

**HONG KONG ADVANCED LEVEL EXAMINATION**  
**AL PHYSICS**  
**1981 Structural Question**

1. A small object is tied to the end of an elastic cord of unstretched length 1 m and then whirled around in a horizontal circle of radius 1.1 m with angular velocity 3 rad/s.
  - (a) The angular velocity is now increased. Calculate its value when the radius of the circle is 1.2 m, assuming that the cord obeys Hooke's Law at all times.
  - (b) If the centripetal force is 1 N when the radius is 1.1 m, calculate the total energy transferred to the rotating system during the increase in radius to 1.2 m. (8 marks)
  
2. Two identical spherical raindrops of radius 0.10 mm falling vertically with the same terminal velocity 1.21 m/s coalesce to form a single spherical drop. For rainwater the surface tension =  $7.5 \times 10^{-2}$  N/m while its density =  $10^3$  kg/m<sup>3</sup>.
  - (a) Calculate the radius  $a$  of the newly formed raindrop.
  - (b) Determine the terminal velocity  $V_T$  of the large drop. (Neglect the upthrust of the air.)
  - (c) Calculate the total energy  $E$  of his falling drop just before it hits the ground (assuming its potential energy to be zero).
  - (d) Assuming no loss of energy in the form of heat, show whether this drop on impact with the ground will be able to split up into two spherical drops identical to the two initial raindrops. (8 marks)

3.

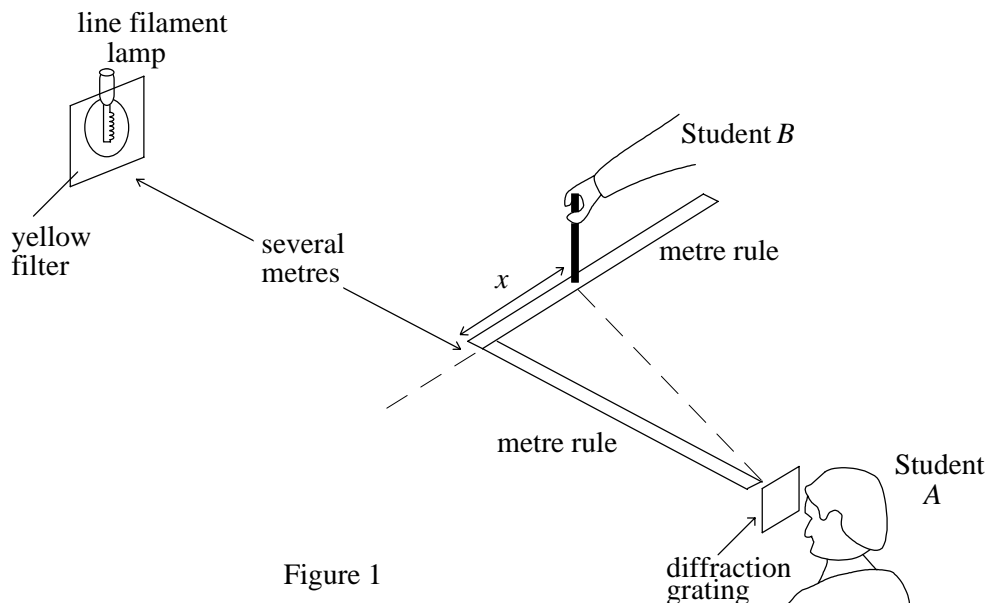
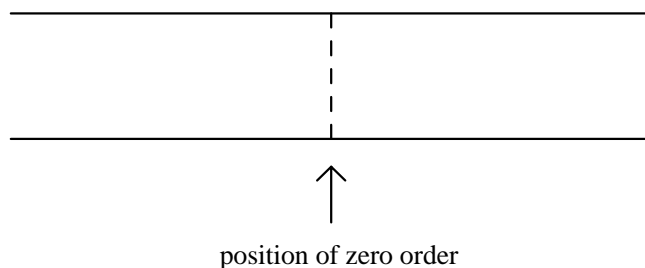


Figure 1

Student A views a line filament lamp covered with a yellow filter through a diffraction grating with its lines parallel to the filament (Figure 1). The grating is held at one end of a metre rule which is aimed at the lamp. At the other end of the metre rule, a second rule is placed at right angles to the first rule.

- (a) Student A asks student B to move a pencil held vertically along the second rule and tells him to stop when it coincides with the yellow band in the first image of the lamp as seen through the grating. If the distance between the first rule and the pencil is  $x = 0.37$  m (see Figure 1) and the diffraction grating has  $6.0 \times 10^5$  lines per metre, calculate the wavelength of the yellow light.
- (b) If student B keeps moving the pencil along the second metre rule in the same direction, how many more yellow bands will be encountered? Explain.
- (c) If the filter is removed, sketch the full pattern seen by student A on both sides of the filament, in the space below. Label significant features.



(8 marks)

4. A student is asked to perform an experiment to demonstrate that the charge on a capacitor is proportional to the p.d. across its terminals. The circuit to be used is shown in Figure 2.

