

GCE ADVANCE LEVEL
PHYSICS
2004 PAPER 2

JUNE 2004

SECTION I

Answer all questions in this section

1. Figure 1 shows a point charge of value -25nC at the center of an earthed hollow metal shell.

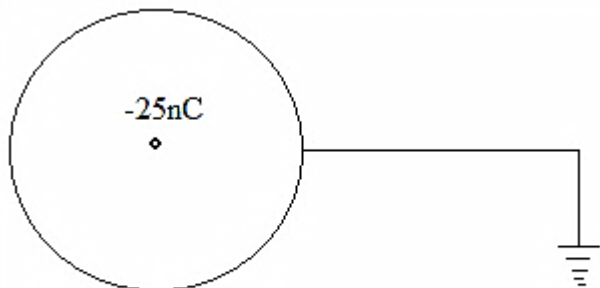


Figure 1

- (i) Copy the diagram and show the charge distribution on the shell. Explain your diagram
 - (ii) Sketch a diagram to show how the electric field intensity varies with distance from the point charge.
2. Figure 2 shows a body of mass 4.0 kg being raised by two unequal forces of 25 N and 40 N . The 25 N force acts at an angle of 30° to the vertical and the 40 N acts at an angle of 60° to the vertical.

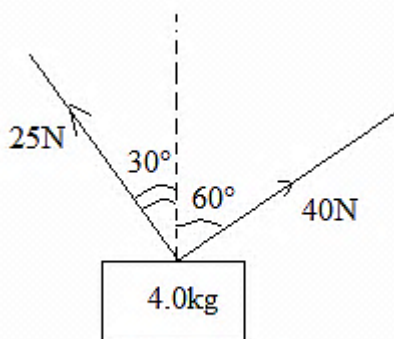


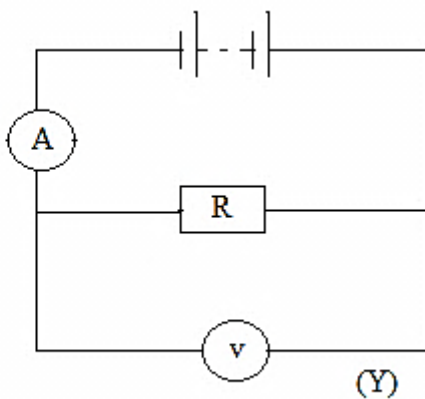
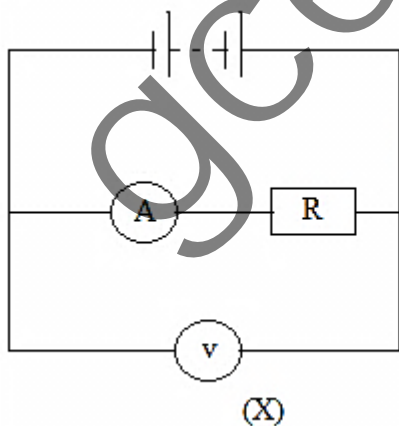
Figure 2

Calculate the acceleration of the body.

3. (a) Figure 3 shows how two circuits which could be used to determine the resistance of conductor.

State and explain which circuit could be appropriate to determine the resistance R , for

- (i) Large R .
- (ii) Small R .



- (b) Describe how you would use a C.R.O to measure time.

4. A close pipe contains air at 24°C . If the fundamental note emitted from the pipe is 512Hz , determine the length of the pipe. (the speed of sound in air at 0°C is 340ms^{-1} .)

5. Figure 4 shows a simple pendulum bob of mass 50g displaced to a height of 1.5cm above the equilibrium.

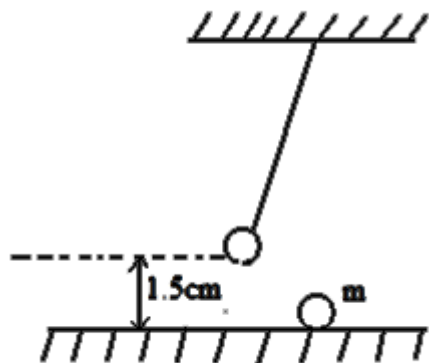


Figure 4

When the bob is release, it makes an elastic head on

collision with a body of mass $m = 50\text{g}$ placed at the equilibrium position.

