

**HONG KONG ADVANCED LEVEL EXAMINATION**  
**AL PHYSICS**  
**1990 Essay Type Question**

1. (a) Describe simple harmonic motion (s.h.m.). (2 marks)
- (b) A simple pendulum consisting of a weight suspended vertically by a string, of length  $l$ , attached to a fixed point is set in motion in a vertical plane, the amplitude of oscillations being small. Show that the motion is simple harmonic and write down expressions for the displacement, velocity and acceleration of the weight after a time  $t$ . Sketch the variations of potential and kinetic energies with time. (6 marks)
- (c) Describe an experiment to verify that such a pendulum undergoes s.h.m. (6 marks)
- (d) A student decides to use the oscillation of such a pendulum to obtain a value for the free-fall acceleration due to gravity. Without describing this experiment, critically discuss TWO possible sources of error in your measurement. (2 marks)
2. (a) Distinguish between heat and internal energy and explain their connection with the temperature of a body. (3 marks)
- (b) Briefly discuss the differences in physical nature between the internal energy for a gas and a solid. (4 marks)
- (c) Describe the use of a constant volume gas thermometer to accurately measure temperature, and explain how this leads to the concept of an absolute zero temperature. (7 marks)
- (d) Explain why there may be disagreement in temperature measurements between thermometers using different physical thermometric properties. (2 marks)
3. (a) Explain the formation of stationary waves along a stretched wire which vibrates with a frequency  $f$  and is fixed at both ends, giving graphical representations of the motion amplitude at different positions along the wire corresponding to time intervals of  $1/(4f)$ . What are the appropriate conditions for such stationary waves to occur? (5 marks)

(b) Suggest a possible experimental method for demonstrating such stationary waves and determining the necessary conditions. (2 marks)

(c) Using this as an example explain the meaning of resonance. Briefly explain how such a phenomenon could occur and be observed in

(i) an a.c. electrical circuit, and

(ii) atoms.

[No theoretical derivations required.] (9 marks)

4. (a) Two long parallel wire, each of length  $l$  and separated by a distance  $d$ , carry a current  $I$  in the same direction. Draw a diagram of this arrangement and on it show

(i) the magnetic field at each wire due to the other, and

(ii) the corresponding forces.

giving their magnitudes. (3 marks)

(b) How may a similar arrangement be used to define the ampere unit of current? (1 mark)

(c) Using suitable diagrams, explain the working of a simple d.c. motor, where the magnetic field is produced by a permanent magnet. (4 marks)

(d) For this motor explain, in detail, the observed sequence of physical effects of

(i) switching it on with no mechanical load and,

(ii) after a while, applying such a load.

(8 marks)

5. (a) Compare the production and maintenance of electrical current flow in a circuit formed by the connection of

(i) a resistance, and

(ii) a heated cathode diode,

across a variable d.c. voltage power supply.

What are the main effects of varying the output voltage? All physical processes involved should be explained. (9 marks)

- (b) Explain the use of an electron beam in a cathode ray oscilloscope. Give a diagram showing the d.c. electrical connections but no details of the beam focussing or electronic circuits are expected. (5 marks)
- (c) Suggest a possible hazard of sitting too near a colour television, giving a brief explanation. (2 marks)
6. (a) Derive an expression for the force experienced by an object of mass  $m$  which is rotating with angular velocity  $\omega$  around a circular path of radius  $r$ , in the absence of any gravitational field. (4 marks)
- (b) In a laboratory a small weight is attached by a piece of string of length  $l$  to a fixed point and set into circular motion in a horizontal plane. Derive an expression for the angle of inclination of the string with the vertical, explaining what happens as  $\omega$  is increased to a high value. (3 marks)
- (c) A closed tube containing a mixture of two liquids of densities  $\rho$  and  $\rho'$  ( $\rho > \rho'$ ) is attached at the end by a hinge (allowing vertical motion) to a rigid rod. If this rod, and also the tube, is rapidly rotated in a horizontal plane with an angular velocity  $\omega$ , compare the excess forces on a small elemental volume  $A\Delta r$  of each liquid at distance  $r$  from the centre of motion ( $A$  being the area of cross-section of the tube). Hence explain the action of a centrifuge. (5 marks)
- (d) A student argues that there is no need to use a centrifuge to separate the two liquids since if the mixture is just left stationary they will separate under the force of gravity. Compare the excess forces using each method and comment on the statement of the student. (4 marks)

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