GCE 2003 - Advanced Level

PHYSICS

JUNE 2003

1. Waves may be classified on the basis of their medium of transmission or mode of propagation.

(a) Which are these classes in terms of

(i) Medium of transmission (ii) Mode of propagation

(b) Give one example of each.

2.

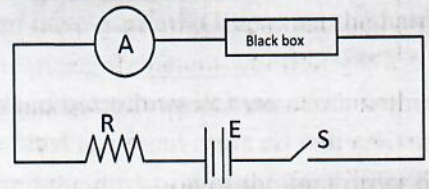


Figure 1

Figure 1 shows a circuit which can be used to establish the I – V characteristic for three conductors, copper, tungsten filament lamp and a junction diode

(i) Copy the diagram and insert the missing component

(ii) Sketch separate I – V characteristic for the three conductors.

3. A nuclide $^{220}_{86}X$ decays to a nuclide Y by emission of two α – particles and two β – emissions

   i. Write down the equation of this decay process

   ii. The activity of radioactive carbon – 12 in living wood is 19 counts per minutes per gram. Measuring the activity of the isotope in a piece of ancient wood gave an activity of 7 counts per minute per gram. Given that the half – life of the isotope is about 6000 years. Estimate the age of the piece of ancient wood.

4. A grating has 6000 lines per mm and is illuminated by light of wavelength 5.9×10^{-7} m. which is incident normal to the grating.

   i. Find the direction of the first order diffraction image

   ii. Is it possible to obtain a third order image with this diffraction grating for this wavelength?

   iii. What would be the effect on the number of orders, if the wavelength of the wave increases?

5. (a) Calculate the root mean square speed for the molecules of nitrogen at stp, if the density of nitrogen at these conditions is 2.6 kgm^{-3}.

   (b) The speed of sound at stp is about 330 ms^{-1}. Explain how this is related to the root mean square speed of nitrogen.

6. Figure 6 shows a pendulum bob of mass 20 g attached to the roof of a train that is in motion. The pendulum hangs when the train was stationary.

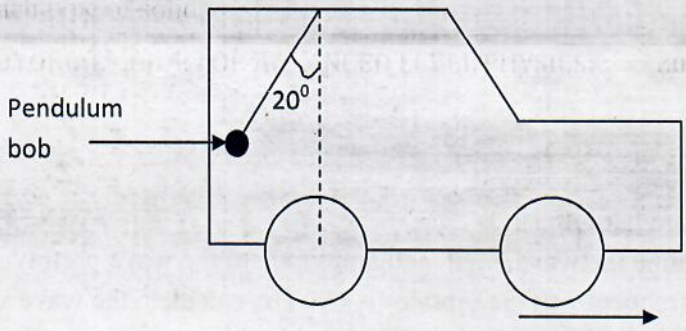


Figure 2

(i) Draw a free body diagram, to show the forces acting on the pendulum bob when the train is in motion.

(ii) Calculate the acceleration of the train

(iii) Describe what happens to the bob if the train attains constant velocity.

7. (a) Distinguish between crystalline , amorphous and polymeric solids

   (b) Give examples of each type of solids.

8. (a) (i) Distinguish between specific latent heat of vaporization and latent heat of vaporization

(ii) Describe an experiment to determine the specific latent heat of vaporization of water.

(b) An electric heater rated at 2.0 Kw is used to heat 15 g of water in a kettle. The initial temperature of the water is 20^0 C.

i. What time does it take to heat the water to its boiling point?

ii. Calculate the mass of the water that would have boiled away in five minutes.

(c) Estimate how long it will take all the water to evaporate. State any assumption that you have made in your calculations.

Specific heat capacity of water is 4200 $JK^{-1}K^{-1}$; Heat capacity of copper is 400 JK^{-1}

Specific latent heat of water is 2.0×10^6 Jkg^{-1}

(d) (i) State the law of conservation of linear momentum

(ii) Describe an experiment to verify the law of conservation of linear momentum.

(e) Two bodies A and B with masses 2m and m, respectively, make a head on collision. The bodies move in the same direction with a velocity of 5.0 ms^{-1} and 2.0 ms^{-1} respectively. If the velocity of A after collision with B is 3.0 ms^{-1}.