(i) Calculate the velocity of the body after collision.

(ii) If the body moves a distance of 50cm before coming to rest, calculate the frictional force acting on the body.

6. (a) Draw a block diagram of the major components of a hydroelectric plant. Explain the role of each component.

(b) Outline two environmental hazards associated with a hydroelectric plant.

7. (a) Define the term half-life as used in radioactivity.

(b) The half-life of carbon 14 is 5730 years. If count rate of carbon-14 in 2kg of living bone is 3×10^4 per minute, determine the count rate in 0.3kg of an ancient bone that is 25000 years old.

SECTION II (one and half hour)

Answer either 8(a), (b) and (c) or (d), (e) and (f).

8(a), (b) and (c)

8. (a) Forces could be classified as *contact forces* or *action at a distance forces*. Explain the meaning of the phrases in italics giving one example of each.

(b) Describe an experiment to describe the acceleration due to gravity of a body undergoing free fall.

OR 8(d), (e) and (f)

(a) Waves may be classified either as *transverse and longitudinal* or *mechanical and electromagnetic*.

Explain giving one example in each case, of the terms in italics.

(b) Describe an experiment to measure the velocity of sound in free air.

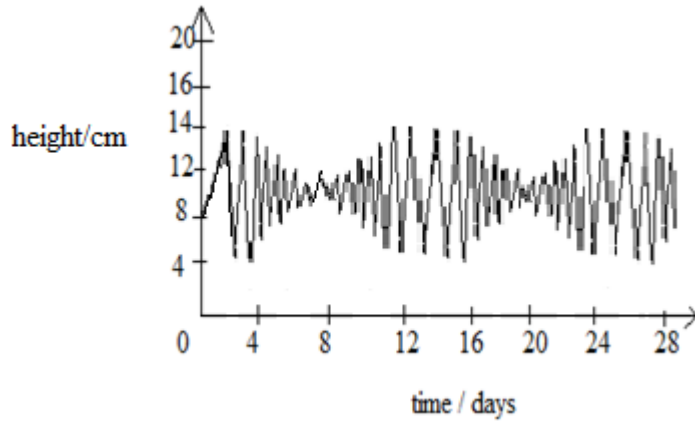


Figure 5

(c) Figure 5 shows a graph of the variations of the height of tides with time at a particular harbor. The variations in height could be regarded as a result of the superposition of two waves.

Estimate the amplitude and frequency of the resultant waves.

Answer either 9(a), and (b) or 9(c) and (d)

EITHER 9(a),(b)

9. (a)(i) Distinguish between self-induction and mutual induction

An inductor with an iron core is connected in series with a millimeter and a 1.5V supply. Figure 6 shows the way the current varies with time when the switch is closed.

