

(d) (i) Figure 6 shows a simple radio receiver. The tuning circuit selects one station. Explain why this happens.

(ii) Explain the functions of the demodulation and the amplifier

(e) (i) Briefly explain the difference between FM and AM transmissions

(ii) If the capacitance  $C$  of the capacitor is  $2 \mu\text{F}$  and the circuit is tuned at a frequency of  $10^6 \text{ Hz}$ . Calculate the inductance of the inductor.

(iii) How could the tuning circuit be altered so that it could select other frequencies.

(f) A satellite of mass ( $m$ ) is launched from the earth's surface to cycle the plane of the equator?

(i) Explain the conditions under which such a situation is possible.

(ii) Explain the height of the satellite orbit above the earth's surface, if the radius of the earth is 6400 km.

### STUDENT'S PROPOSED ANSWERS TO JUNE 2003

### JUNE 2004

1. Figure 1 shows a point charge of value  $-25 \text{ nC}$  at the centre of an earth hollow metal shell.

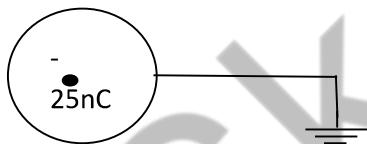


Figure 1

(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  $4.0 \text{ kg}$  being raised by two unequal forces of  $25 \text{ N}$  and  $40 \text{ N}$ . The  $25 \text{ N}$  force acts at an angle of  $30^\circ$  to the vertical and the  $40 \text{ N}$  acts at an angle of  $60^\circ$  to the vertical.

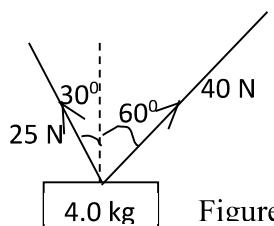


Figure 2

Calculate the acceleration of the mass

3. Figure 3 shows how two circuits which could be used to determine the resistance of a conductor. State and explain which circuit could be appropriate to determine the resistance  $R$ , for

(i) Large  $R$       (ii) Small  $R$

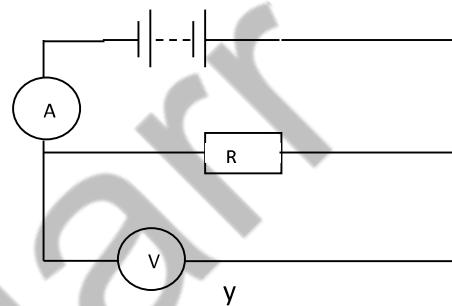
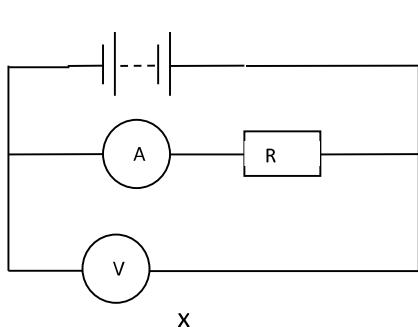


Figure 3

(b) Describe how you would use the CRO to measure time.

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

5. Figure 4 shows a simple pendulum bob of mass 50 g displaced to a height of 1.5 cm above the equilibrium. When the bob is released, it makes an elastic head on collision with a body of mass = 50 g placed at the equilibrium position.

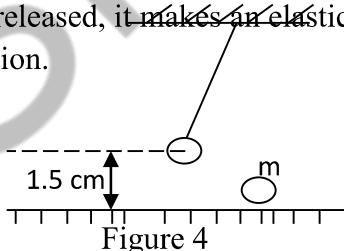


Figure 4

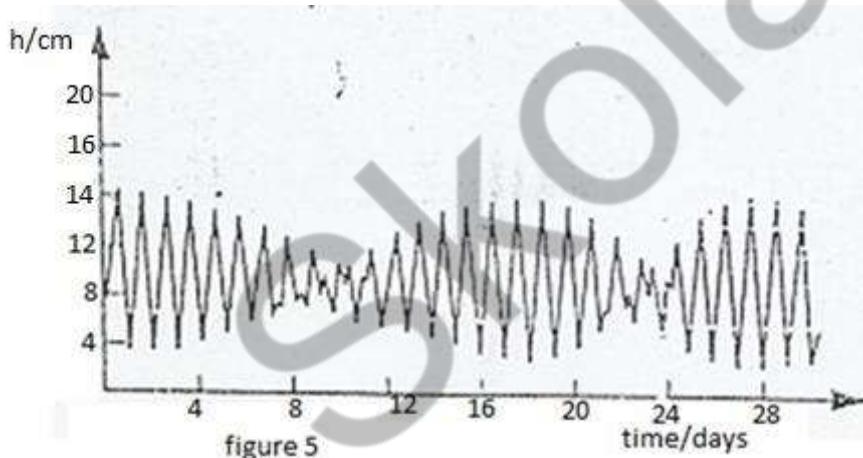
- i. Calculate the velocity of the body after collision
- ii. If the body moves a distance of 50 cm before coming to rest, calculate the frictional force acting on the body.

