

King's College London

UNIVERSITY OF LONDON

This paper is part of an examination of the College counting towards the award of a degree. Examinations are governed by the College Regulations under the authority of the Academic Board.

B.Sc. EXAMINATION

CP/1020 Basic Physics II

Summer 2000

Time allowed: THREE Hours

**Candidates must answer SIX parts of SECTION A,
and TWO questions from SECTION B.**

The approximate mark for each part of a question is indicated in square brackets.

Separate answer books must be used for each Section of the paper.

**You must not use your own calculator for this paper.
Where necessary, a College Calculator will have been supplied.**

TURN OVER WHEN INSTRUCTED
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Acceleration due to gravity = 9.8 m s^{-2}

SECTION A - Answer SIX parts of this section

- 1.1) What are the special names given to the SI units of force, energy and frequency? Express these units in terms of the fundamental SI units. [7 marks]
- 1.2) Explain briefly the meanings of *pitch*, *loudness* and *quality* when applied to sound waves. [7 marks]
- 1.3) Describe briefly the arrangement and behaviour of atoms in
(a) a crystalline solid and
(b) a monatomic gas. [7 marks]
- 1.4) Explain carefully the difference between *transverse waves* and *longitudinal waves*. Give one example of each type of wave motion. [7 marks]
- 1.5) Distinguish between a *perfectly elastic collision* and a *totally inelastic collision*. [7 marks]
- 1.6) Define the terms *mechanical advantage* and *velocity ratio* as applied to a machine. A worker uses a crowbar to lift a paving slab. The distance from the point of contact of the crowbar with the slab to the fulcrum is 20 cm, while the worker holds the bar at a distance of 1.2 m from the fulcrum. Estimate the mechanical advantage of the crowbar for this application. [7 marks]
- 1.7) Explain the meaning of *viscosity* when applied to fluid flow, and show how the *coefficient of viscosity* is defined. [7 marks]
- 1.8) Give a brief description of the phenomenon of *natural radioactivity*. [7 marks]

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SECTION B - Answer TWO questions

- 2) Explain the meaning of *surface tension* as applied to a liquid, taking care to include the units in which it is measured. What is meant by the *angle of contact* between a liquid and a solid surface?

[7 marks]

The angle of contact between water and clean glass is 0° , while that between mercury and clean glass is 140° . Use this information to describe, with clearly-labelled diagrams, the behaviour of the liquids when (a) drops of the two liquids are placed on a clean glass surface and (b) open-ended capillary tubes are partially immersed in the bulk liquids.

[8 marks]

Describe an experiment using capillary tubes to determine the surface tension of water. Show clearly, with appropriate analysis, how you would use the results of your experiment to obtain a value for the surface tension.

[15 marks]

- 3) Explain the meanings of the terms *exposure*, *absorbed dose* and *dose equivalent* as used in discussions of radiation therapy and diagnosis, being sure to include the modern units in which each is measured. What are the relationships between the physical parameters described by the three terms?

[12 marks]

Describe the structure and method of operation of a Geiger counter. What are the advantages and limitations of the instrument when used in the detection and measurement of radiation?

[12 marks]

Using a Geiger counter, the activity of a particular radioactive sample of ^{128}I is found to be 390 Bq. One hour later, the activity of the same sample is 70 Bq. Determine the decay constant of ^{128}I .

[6 marks]

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- 4) Describe the construction and mode of operation of a transducer for the generation and detection of ultrasound.

[10 marks]

In the use of ultrasound for non-invasive examination of the human body, *impedance matching* is an important aspect of the procedure. Explain what is meant by *impedance matching*, why it is important in medical procedures involving ultrasound and how it is achieved in practice.

[10 marks]

Describe the Doppler effect in relation to ultrasound. Explain how this effect is used in the assessment of blood flow in the body.

[10 marks]

- 5) Describe the three main processes by which heat is lost from a body.

[12 marks]

Describe the construction and operation of the following thermometers:

- (a) mercury-in-glass;
- (b) a thermocouple.

[12 marks]

A $3\text{ m} \times 3\text{ m}$ square plate glass shop window is 2 cm thick. If the temperature inside the shop is 23°C , while that outside is -2°C , calculate the rate at which heat is lost through the window. (Thermal conductivity of glass = $1\text{ W m}^{-1}\text{ K}^{-1}$.)

[6 marks]