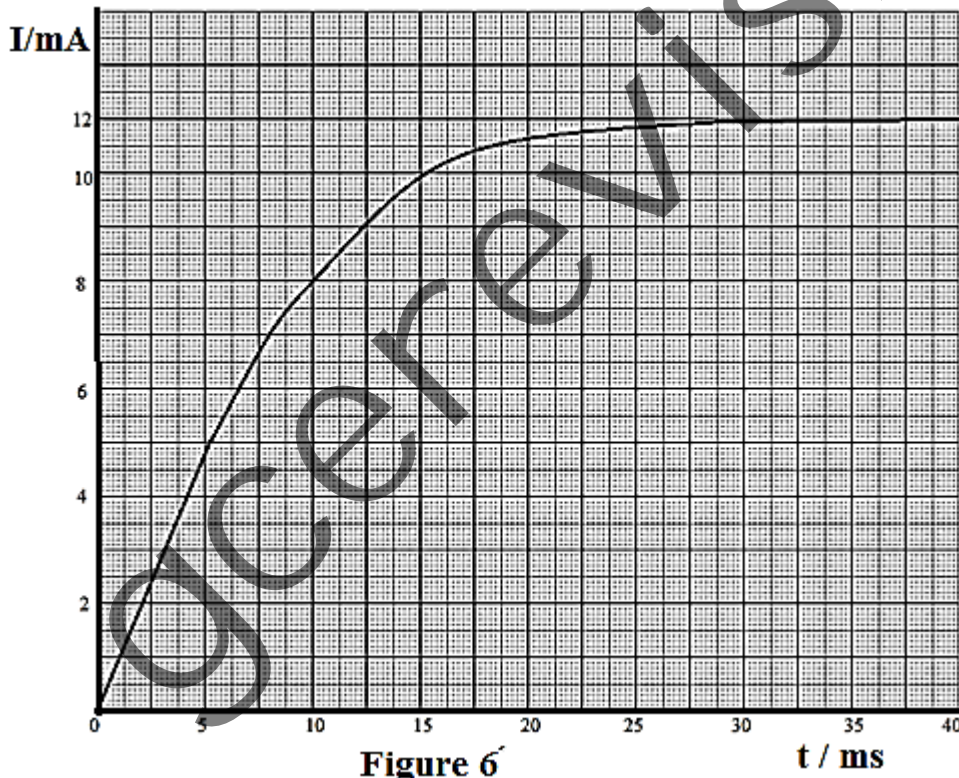


Figure 6

(ii) Sketch a circuit diagram from which such results could have been obtained.

(iii) How long does it take for the current to reach its maximum value?

(iv) How would the graph in figure 6 be modified, if a resistor replaced the inductor?

(b) (i) In an experiment to investigate the behavior of a charge on a small insulated charged ball of mass 50g, the ball is suspended by an insulated thread between two vertical and parallel plates which are 5cm apart. When a potential difference of 600V is applied between the plates, the ball is pulled such that the thread makes an angle of 60° to the horizontal.

(ii) Sketch a diagram showing all the forces acting on the ball. State the origin of these forces with respect to the fundamental forces.

(iii) Calculate the electric charge on the ball.

OR 9(c),(d) and (e)

(c)(i) Distinguish between potential difference and electromotive force.

In an experiment to determine the internal resistance of a cell, current through the cell was made to vary with the voltage across the cell as shown in figure 7.

