

*Ollscoil na hÉireann, Gaillimh*  
*National University of Ireland, Galway*

GX 911

**Semester II Examinations, 2002/2003**

Exam Code(s)	<u>3BS1, 3BS9, 3EL1, 3EL2</u>
Exam(s)	<u>3<sup>rd</sup> Science</u>
Module Code(s)	<u>EP329 (EP327)</u>
Module(s)	<u>EP329: Physics of the Environment II</u>
Paper No.	<u>                    </u>
Repeat Paper	<u>                    </u> Special Paper <u>                    </u>
External Examiner(s)	<u>Professor E. Kennedy</u>
Internal Examiner(s)	<u>Professor S. G. Jennings</u>
	<u>Professor P. W. Walton</u>
	<u>Dr. M. Byrne</u>

**Instructions:**      Answer THREE questions.

Duration	<u>2 hrs</u>
No. of Answer Books	<u>1</u>

**Requirements:**

Handout	<u>                    </u>
MCQ	<u>                    </u>
Statistical Tables	<u>                    </u>
Graph Paper	<u>                    </u>
Log Graph Paper	<u>                    </u>
Other Material	<u>                    </u>

No. of Pages	<u>4</u>
Department(s)	<u>Experimental Physics</u>

## EP329: Physics of the Environment II

Answer THREE questions. Time allowed: TWO hours.

Q.1 (a) The energy needed to boil 15 litres of water (initial temperature  $20^{\circ}\text{C}$ ), can be supplied by any of the three methods below.

- (i) Burning 40 cylindrical sticks of wood, each of diameter 3 cm and length 12 cm, on an open fire.
- (ii) Burning  $2.5 \times 10^{-4}$  kg of methane in a gas burner.
- (iii) Burning  $5 \times 10^{-4}$  kg of pentane in an oil burner.

Calculate the efficiency of each of the three methods, and calculate the respective amounts of  $\text{CO}_2$  produced in method (ii) and method (iii). Burning methane produces 55 GJ per kg, burning pentane produces 48 GJ per kg, and burning wood produces 10 GJ per  $\text{m}^3$ . The specific heat capacity of water is  $4180 \text{ J kg}^{-1} \text{ K}^{-1}$ , and its density is  $10^3 \text{ kg m}^{-3}$ .

[7 marks]

(b) Briefly explain how the third law of thermodynamics limits the efficiency of a steam engine. Explain how the use of leaded petrol helps in increasing the efficiency of a petrol engine and explain the term “engine knock”.

[3 marks]

Q.2 (a) Briefly explain why electricity transmission lines carry high voltages. If the transmission voltage at a power station is increased by a factor of 10, what is the effect on the power dissipated as heat along the transmission line? A step-down transformer that converts 230V a.c. to 10V a.c. is rated for 1.5 A output current on the secondary winding. What is the input current?

[3 marks]

(b) List one factor that limits each of (a) the height (b) the spacing and (c) the location of wind turbines. A wind farm has 100 wind generators, each of blade diameter 50 m. Estimate the power that can be generated by the farm at a time when the wind speed is  $12 \text{ ms}^{-1}$ . Assume that each wind generator is 15% efficient. The density of air is  $1.3 \text{ kg m}^{-3}$ .

[5 marks]

(c) Briefly explain what you understand by the terms *pumped storage hydroelectric station* and *solar pond*.

[2 marks]

Q.3 Answer ALL parts.

- (a) With reference to thermal comfort assessment, explain the term *Predicted Mean Vote*.  
[2 marks]
- (b) What is the U value of a  $1\text{ m}^2$  double glazing panel that comprises two 4 mm thick glass panes, separated by a 10 mm thick airspace. The thermal conductivities of air and glass, respectively, are  $0.025\text{ W m}^{-1}\text{ K}^{-1}$  and  $0.8\text{ W m}^{-1}\text{ K}^{-1}$ .  
[3 marks]
- (c) Calculate the contact temperature between a bare foot at  $32^\circ\text{C}$  and an oak wood floor at  $20^\circ\text{C}$  if the contact coefficients ("b-values") for oak wood and skin are  $499\text{ Jm}^{-2}\text{ K}^{-1}\text{ s}^{-1/2}$  and  $1120\text{ Jm}^{-2}\text{ K}^{-1}\text{ s}^{-1/2}$ , respectively.  
[3 marks]
- (d) Briefly explain why the ozone hole over the Antarctic is larger during the polar spring than during other seasons of the year.  
[2 marks]

Q.4 Answer ALL parts.

- (a) With reference to a nuclear reactor, explain that is meant by the term *positive void coefficient* and *negative fuel coefficient*.  
[3 marks]
- (b) Briefly explain what happens during the milling stage of the nuclear fuel cycle.  
[2 marks]
- (c) Describe, using a diagram, the operation of a modern x-ray tube.  
[3 marks]
- (d) The output in the primary beam of an x-ray tube, operated at 150 kVp and 1 mA, is 1.0 Sv/hr at a distance of 1 m. Calculate the output from this tube at a distance of 2 m if it is operated at a current of 5 mA and 150 kVp.  
[2 marks]

**Q.5** Write notes on THREE of the following.

***[3.3 marks for each part]***

- (a)** Outline three practical applications for alpha emitting radioisotopes.
- (b)** Define the units of absorbed dose and dose equivalent as used for ionising radiation. What are the dose limits set for radiation workers and for the general public?
- (c)** Outline the principles of a scintillation counter. Show the pulse height spectrum for a monoenergetic gamma ray.
- (d)** Discuss the radon problem and its remediation.
- (e)** Give the basic restriction used to limit the exposure to ELF electromagnetic fields. What are the magnetic field and electric field limits set by ICNIRP for the general public? Define the SAR unit used as the basic restriction for high frequency (RF) electromagnetic fields.