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 the count rate of carbon – 14 in 2 kg of living bone is  $3 \times 10^4$  per minute, determine the count rate in 0.3 kg of an ancient bone that is 25000 years old.

8. (a) Forces could be classified as *contact forces* or *action at a distance forces*. Explain the meaning of the phrases in italics.  
 (b) Describe an experiment to determine the acceleration due to gravity of a body undergoing free fall.  
 (c) A car driver stops at a traffic light when the light shows red. A truck driver arrives at the traffic light just when it shows green. He continues driving at a constant speed of  $36 \text{ kmh}^{-1}$ . Suppose the road beyond the traffic light is straight and flat. How long will the car driver take to catch up with the truck, if he is driving at a constant acceleration of  $2 \text{ ms}^{-2}$  in the direction of the truck? Assume the average reaction time for a driver is 0.7 s.  
 (d) Waves may be classified as *transverse and longitudinal* or *mechanical and electromagnetic*. Explain giving one example in each case, of the terms in italics.  
 (e) Describe an experiment to measure the velocity of sound in free air.



(f) Figure 5 shows a graph of the variation of height of tides with time at a particular harbor. The variation in height could be regarded as a result of the superposition of two waves. Estimate the amplitude and frequency of the waves.

9. (a) (i) Distinguish between self induction and mutual induction.  
 An inductor with an iron core is connected in series with a milliammeter and a 1.5 V supply. Figure 6 shows the way the current varies with time when the switch is closed.

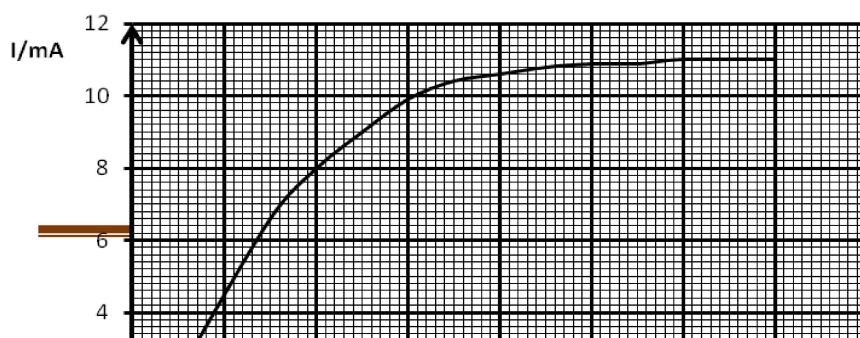
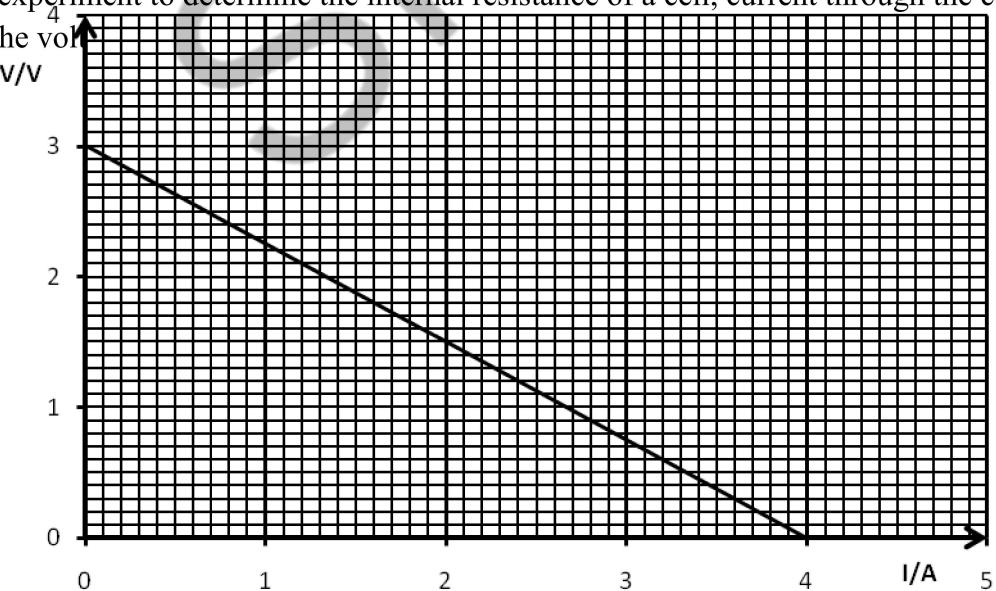


Figure 6

(ii) Sketch a circuit diagram from which such results could have been obtained.  
(iii) How long does it take for the current to reach maximum value?  
(iv) How would the graph in figure 6 be modified if a resistor replaced the inductor?  
(b) In an experiment to investigate the behavior of a charge on a small insulated charged ball of mass 50 g, the ball is suspended by an insulated thread between two vertical and parallel plates which are 5 cm apart. When a potential difference of 600 V is applied between the plates, the ball is pulled such that the thread makes an angle of  $60^{\circ}$  to the horizontal.  
(i) Sketch a diagram showing all the forces acting on the ball. State the origin of these forces with respect to the fundamental forces.  
(ii) Calculate the electric charge on the ball.  
(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  $V$