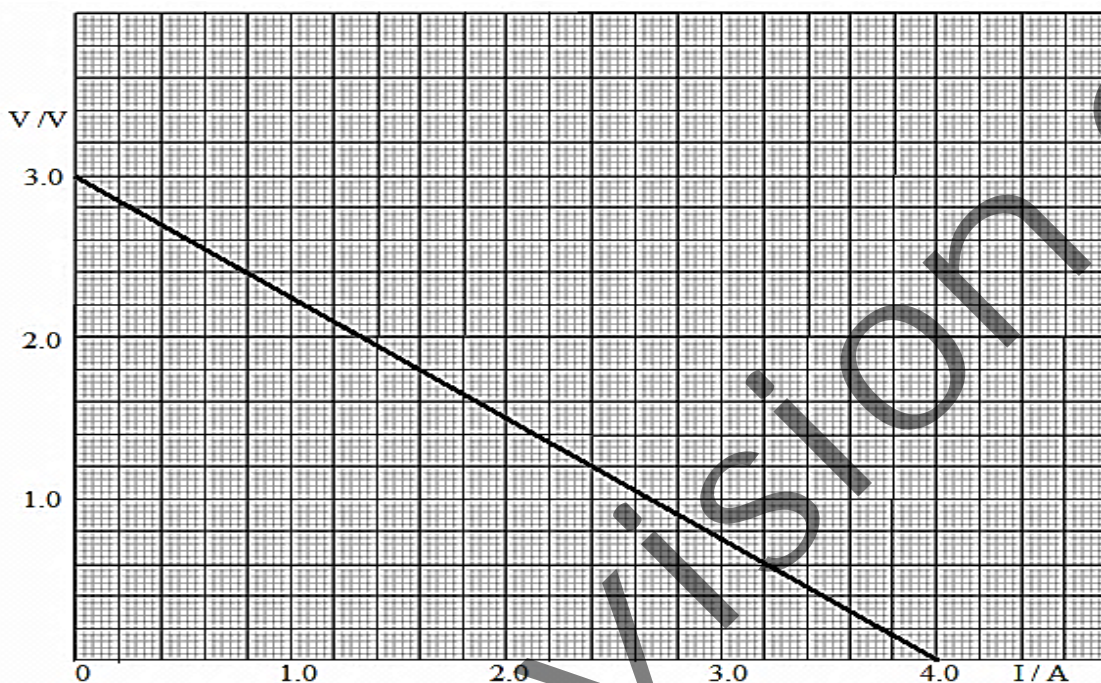


Figure 7.

(ii) Sketch a circuit diagram from which such results could have been obtained.

(iii) Determine using the graph of figure 7 values for the

(a) e.m.f of the cell,

(b) internal resistance of the cell

(d) A heating coil of power 10W is required when the p.d. across it is 20.0V. Estimate the length of the copper wire that would be needed to make the coil, if its cross sectional area is $1.0 \times 10^{-7} \text{m}^2$ and its resistivity is $1.0 \times 10^{-6} \Omega \text{m}$.

(e) How much would it cost to use the coil in (d) for thirty days if AES-SONEL charges 60 frs per kWh.

Answer Either 10(a),(b) and (c) or (e),(f),(g),(h)

EITHER 10(a),(b) and (c)

10. (a) Figure 8 shows a circuit diagram that can be used to measure the charge on a conducting sphere by transferring the charge to the capacitor.

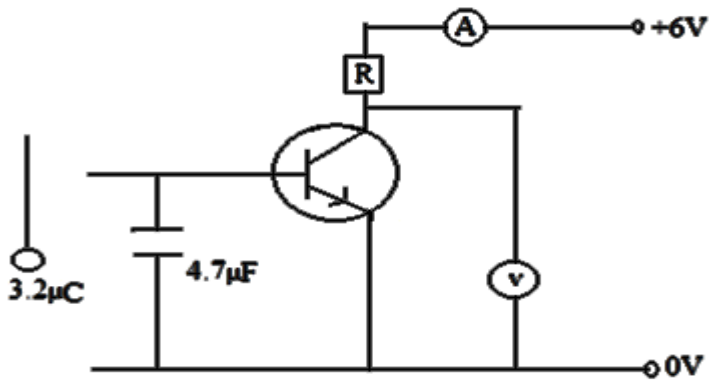


Figure 8

- (i) What is the reading of the ammeter, if the base-emitter voltage is 0.6V?
 - (ii) What is the reading of the voltmeter, if the voltage gain is 20?
- (b) An LED is mounted on the dashboard of a car and is used as an indicator for a car alarm. The car battery supply is 12V and the LED requires 10mA to run correctly. What is the value of the protective resistance needed for the correct functioning of the LED?
- (c) Figure 9 shows a basic circuit that can be used to provide a back-up energy source for a solar powered wrist watch.

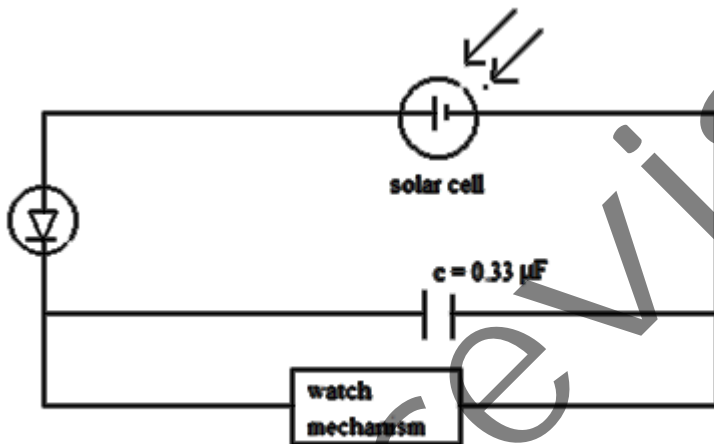


Figure 9

In direct sunlight the solar cell supplies power to the watch mechanism and charges the capacitor C to a voltage $V = 2.4\text{V}$. Calculate

