorber	percent
_____	_____
_____	_____
_____	_____

_____ _____

_____ _____

Considering all of the elements that absorb the energy from the sun, what percentage of incident solar energy makes its way to the surface as direct sunlight? _____

Typically about 25% will make it through

Use this percentage to determine how much sunlight energy is direct sunlight. Multiply the above percentage by ☆^2 _____

This is the power per unit area of sunlight that is incident upon the earth and available as an energy source. Although the sun generates this power constantly, this energy is not available continuously. What are some of the reasons that this power is not available constantly?

_____

_____

_____