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 2

Summer 1998

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

Acceleration due to gravity at surface of the Earth = 9.8 m s^{-2}

Section A - Answer **SIX** parts of this section

1.1) What is meant by the *surface tension* of a liquid? Explain briefly the role played by surface tension in the action of a surfactant in the human lung.

[7 marks]

1.2) What is meant by *radioactivity*? Indicate the character of each of the following emissions from radioactive materials: α-, β- and γ-radiation.

[7 marks]

1.3) Describe briefly the arrangement and relative movement of atoms in (a) a crystalline solid,
(b) an atomic liquid and (c) a monatomic gas.

[7 marks]

1.4) Explain the terms *load, effort* and *mechanical advantage* when applied to a machine, using a lever to illustrate your answer.

[7 marks]

1.5) What is the basic requirement needed for a sound wave to propagate? Explain briefly how the wave is propagated. Write down an equation to describe the wave, explaining the meaning of each term.

[7 marks]

1.6) What is meant by each of the following physical quantities: *force, work, potential energy* and *kinetic energy*? Give the units in which each is measured.

[7 marks]

1.7) Write down an expression for the energy needed to heat a solid of mass *m* and specific heat capacity *c* from a temperature T_1 to a temperature T_2. Hence determine the heat energy needed to raise the temperature of 10 g of water from 15°C to 40°C. (Specific heat capacity of water is 4218 J kg^{-1} K^{-1}.)

[7 marks]

1.8) Explain the principles by which the ideal gas scale of temperature may be established.

[7 marks]

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Section B - Answer **TWO** questions from this section

2) State the principles of (a) the conservation of mechanical energy and (b) the conservation of linear momentum. Under what conditions do these principles apply?

[10 marks]

A railway truck of mass *M* moves with a velocity *v* along a straight track and collides with a stationary truck of mass *m*. If the impact is perfectly elastic, show that, after the collision, the velocity of the truck of mass *M* is $\frac{M-m}{M+m}v$ while that of the truck of mass *m* is $\frac{2M}{M+m}v$. (Assume that the trucks remain on the track and neglect the effects of friction and air resistance.)

[15 marks]

From the above results explain what happens if the trucks are of equal mass.

[5 marks]

3) Explain the meaning of *viscosity* as applied to fluid flow.

[5 marks]

Stokes' Law states that the viscous drag force *F* exerted on a sphere of radius *r* moving with velocity *v* through a fluid with coefficient of viscosity η is given by:

$$F = 6\pi r\eta v .$$

Describe an experiment to determine the coefficient of viscosity of a liquid based on this law and explain how the results are used to determine the coefficient of viscosity.

[15 marks]

The terminal velocity of a steel sphere, of radius 3 mm, dropped to fall vertically under the influence of gravity in a container of glycerin at 6°C is found to be 20 mm s^{-1}. Determine the coefficient of viscosity of the glycerin. The glycerin is heated to 30°C, when the terminal velocity of the same sphere is 200 mm s^{-1}. Determine the coefficient of viscosity of glycerin at 30°C. (Density of steel = 8000 kg m^{-3}; density of glycerin = 1300 kg m^{-3} The variation in the densities of steel and glycerin with temperature can be neglected.)

[10 marks]

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4) Give an account of the three heat transfer processes by which a body loses thermal energy.

[20 marks]

What is meant by a *Black Body* as applied to thermal energy. A body (which can be assumed to have black body characteristics) with a surface area of 1.5 m^2 and a temperature of 300°C is in an environment of temperature 20°C. Determine the initial rate at which heat is lost by radiation from the body.
(Stefan-Boltzmann constant = 5.67×10^{-8} W m^{-2} K^{-4}.)

[10 marks]

5) Give a brief description of a transducer which can both generate and detect ultrasound.

[10marks]

Ultrasonic pulses from the transducer are directed towards a moving surface within the human body. The reflected signals undergo a Doppler shift. Give a qualitative explanation of this phenomenon.

[10 marks]

Explain how ultrasound can be used

(a) to measure the depth of tissues in the human body;

[5 marks]

(b) to produce an image of tissues in the human body.

[5 marks]

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