- (i) the charge stored on the capacitor
 - (ii) the energy stored in the capacitor
- (d) In conditions of poor light, the voltage produced by the solar cell drops to zero and the watch mechanism will cease to function if the voltage across it falls to a value below 1.0V capacitor acts as a backup power supply discharging through the watch mechanism. The
- (i) What is the purpose of the diode in the circuit?
 - (ii) Calculate the charge which will have flowed through the watch mechanism when the voltage across the capacitor falls to 1.0 V.
 - (iii) The watch mechanism is design to draw a constant current of $1.0\mu\text{A}$, as long as the voltage across it is greater than 1.0V. use this fact and your answer in d(ii) to estimate for how many hours the capacitor can back up the watch mechanism.

OR 10(d),(e),(f),(g) and (h)

10. (e) Figure 10 shows a section through a possible crystalline structure for a metal. Each circle represents an atom of the metal.

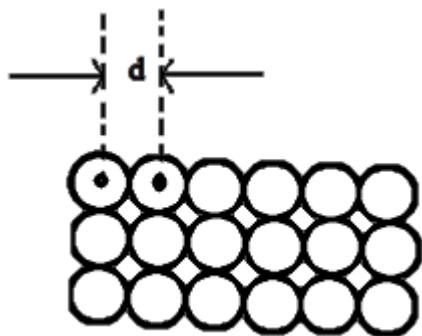


Figure 10

- (i) calculate the spacing, d , between the centres of adjacent atoms, if the molar mass of the metal is $6.4 \times 10^{-2} \text{kg}$; density of the metal is $8.9 \times 10^3 \text{kg m}^{-3}$, Avogadro's constant = $6.0 \times 10^{23} \text{kg m}^{-3}$.
- (ii) Figure 11 shows how the force, F , between a pair of atoms in a solid varies with their separation, x .

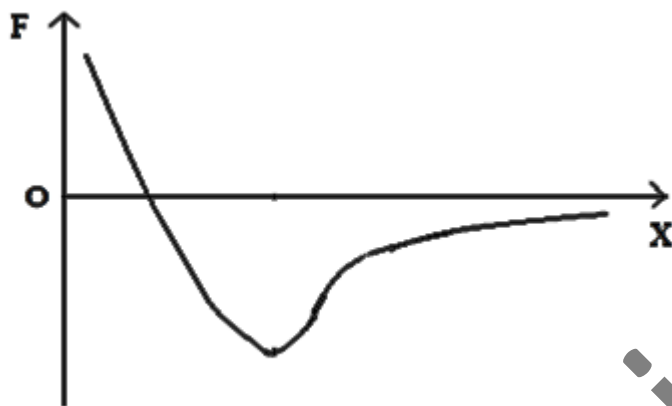


Figure 11

Copy the diagram and mark on it the distance, d , calculated in a(i) above. you indicated.

Explain why you have chosen the point

(f) Explain briefly with the aid of a diagram what you would expect to happen to a nearly spherical droplet of water resting on a clean horizontal surface, if a tiny droplet were added to it. How do you account for the change that might occur?

(g) (i) Define surface tension

(ii) Give a brief explanation, in terms of intermolecular forces, of the origin of surface tension.

(iii) In terms of intermolecular forces explain how the surface of a liquid differs from the bulk of the liquid.

(h) The two vertical arms of manometer containing water have different internal radii of 10^{-3}m and $2.0 \times 10^{-3} \text{m}$ respectively. What is the difference in height of the two liquid levels when the arms are open to the atmosphere? (Density of water = 10^3kg m^{-3} and surface tension = $7.0 \times 10^{-2} \text{N m}^{-1}$.)