Edukamer

GCE ADVANCED LEVEL PHYSICS JUNE 2005

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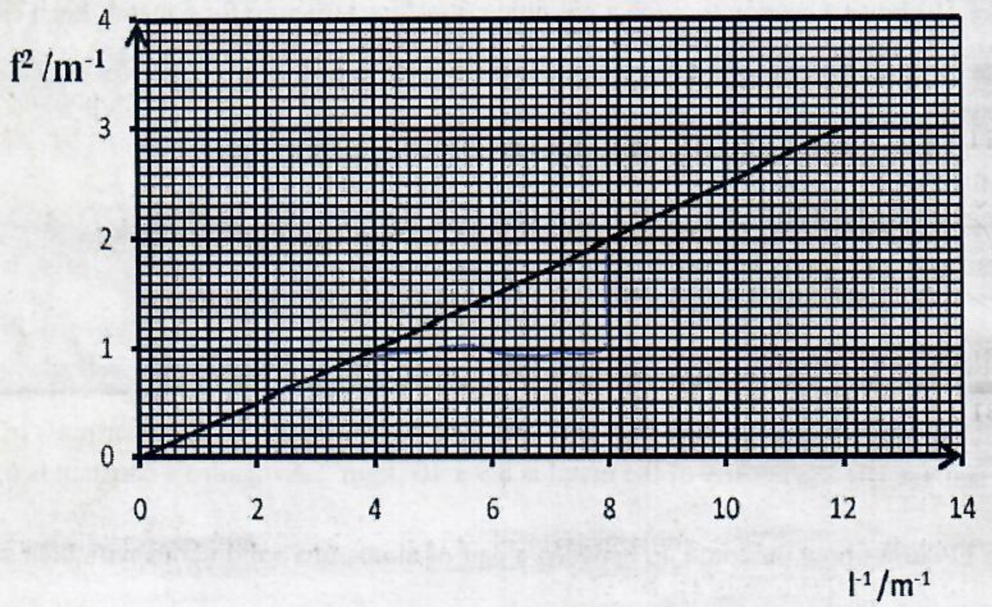
1. (a) Explain what is meant by the homogeneity of a physical equation.

   (b) show that the expression $c^2\mu_0\varepsilon_0 = 1$ is homogeneous where μ_0 is the permeability of free space, ε_0 is the permittivity of free space and c is the speed of light.

   (c) Given that $\mu_0 = 4\pi \times 10^{-7}\ Hm^{-1}$, calculate the value of ε_0.

2. Figure 1 shows a graph of the square of the frequency against the inverse of the length for a simple pendulum.



   (i) Use the graph to determine the acceleration due to gravity

   (ii) Calculate the length for which the pendulum would have a frequency of 20.0 Hz

3.

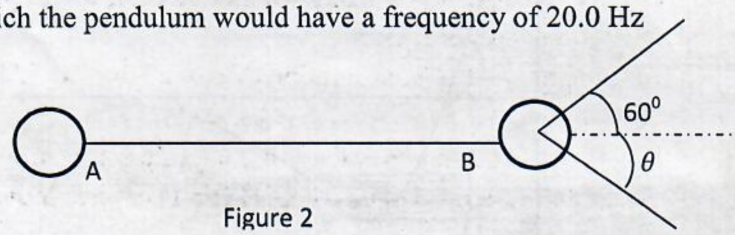


Figure 2

Figure 2 shows snooker ball A moving with velocity of 5.5 ms^{-1}, which hits a stationary snooker ball B. after collision A moves with a velocity of 2.5 ms^{-1} at 60^0 to its original path. Calculate the velocity of B after collision

4. Figure 3 shows two light beams X and Y of wavelength 450 nm travelling in air and incident on a composite crystal of thickness 20 μm. The refractive index of P is 1.40 and that of Q is 1.45

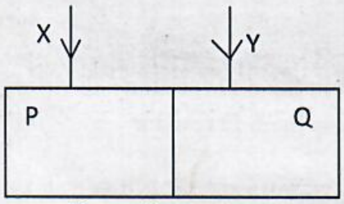


Figure 3

a) Determine which will first emerge from the crystal
b) If X and Y are in phase as they enter the crystal, calculate their phase difference as they leave the crystal.