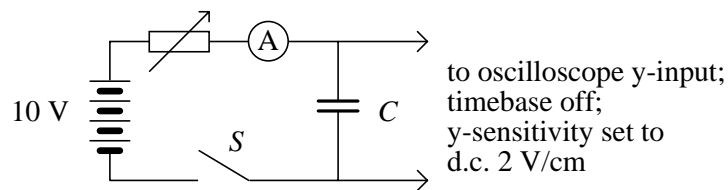


Figure 2

The principle of the experiment is to close switch  $S$  and charge the capacitor linearly by continuously adjusting the variable resistor to keep the current in the circuit constant at its initial value. The p.d. across the capacitor will therefore increase linearly with time, and a graph of the deflection of the oscilloscope spot in the  $y$ -direction against time will be a straight line.

- (a) The student decides that it would be most convenient to start with the variable resistor set to its maximum value of  $100 \text{ k}\Omega$  and to use an ammeter which he can maintain at full scale deflection when the switch is closed. What should be the full scale deflection of the meter?
- (b) Having selected his meter, the student considers the deflection of the oscilloscope spot. He decides that he will be able to time a deflection rate of  $0.1 \text{ cm/s}$  satisfactorily. What value of  $C$  should he choose?
- (c) What will be the value of the variable resistor  $10 \text{ s}$  after closing the switch  $S$ ?

(8 marks)

- 5.

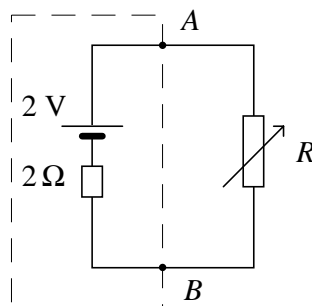
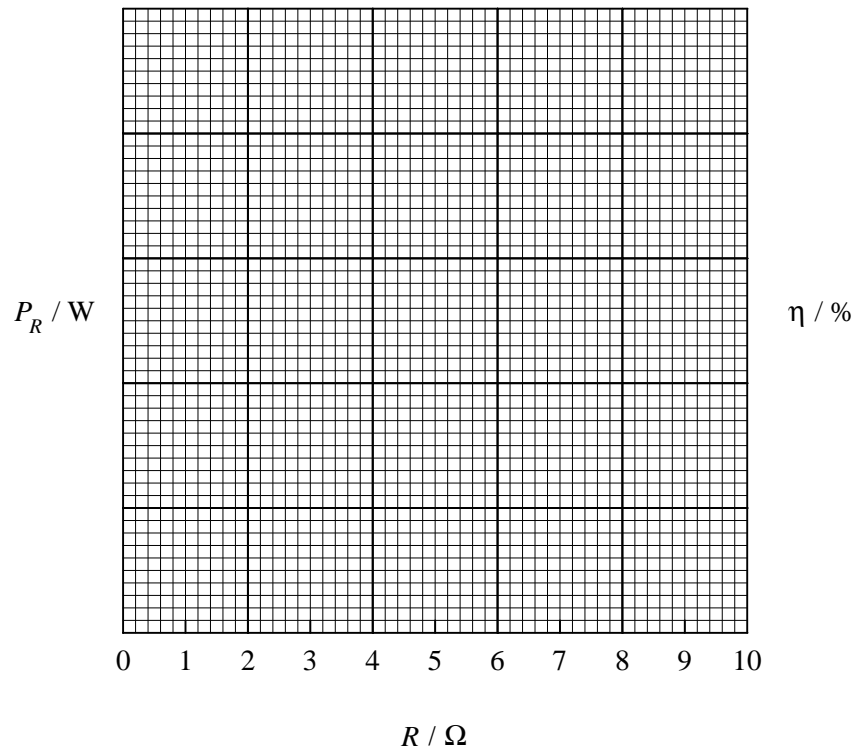


Figure 3

A variable resistance  $R$  is connected across the output terminals,  $A$  and  $B$ , of a box containing a battery of e.m.f.  $2\text{ V}$  and internal resistance  $2\ \Omega$ .

- (a) Plot the variation of the power,  $P_R$ , dissipated in the resistance  $R$  as it is varied from zero to  $10\ \Omega$ .
- (b) On the same graph, plot the corresponding variation of efficiency of power transfer,  $\eta$ , from the cell to the resistance  $R$ . In both cases, give scales.



- (c) Determine the potential difference across  $R$  when  $\eta = 75\%$ . (6 marks)

6. Three physics students suggest the following different theories of radioactive decay.

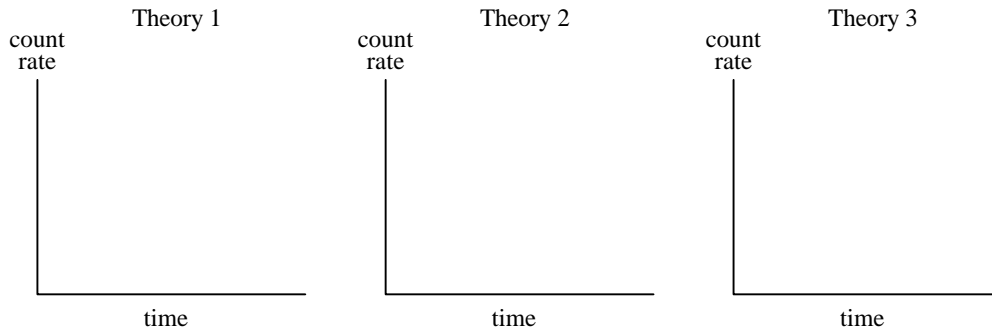
Theory 1 Radioactive atoms have the same expected lifetime though there are slight statistical variations from atom to atom in practice.

