Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

GX 903

Spring Examinations, 2002/2003

Exam Code(s)	1MB2, 1MR1, 1HF1
Exam(s)	First Medicine First Science (Marine Science) First Science (Health & Safety Systems)
Module Code(s)	EP102
Module(s)	Experimental Physics
Paper No.	
Repeat Paper	Special Paper
External Examiner(s)	Prof. E.T. Kennedy
Internal Examiner(s)	Prof. S.G. Jennings Prof. P.W. Walton Dr. G. Gillanders
Instructions:	Answer all of Question 1 (30 marks) and THREE questions from the remainder (30 marks). This paper forms 70% of the overall subject mark. Use a separate answer book for Question 1. Numerical values of physical constants and relevant data are given at the end of the paper.
Duration	2 hrs
No. of Answer books	2
Requirements:	
Handout	
MCQ	
Statistical Tables	X Log tables
Graph Paper	
Log Graph Paper	
Other Material	
No. of Pages	5
Department(s)	

Q.1 **All parts carry 2 marks each.**

(a) A patient's temperature is measured as 38.0 °C to an accuracy of $\pm$0.2 °C using a pyroelectric ear thermometer. What is the percentage uncertainty in this measurement?

(b) State clearly which of the following are vectors and which are scalars: pressure, torque, temperature, power.

(c) During the Apollo 15 mission, astronaut David Scott released a hammer and a feather and watched them fall together to the moon's surface. If he had dropped them from a height of 1.0 m, how long would they have taken to fall to the surface? (Note: Take acceleration due to gravity at the moon's surface to be one sixth acceleration due to gravity at the earth's surface.)

(d) A 45 kg cheetah accelerates from rest to 27 m s^{-1} in 4.0 s. What is the average power required for this acceleration?

(e) On a cold day, 25 m^3 of air at 0 °C, and at atmospheric pressure, enters a room through an open window. How much heat is required to warm this air to 22 °C? (Note: Specific heat capacity of air = 1050 J kg^{-1} K^{-1}.)

(f) Convert a temperature of 103 °F to degrees Celsius.

(g) What is the net rate of heat transfer by radiation from an unclothed person standing in a dark room of temperature 25 °C. Assume the exposed skin has an area of 1.5 m^2, a temperature of 33 °C, and an emissivity of 1.00. (Note: Stefan's constant = 5.67×10^{-8} W m^{-2} K^{-4}.)

(h) How many moles of gas are contained in a room of volume 50.0 m^3 at a temperature of 20 °C and a pressure of 1 atmosphere?

(i) Explain what is meant by surface tension and give its SI unit.

(j) Calculate the period and the wavelength in air of a sound wave with a frequency of 264 Hz.

(k) What is the sound level in decibels of a sound intensity that is twenty times the hearing threshold intensity level?

(l) What work is done by a 1.5 volt battery when 0.2 coulombs of charge moves round an external circuit?

(m) What is the electrical resistance of a 2 kW electric fire when it is operated by the 220 volt mains supply?

(n) What is the speed of light in glass if its refractive index is 1.5?

(o) The nuclide $^{238}U_{92}$ decays to thorium with the emission of an alpha particle. Write down the decay equation.

Q.2 Derive the three formulae (known as the equations of motion) relating initial speed, final speed, distance traveled, acceleration, and time, for motion with uniform acceleration. (4 marks)

Modern cars are designed with "crumple zones" so that the front of the car compresses easily in a crash. With the aid of one of the equations of motion, explain why this design is safer in crashes than having cars with very stiff incompressible bodies. (2 marks)

Assuming that the maximum acceleration the human body can survive is 250 m s^{-2}, calculate the minimum distance the front of a car would have to compress so that a person could survive a 90.0 km h^{-1} crash with an immovable object. How long would it take a person firmly belted in a car seat to come to rest in such a crash? What force would be exerted by a seatbelt on a 70.0 kg driver during the crash? (4 marks)

Q.3 Explain clearly what are meant by the terms: gauge pressure, systolic pressure, and diastolic pressure. (1.5 marks)

Give a brief description of how blood pressure is measured using a sphygmomanometer. (3 marks)

Derive an expression for the gauge pressure at a depth h in a fluid, where the top surface of the fluid is at atmospheric pressure. (2.5 marks)

A very inexperienced medical student, measuring a patient's blood pressure, erroneously places the cuff of the sphygmomanometer on the patient's lower arm, so that the cuff is located 30 cm below heart level during the measurement. If the student records a maximum pressure during the patient's heart cycle of 150 torr, what is the patient's correct systolic pressure (expressed in torr)? (Note: Density of blood = 1060 kg m^{-3}) (3 marks)

Q.4 Outline the effects on the body of electric currents through the trunk (1 sec shock at the mains frequency) in the range of 1 mA to 6000 mA. (4 marks)

Using a diagram outline the operation of an electrical circuit breaker. (2 marks)

Draw a diagram showing how a three-pin plug is connected to an appliance that has a metal enclosure. Explain how the fuse and the earth connection provide electrical safety. (3 marks)

Why can a bird perch on a high voltage power line without being electrocuted? (1 mark)

Q.5 Explain the phenomena of total internal reflection with the aid of a diagram. (2 marks)

Derive the expression for the critical angle (θ_c) in terms of the refractive indices of the media. (2 marks)

Explain Snell's circle and calculate its radius as seen by a diver situated at a depth of 10 m below a flat surface of water. (3 marks)

Explain what is meant by a coherent bundle of optical fibres and show how it is used in a medical endoscope. (3 marks)

Q.6 Using a diagram, explain the operation of an x-ray tube. (4 marks)

Show the spectrum of x-rays produced by such a tube and explain the origin of the characteristic x-rays. (2 marks)

Explain the purpose and operating principles of intensifying screens and grids as used in clinical radiography. (4 marks)