5. A converging lens of focal length 20.0 cm is placed 25.0 cm away from a screen on which an image is formed. A biconcave lens of focal length 30. 0cm is now placed between the converging lens and the screen so that it is 10.0 cm from the converging lens. Calculate how far the screen has to be moved to focus the new image.
6. Figure 4 shows an electrical circuit.

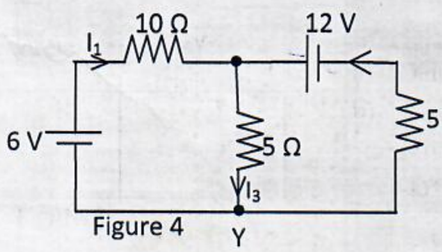


Figure 4

Determine the
(i) Currents I_1 , I_2 and I_3
(ii) Pd between X and Y

7.

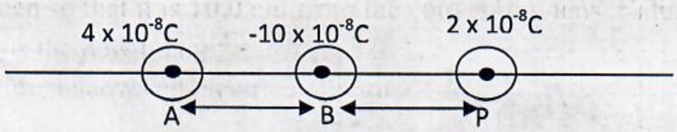


Figure 5

Figure 5 shows three charges A, B and P placed in a straight line. The charge at A is 4×10^{-8}C, that at B is -10×10^{-8}C and that at P is 2×10^{-8}C

a) Calculate the force on the charge at P due to the charges A and B.
b) Show that the resultant force on P cannot be zero, if P is placed between A and B.

8. (a) (i) State Newton's laws of motion
(ii) Show how the principle of conservation of momentum could be derived from the second and third laws of motion.
(b) Describe an experiment to verify the principle of conservation of linear momentum.
(c) Distinguish between conservative force and non – conservative forces, giving one example of each.
(d) (i) State Kirchhoff's laws

(ii) Explain how each of the laws is essentially a statement of either the conservation of energy or the conservation of electric charge.

(e) Describe an experiment to investigate how the pd across a wire filament varies with current through it at constant temperature.

(f) Given the circuit in figure 6.

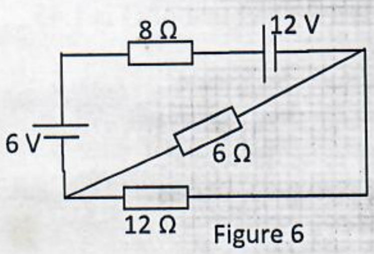


Figure 6

Calculate

a) The current in the 6 Ω resistor

b) The pd across the 6 Ω resistor

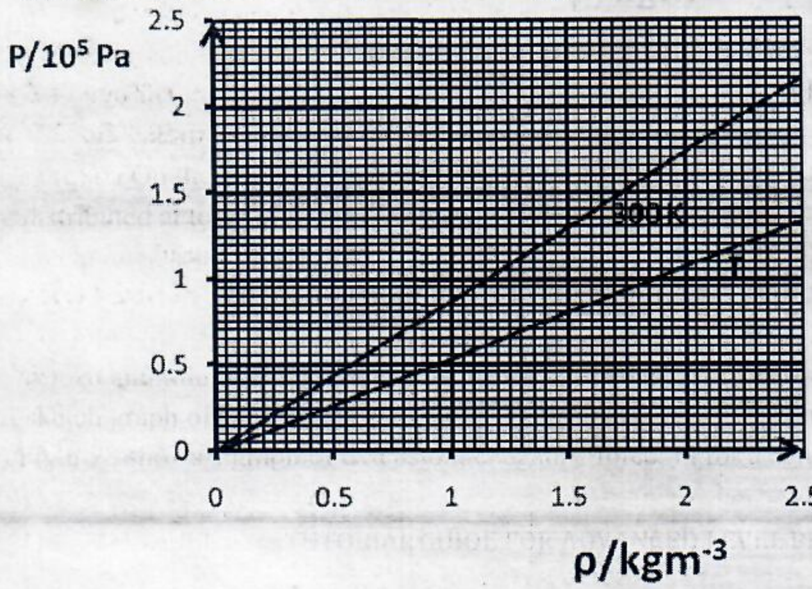
9. (a) State the assumptions used in deriving the kinetic theory equation. From these assumptions, derive the kinetic theory equation

$$P = \frac{1}{3}\rho \overline{c^2}$$

Where P = pressure of the ideal gas

ρ = density of the gas molecules.