(i) Calculate the velocity of B after the collision

(ii) IS the collision elastic or inelastic? Explain.

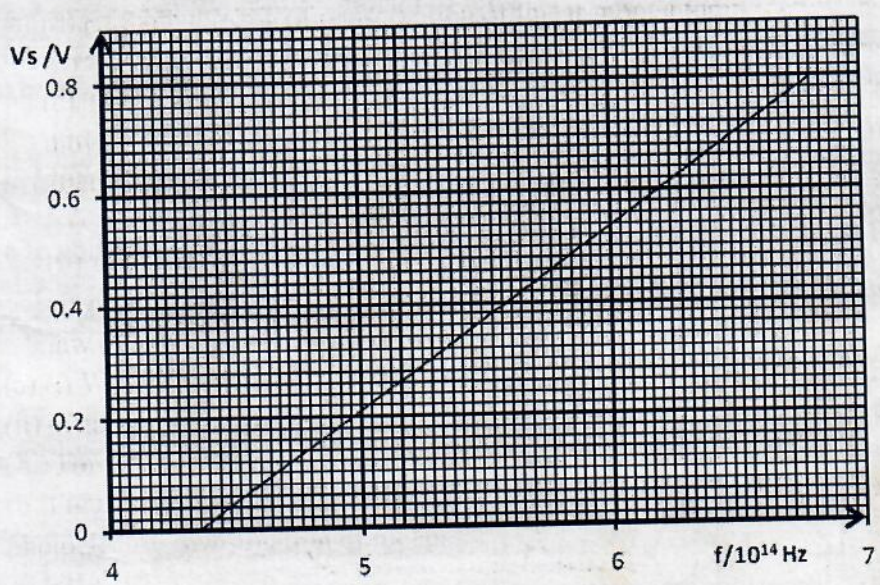
(f) A particle of mass m hits a rigid wall and bounces back with the same speed. Explain whether the law of conservation of linear momentum is satisfied or not?

9. (a) (i) What is the photoelectric effect?

(ii) What are the experimental observations of the photoelectric effect?

(iii) How do these observations compare the classical theory?

(b) Figure 3 shows how the stopping V_s varies with the frequency, f, of the incident radiation in a photoelectric investigation of metals.



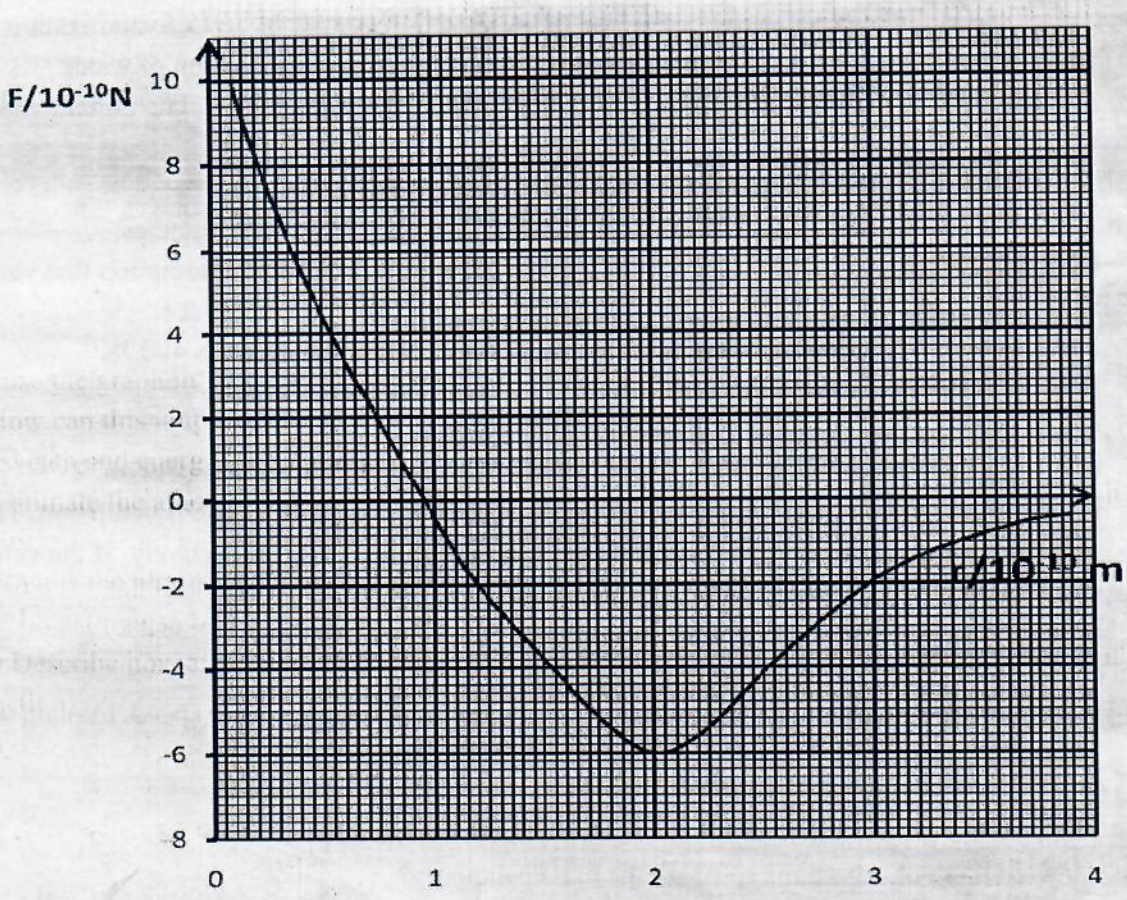
Use the graph in figure 3 to calculate values for

