CAMEROON GENERAL CERTIFICATE OF EDUCATION BOARD

General Certificate of Education Examination

JUNE 2006 **ADVANCED LEVEL**

Subject Title	Physics
Paper No	Paper 3
Paper Code	780

Two and a half hours

Answer all questions

Section I of the paper is designed to be answered in one hour and Section II is designed to be answered in one and a half hours. You are advised to divide your time accordingly, and the invigilators should announce when one hour has elapsed.

You are reminded of the necessity for good English and orderly presentation in your answers.

In calculations you are advised to show all the steps in your working, giving your answers at each stage.

Calculators may be used.

2 2

SECTION I
(One hour)

Read the following passage and answer the questions that follow.

The energy crisis would forever be a subject for heated debate amongst politicians and scientists. Imagine being able to charge up your cell phone with just a walk to the shop. It would be wonderful. Scientists believe that traditional methods of generating and supplying power are not flexible enough.

They have realized that there is a lot of unused energy flowing around our local environment. Speeding traffic, vibrating machinery, stray waves, even families walking on the streets would be fair targets for these power pirates. Power has been harnessed from wind and running water for millennia, solar cells have spread everywhere. But these forms of energy collection are not versatile enough to provide for anticipated technological revolutions such as ubiquitous computing in which tiny ultra-low power microprocessor will be built into everything from fridges, cloths, electronic door keys, to street signs and bus stops. Researchers hope that these devices will be able to communicate with each other and with chips built into our phones.

Scientist hope to convert the myriad vibrations that surround us everyday into electricity. Vibrations from car engines, industrial machinery and air conditioning offer rich pickings. To harvest the power, two thin strips of lead

zirconate titanate (PZT) are stuck together to form a bimorph. PZT is a piezoelectric material. When the bimorph was tested on car engines the vibrations set up a voltage. An output of 80 microwatts was produced which could be used to monitor oil pressure or engine temperature.

In New York roads have been dug and pumps installed at regular intervals. As cars and other machinery pass they would generate electricity. Each pump consist of metal plates that sits on a liquid filled bladder. When a car drives across it, the vehicle pushes the plates down. This forces the liquid out of the bladder through a one way valve and into a turbine.

Each pump is capable of generating 80 watts of electricity each time a car runs over it. This power can be stored in re-chargeable batteries while the fluid is returned to the pump via an outlet. This kind of electric power supply could benefit local communities a lot.

Instead of digging up roads, an idea of developing boots that generate power from every step the wearer makes is on the way. Inside the hill of the boot is a disk made from a silicon polymer that works much like PZT strip. Squeezing the polymer produces an inbalance of electric charge between its top and bottom surfaces. Right now there are boots that can produce 0.8 watts of power.

It is possible to generate power while sitting still by making ceiling tiles that grap energy from ambient A.M radio. Calculations show that power from a radio station one kilometre away is possible. Special antennas are being developed that can absorb visible light as well as radio waves. This approach has a large advantage over traditional solar cells.

23

Antennas could be used to collect energy efficiently from ambient light and background radio waves to power small radios. Scientist have worked out already how much electrical energy can be captured from the beat of your pulse and the air pressure created as you breath to produce up to 60 watts of power. As electronic devices become less and less power hungry, even more unlikely means could be used to power them. Only time would tell what advances will take place in this area of alternate power generation.

QUESTIONS

1. Explain the meaning of the following terms as used in the passage:
   (a) charge your cell phone
   (b) pirates
   (c) ubiquitous
   (d) piezoelectric

(8 marks)

2. (i) Identify the various methods of generating power from the passage.
   (ii) Why do scientist think that traditional methods of generating power are not flexible enough.

(6 marks)

3. (i) Explain how vibrations can be a source of energy
   (ii) Draw an energy flow diagram for producing energy by vibrations.

(6marks)

4. (a) What are the difficulties to be encountered by using pumps to generate electricity?
   (B) State and explain the ways which power generation using pumps would benefit local communities.

(6 marks)

5. (a) Compare the boot and radio wave methods of generating power.
   (b) Why is there an energy crisis when energy cannot be created nor destroyed ?

(4marks)

SECTION II

(One and a half hours)

Read the following account of an experimental investigation and answer the questions that follow.

The resistance of most materials is affected by changes in temperature. The temperature dependence for a thermistor is given by an exponential function

$$R = R_o \exp \beta \left(\frac{1}{T} - \frac{1}{T_o} \right) \quad \text{.....(i)}$$

where R is resistance at any temperature.
T is temperature in kelvin
β is a constant
R_o is the resistance at temperature T_o.

When T_o becomes zero equations
(i) may be re-written as

$$R = R_o \exp \frac{\beta}{T} \quad \text{.....(ii)}$$

In an experiment to determine the constant β the following results were obtained for the resistance R and temperature θ, in degrees celsius at $R_o = 1.0 \times 10^6 \Omega$:

$R / x10^6 \Omega$	θ/ °C
2.0	10.0
3.0	20.0
5.0	30.0
7.0	40.0
11.0	50.0
19.0	60.0
30.0	70.0
46.0	80.0
64.0	90.0
95.0	100.0

6. (i) Plot a graph of R on the vertical axis and T on the horizontal axis. **(6 marks)**
(ii) The slope, S, of the graph at any temperature is given by the equation,

$$S = R\beta T^{-2}$$

Take the slope of your graph at a temperature of 348 K and use it to determine a value to β

(6 marks)

7. Using equation (i) plot a suitable graph to determine values for β and T_o

(12 marks)

8. Comment on the values of β obtained in 6 (ii) and 7. **(3 marks)**

25