Theory 2 All atoms have the same constant chance of disintegrating. Decay of atoms is completely random, so that the number of disintegrations per second depends only on the number left.

Theory 3 Different atoms have different lifetimes. A particular atom may have a lifetime from practically zero up to a certain maximum life.

These possible lifetimes are distributed at random amongst the atoms.

- (a) Draw a sketch graph of the probable behaviour of the count rate from a newly-formed radioactive substance with time predicted by each theory.



- (b) Which theory is correct? Give a reason for your choice. (8 marks)

7.

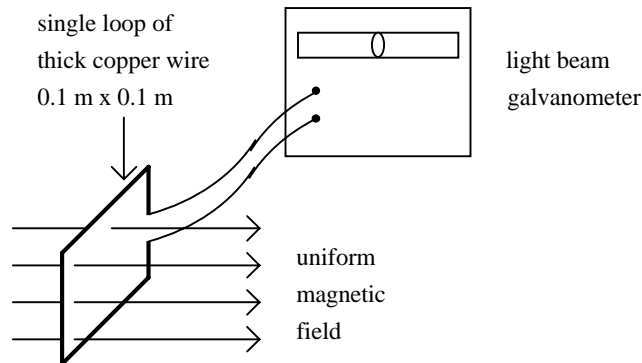


Figure 4

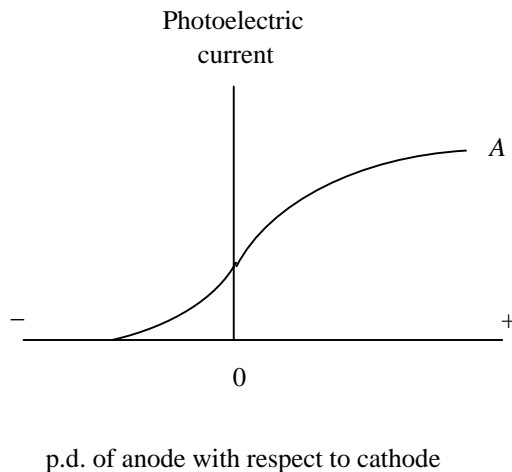
A light beam galvanometer of sensitivity  $20 \text{ mm}/\mu\text{A}$  and resistance  $13 \Omega$  is connected in series with a single loop of thick copper wire of negligible resistance bent into a square of side  $0.1 \text{ m}$  (Figure 4). The coil is perpendicular to a magnetic field which can be assumed uniform throughout the area of the coil and zero elsewhere.

- (a) The field is reduced to zero at a rate which maintains the galvanometer deflection steady at  $60 \text{ mm}$ . Calculate this rate.
- (b) The field is restored to its original value and kept constant while the coil is removed from the field vertically at a constant rate. If it takes  $10 \text{ s}$  to remove the coil

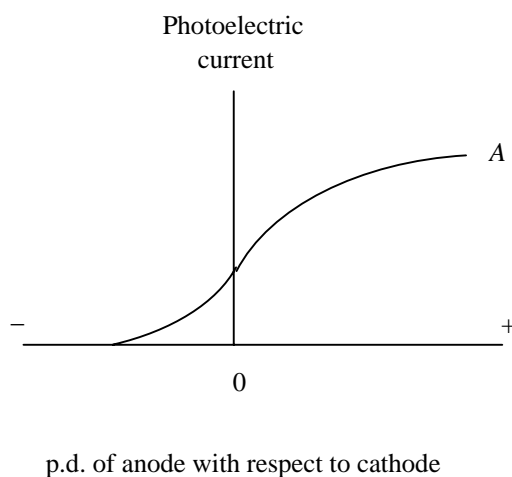
completely from the field while maintaining the same steady 60 mm galvanometer deflection, calculate the field strength. (6 marks)

8. In an experiment using a photoelectric cell, the photoelectric current was measured as a function of the potential difference of the anode with respect to the cathode.

- (a) Curve *A* below shows the result when monochromatic light of constant intensity was used to illuminate the photocathode. Sketch to scale the curve you would expect to obtain if the intensity of the light were halved. Label your curve *B*.



- (b) State one way in which curves *A* and *B* contradict the wave theory of light, explaining clearly why.
- (c) Curve *A* is shown again below. Sketch the form of the curve you would expect to obtain if light of the same intensity but double the frequency were used. Label your curve *C*.



(8 marks)