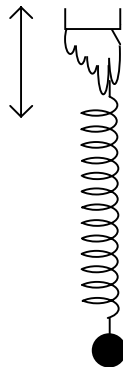


**HONG KONG ADVANCED LEVEL EXAMINATION
AL PHYSICS
1986 Essay Type Question**

1. (a) From a consideration of the flow of a liquid through a narrow tube, define the coefficient of viscosity in terms of the internal frictional force and determine its unit.
 - (b) Explain how you would compare the viscosities of two liquids, deriving any mathematical relations required (Stokes' Law may be assumed). Briefly indicate any necessary precautions or procedures for improving the accuracy of your measurements.
 - (c) Explain the physical effects on your experimental measurements as the sizes of the ball-bearings were increased until their diameter became similar to that of the liquid container.
 - (d) Distinguish between Newtonian and Non-Newtonian liquids, regarding their viscous behaviour, and give one example of each.
2. (a)



- A spring is held vertically with a weight, attached to its lower end. It is made to oscillate vertically by a periodic up-and-down motion of the hand. On increasing the frequency of motion of the hand, it is observed that the amplitude of motion of the weight increases, becoming a maximum at a certain frequency. Give a brief qualitative explanation of this observation. As the frequency of motion of the hand increases, what other observations can be made about the phase between the driving force and the motion of the weight?
- (b) Consider the analogous physical system of an a.c. circuit, consisting of a coil and capacitor connected in series with a.c. voltage generator and, from first principles, derive the corresponding observable effects.

- (c) Give one practical example each of resonance (either mechanical or electrical) which is
- (i) useful,
 - (ii) undesirable.
3. (a) Explain, by using wave-front diagrams, how the wave theory of light is able to explain
- (i) the refraction, and
 - (ii) the dispersion
- of a narrow light beam incident upon the interface of two different optically transparent media.
- (b) Draw a diagram showing the ray paths through a prism spectrometer when a line spectrum is observed, and explain the necessary optical adjustments of the collimator and telescope.
- (c) Suggest possible advantages of replacing the prism by a diffraction grating.
4. (a) Using the rotating coil of a simple d.c. motor as an example, describe, with the aid of a diagram, the force effects of a magnetic field on an electrical current. (Details of the commutator are not required.)
- (b) Briefly explain electrical conduction in metals.
- (c) Account for the production of a Hall voltage when a thin strip of a conducting material, carrying a current, is placed in a magnetic field.
- (d) Derive an expression for the Hall voltage and indicate the various physical factors which may be adjusted to ensure
- (i) high sensitivity, and
 - (ii) good spatial resolution
- in a Hall probe used for measuring magnetic fields.

5. (a) Compare the physical means of production of electromagnetic waves by

(i) a gas discharge tube, and

(ii) an X-ray tube.

Describe the main differences between the emitted spectra and how these can be explained by the different internal atomic processes which occur.

(b) Briefly indicate how X-rays may be used to determine the separation of atomic planes in a crystal.

6. (a) Consider a satellite of mass m moving in a circular orbit of radius r around an assumed homogeneous spherical earth of mass M and radius R .

(i) Show that the period T of the satellite for a complete orbit is proportional to $r^{3/2}$.

(ii) Derive an expression for the total energy of the satellite in terms of the given parameters, together with G , the gravitational constant.

(b) Due to the friction of the earth's atmosphere the satellite experiences a drag force $C\rho v^2$, where ρ is the density of the atmosphere and v is the speed of the satellite, C being a constant.

(i) Explain why the speed v of the satellite would be expected to increase with time, t .

(ii) From a consideration of the work done by the drag force and the rate of loss of energy of the satellite, show that $dr/dt = -2\rho Cvr/m$.

(iii) Assuming that (dr/dt) changes slowly and may be considered constant over one orbit show that the small fractional change in period time is given by $\Delta T/T = -6\pi\rho Cr/m$.

(iv) Describe the path taken by the satellite, explaining what, finally, should happen to it.

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