

HONG KONG ADVANCED LEVEL EXAMINATION
AL PHYSICS
1995 Essay Type Question

1. (a) In each of the following situations, use Newton's law of motion to explain whether or not a net force is acting on the body. If no net force is acting, describe how the forces are balanced. If a net force is acting, explain the origin of the net force and state its direction.

(i) A raindrop which falls at terminal speed.

(ii) A ping pong ball which collides obliquely with a smooth wall.

(iii) A communications satellite which maintains a constant position above the earth's surface.

(8 marks)

(b) A rubber ball is dropped freely from a certain height onto a horizontal floor. It rebounds to the same height after each bounce. In terms of the force acting, state two ways in which the motion, although periodic, differs from simple harmonic motion. (4 marks)

(c) (i) For a planet revolving round the sun in a circular orbit of radius r and with period T , show that $r^3 = KT^2$ where K is a constant.

(ii) Is the equation $r^3 = KT^2$, with the same constant K for the planet, also valid for a satellite circling round the earth? Explain briefly. (4 marks)

2. (a) In terms of the kinetic theory model of gases, explain:

(i) what an ideal gas is,

(ii) how gases exert pressure on the walls of their containers,

(iii) why compressing a gas increases its temperature.

(7 marks)

(b) Explain why some of the assumptions of the kinetic theory of an ideal gas could not be applied to real gases at high pressures or low temperatures. (4 marks)

(c) Quantitatively, the first law of thermodynamics can be stated as:

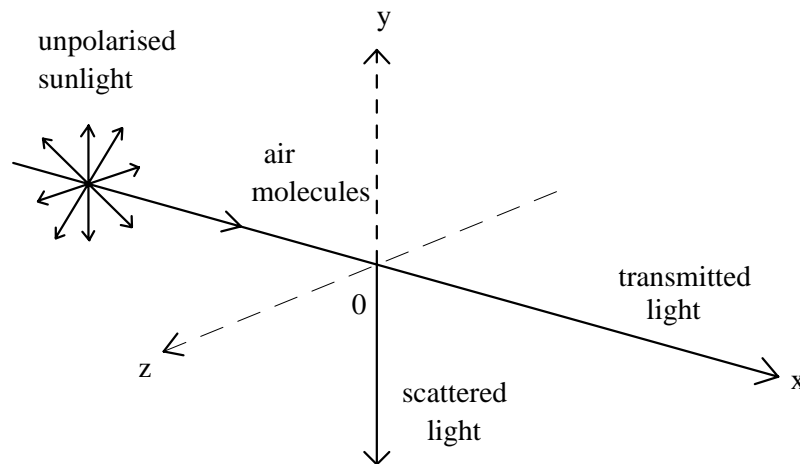
$$\Delta Q = \Delta U + \Delta W$$

- (i) Explain this relationship in words.
- (ii) 'A compressed gas in a hollow, steel cylinder expands and lifts a weight; it cools in the process and is then heated by conduction through the cylinder.'

Describe the above change in terms of the first law of thermodynamics and hence explain whether you can determine that there has been any change in internal energy of the gas.

(5 marks)

3. (a) Unpolarised sunlight is incident horizontally on air molecules around O in the earth's atmosphere. Part of the light is transmitted horizontally and part is scattered vertically downward.



Briefly explain which ray, the transmitted one or the scattered one, is plane polarised and give the direction of the electric field vector for this ray. Describe a method to identify this polarised light ray. (5 marks)

(b) Give an account of an everyday example involving polarised light. (3 marks)

(c) (i) State two differences between laser light and light emitted by a light bulb.

(ii) What is meant by 'population inversion'? How do gas lasers rely on this to operate?

(iii) State and explain two advantages of using laser for cutting over mechanical devices.

(8 marks)

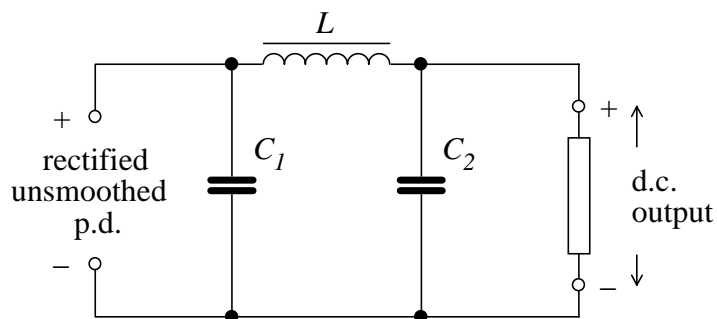
4. (a) With the aid of a circuit diagram, briefly describe how a reed switch works in investigating the dependence of the charge stored in a parallel-plate capacitor on

- (i) the area of overlap of the plates, and
- (ii) the separation between the plates.

Show graphically the expected results. (8 marks)

- (b) What is the physical meaning of the reactance of a capacitor? On what factors does the reactance of a capacitor depend? (2 marks)

- (c) Briefly explain the actions of the two capacitors and the inductor in the following smoothing circuit. (6 marks)



5. (a) Describe an experiment for measuring the wavelength of monochromatic light using a spectrometer and a diffraction grating with a known grating spacing. (4 marks)

- (b) A spectrometer together with a diffraction grating can also be used to observe the line emission spectrum from a hydrogen discharge tube.

- (i) Explain why hydrogen atoms emit light only of discrete wavelengths.
- (ii) How does this kind of spectrum differ from a line absorption spectrum? Explain how an absorption spectrum can be formed.

(5 marks)

- (c) (i) Sketch a graph of a typical X-ray spectrum, and explain how the characteristic and continuous parts of the spectrum are formed.

- (ii) Why is there a definite minimum wavelength of the X-rays produced?

(7 marks)