(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) Emf of the cell      (b) Internal resistance of the cell  
 (d) A heating coil of power 10 W is required when the p.d across it is 20.0 V. 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

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

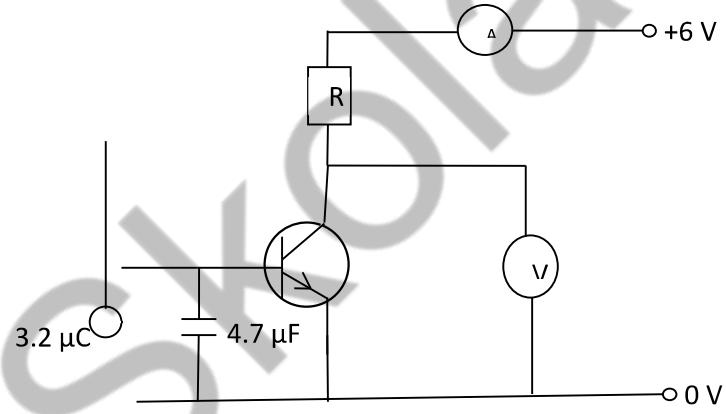


Figure 8

i. What is the reading of the ammeter, if the base emitter voltage is 0.6 V  
 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 12 V and the LED requires 10 mA 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.

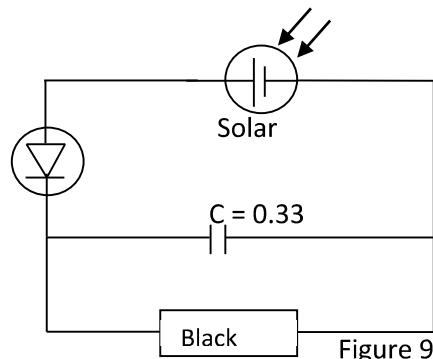


Figure 9

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

- The charge stored on the capacitor
- 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 1.0 V. The capacitor acts as a backup power supply discharging through the watch mechanism.

- What is the purpose of the diode in the circuit
- Calculate the charge which would have flowed through the watch mechanism when the voltage across the capacitor falls to 1.0 V
- The watch mechanism is designed to draw current of  $1.0 \mu\text{A}$ , as long as the voltage across it is greater than 1.0 V. use this fact and your answer in d (ii) to estimate for how many hours the capacitor can back up the watch mechanism.

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

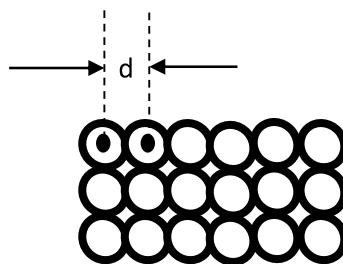


Figure 10

- (f) Calculate the spacing  $d$ , between the centers of adjacent atoms, if the molar mass of the metal is  $6.4 \times 10^{-2}$  kg, density of the metal is  $8.9 \times 10^3 \text{ kg m}^{-3}$ , Avogadro's constant is  $6.0 \times 10^{23} \text{ mol}^{-1}$
- Figure 11 shows how the force,  $F$ , between a pair of atoms in a solid varies with their separation

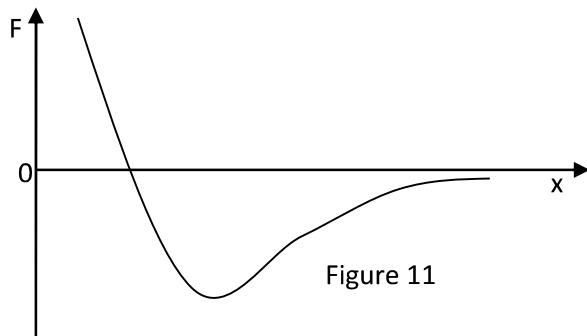


Figure 11

Copy the diagram and mark on it the distance  $d$ , calculated in a (i) above. Explain why you have chosen the indicated 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 horizontal surface, if a tiny droplet were added to it. How would you account for the change that might occur?

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

#### STUDENT'S PROPOSED ANSWERS TO JUNE 2004

#### JUNE 2005

1. (a) Explain what is meant by the homogeneity of a physical equation.  
 (b) Show that the expression  $c^2 \mu_0 \epsilon_0 = 1$  is homogeneous where  $\mu_0$  is the permeability of free space,  $\epsilon_0$  is the permittivity of free space and  $c$  is the speed of light.  
 (c) Given that  $\mu_0 = 4\pi \times 10^{-7} \text{ Hm}^{-1}$ , calculate the value of  $\epsilon_0$ .
2. Figure 1 shows a graph of the square of the frequency against the inverse of the length for a simple pendulum.