(b) Figure 7 shows how the pressure of oxygen at temperature T and 300 K varies with density.



Use the graph to

i. Calculate the value for the r.m.s speed of oxygen molecules at 300 K

ii. Explain whether T is higher or lower than 300 K

(c) (i) On the same axis sketch labeled graphs to show how the speed of the molecules in an ideal gas are distributed at temperatures of 300 K and 600 K.

ii) On one of the graphs, show the position of average velocity, r.m.s speed and most probable speed.

(d) Materials could be classified as *crystalline, amorphous* or *polymeric*. Define the terms in italics. Give one example for each of the terms.

(e) An aluminum wire and a glass thread are subjected to linear stress until they break. On the same axis, sketch graph of stress – strain to show the behavior of each material.

(f) Figure 8 shows a graph of extension, e, against force, F, for a certain nylon climbing robe.

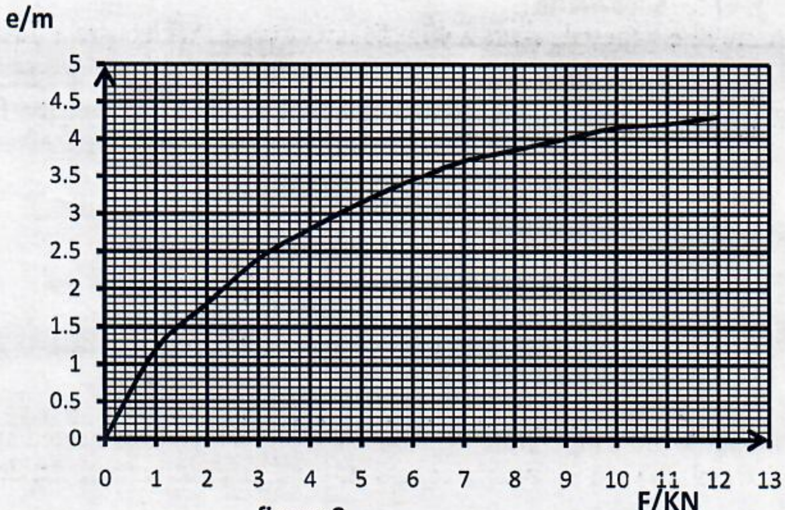


figure 8

A climber of mass 80 kg attached to a 10 m length of robe can withstand a force from the rope of not more than 7.5 KN without the risk of serious injury. Use the graph to

(i) Estimate the maximum energy stored in the rope when climber is not at risk.

(ii) Explain how you would determine a value for Young's modulus for a given extension.

10. (a) Differentiate between interference and diffraction of light

(b) A parallel beam of light of wavelength 5.5×10^{-2} m in air is incident on the slits in Young's double slit experiment. A thin film of transparent plastic of refractive index 1.48 and thickness 5.2×10^{-6} m is placed over one of the slits.

i. Determine the increase in the optical path of the light passing through the thin film. Hence determine the number of fringes by which the central bright fringe is displaced.

ii. Explain how the fringe spacing would change if the slit separation were increased, the slit – screen distance were increased.

(c) Light of wavelength 5.5×10^{-7} m falls on a single slit of width 0.15 mm. A screen is placed 1.2 m beyond the slit.

i. Sketch a graph showing the light pattern observed on the screen

ii. Calculate the width of the central fringe

(d) State the following laws

(i) Newton's law of gravitation (ii) Coulomb's law.

(e) Explain in what way the Coulomb force between two charge particles is

i. Different

ii. Similar to the gravitational force between two masses

(f) The gravitational potential energy U of a mass, m, a distance h above the surface of the earth is

$$U = -\frac{GMm}{(R+h)}$$

Where M is the mass of the earth, R the radius of the earth and G, the gravitational constant (R = 6.4 x 10^6)

i. Show that this expression is equivalent to U= mgh usually adopted in elementary physics courses where g is the gravitational force per unit mass near the surface of the earth.

iii. Explain what would happen if the spacecraft had

- Less energy, More energy