i. The plank's constant (ii) The work function of this metal

(c) (i) Explain the meaning of thermionic emission

(ii) Make a sketch of an electron gun

(d) Using either force and kinetic energy or separation and motion of particles, differentiate between the different states of matter.



(e) (i) use the graph in figure 4 to describe the forces that exist between the two molecules

(ii) How can this graph be used to explain Hookian behavior of matter

(iii) Sketch and energy – separation curve from this graph

(iv) Estimate the amount of work done in separating the molecules from the equilibrium position to infinity.

(v) What is the physical significance of this energy?

10. (a) (i) Distinguish between the conduction mechanism for copper and silicon.

(ii) Describe how an n – type semiconductor may be produced. Hence explain the formation of a p – n junction.

(b)

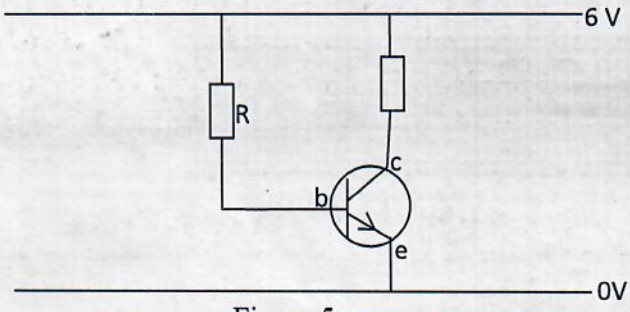


Figure 5

From the circuit in figure, calculate

i. The base emitter voltage of the transistor at saturation

ii. If the base emitter resistance is 100 Ω. Calculate a value for R at saturation.

(c) (i) Draw a circuit diagram of a bridge rectifier to convert a.c to d.c.

(ii) Sketch the output characteristic of a transistor in the C.E mode.

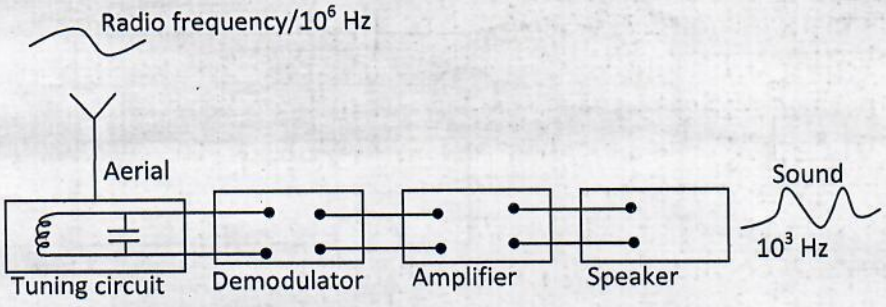


Figure 6

(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 μF and the circuit is tuned at a frequency of 10^6 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.