



**First year entrance exam  
 GCE Specialization**

**physical test**  
**Duration : 3 Hours**

1. In the displacement method to determine the focal length ( $f$ ) of a convex lens, the lens is placed on an optical bench between an object and a screen. The screen's position is adjusted until image is formed on it. The distance,  $l$  between the object and the screen is recorded. The displacement  $d$ , of the lens along the optical bench for which another sharply focused image is produced on the screen is noted. The relationship between the variables is given by the relation  $f = \frac{l^2 - d^2}{4l}$  the table below shows the values of  $l$  and  $d$  for one such experiment.

$l/\text{cm}$	40.0	45.1	69.9	80.2	101.8	122.0	145.3
$d/\text{cm}$	25.3	30.0	56.1	69.3	87.5	107.7	131.9

- a) Use the data above to plot a suitable graph from which  $f$  can be determined  
 b) Use the graph in (a) above to determine  $f$ .

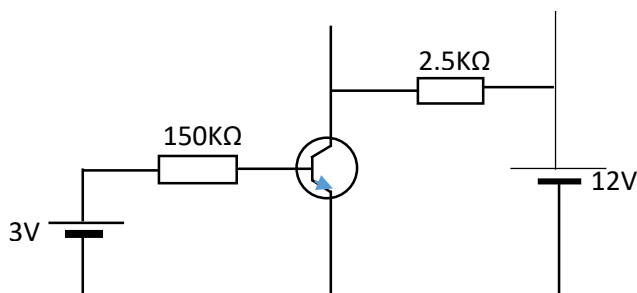
**6 marks**  
**5 marks**

The force per unit length,  $F$ , acting on two straight wires placed a distance  $r$  apart in a medium of permeability  $\mu$ , and carrying currents,  $I_1$  and  $I_2$  is given by  $F = \frac{\mu I_1 I_2}{2\pi r}$ .

- a) Show that this equation is homogeneous.  
 b) A physical equation is homogeneous and a student concludes that the equation is correct. Explain whether or not the student is right.  
 c) Give an example of a dimensionless physical quantity.

**6 marks**

2. This figure shows an N-P-N transistor in a circuit that can be used in voltage amplification

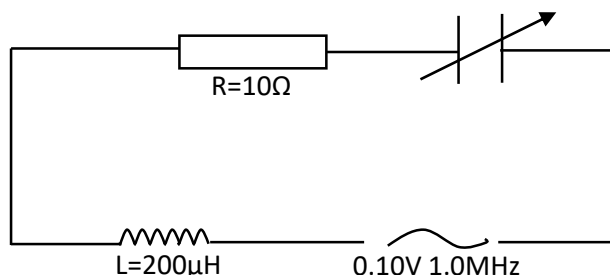


The base-emitter voltage,  $V_{BE} = 0.7\text{V}$  and current gain ( $\beta_{FE}$ ) = 100

- a) Determine the base current and the collector current.  
 b) What is the operating point of the above transistor ?

**6 marks**

3. this figure shows a  $200\ \mu\text{H}$  inductor, a  $10\ \Omega$  resistor and a variable capacitor connected in series with a  $0.10\text{V}$  (r.m.s value)  $1.0\text{MHz}$  supply. The inductor has an inductance of  $200\ \mu\text{H}$ . At resonance determine



- (i) the capacitance of the variable capacitor  
 (ii) the current flowing in the circuit  
 (iii) the voltage across the inductor  
 (iv) the voltage across the capacitor

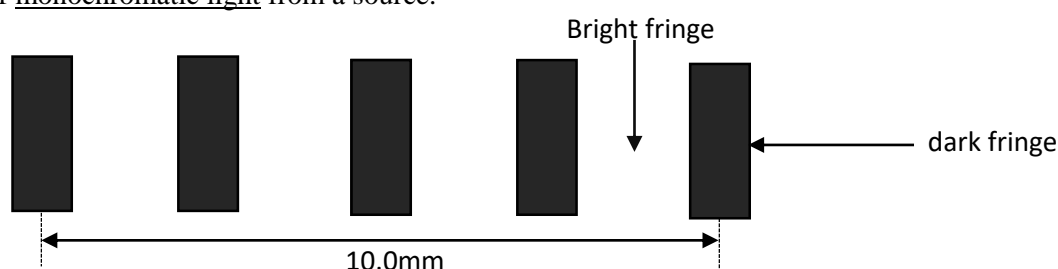
**6 marks**

4. The three lowest energy levels of an atom are shown in this figure below

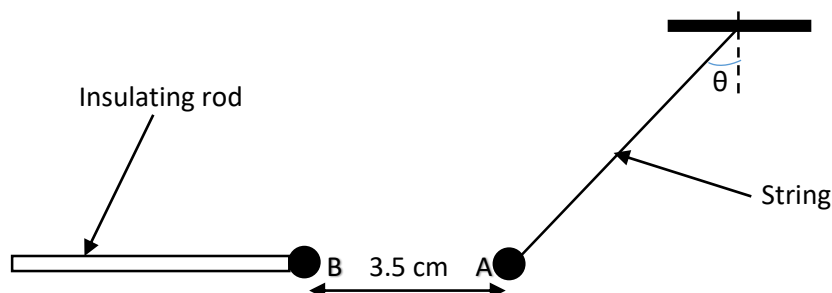
7 marks

n=3	_____	-1,6eV
n=2	_____	-6,2eV
n=1	_____	-18,6eV

- (i) Determine the minimum energy in joules required to eject an electron initially in the lowest energy level from the atom.
- (ii) Assuming that the energy level,  $n$ , is associated with energy  $\frac{k}{n^2}$ , determine the energy of the level  $n=4$  in electron-volts.
- (iii) Determine the wavelength of the electromagnetic radiation emitted when an electron makes a quantum jump from the level  $n = 3$  to the level  $n = 2$ . Name the region of the electromagnetic spectrum in which this radiation is found.
5. This figure shows the fringe pattern obtained on a screen from Young's double slit experiment to measure the wavelength of monochromatic light from a source.



- (a) Explain the meaning of the underlined phrase.
- (b) Determine the fringe separation.
- (c) If the distance from the double slits to the screen is 2.5m while the separation of the double slits is 0.50mm, determine the wavelength of the light from the source.
- 5 marks
6. (a) State (i) two similarities and (ii) two differences between electrostatic and gravitational forces
- (b) The acceleration due to gravity on the moon's surface is one-sixth that on the earth's surface. A simple pendulum of length,  $l$ , is taken from the earth's surface. What should be its length on the moon's surface such that the period time on the moon should be twice that on earth?
- 7 marks
7. In this figure, a charged metal sphere (A) is hung from an insulating string. Another charge sphere (B) on an insulating rod is then placed close to A as shown. The charge on sphere A is +5.0 nC while that on sphere B is -4.0 nC.



- (a) Draw the two spheres and show the electric field pattern around them.
- (b) Determine the magnitude of the electric force between the two spheres.
- (c) What is the value of the angle  $\theta$  if sphere A has a mass of  $4.5 \times 10^{-5}$  kg?
- 7 marks
9. Strontium-89 has a half-life of 84 days
- (a) Explain the meaning of the underlined phrase.
- (b) A laboratory prepares a strontium-89 source 21 days after preparation, its activity is measured to be  $7.4 \times 10^4$  Bq. What is the activity of the source at the time of preparation?
- 5 marks