General Certificate of Education
June 2005
Advanced Level Examination

PHYSICS (SPECIFICATION B) **PHB6/1**
Unit 6 Exercise 1

to be conducted between 1 March 2005 and 25 May 2005

In addition to this paper you will require:
- an 8-page answer book;
- A4 graph paper;
- a calculator;
- a ruler.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Write the information required on the front of the answer book. The *Examining Body* for this unit is AQA. The *Paper Reference* is PHB6/1.
- Answer **all** questions. A separate sheet of graph paper is required.
- *Formulae Sheets* are provided on pages 3 and 4. Detach this perforated page at the start of the examination.
- Show all your working. Do all rough work in the answer book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 39.
- Mark allocations are shown in brackets.
- You are expected to use a calculator where appropriate.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

Advice
- Before commencing the first part of any question, read the question through completely.
- Ensure that **all** measurements taken, including repeated readings, gradients, derived quantities, etc., are recorded to an appropriate number of significant figures with due regard to the accuracy of measurement.
- If an experiment does not operate correctly, you should request assistance from the Supervisor. The Supervisor will give the minimum help necessary to make the experiment operate and will report the action taken to the Examiner. If the fault is due to your inability to make the experiment operate, a deduction of marks will be made, but it will be possible for you to complete the remainder of the question and gain marks for the later parts of that question.

Answer **all** questions.

Total for this question: ***39 marks***

1 You are to investigate the relationship between the voltage generated by an illuminated light emitting diode (LED) and its distance from the filament of the illuminating lamp.

(a) Measure the length, d, of the black tube.
Record your values in cm. *(2 marks)*

(b) Set up the apparatus as shown in **Figure 1**.

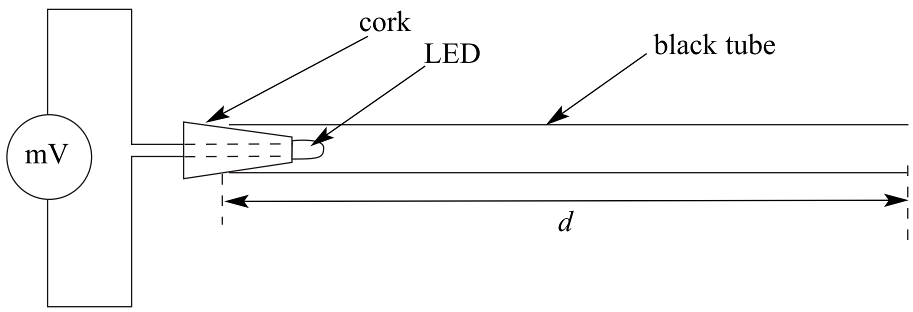

Figure 1

By covering the open end of the tube, determine what voltage, if any, is generated when the LED is in the dark. Record your answer. *(1 mark)*

(c) (i) Explain what happens to the charge carriers in a semiconductor light dependent resistor when it is illuminated. *(1 mark)*

(ii) Insert the lamp into the end of the tube that you have just covered. Connect the lamp to the power supply and observe that a small voltage registers on the millivoltmeter.

LEDs consist of two different types of semiconductor in contact.
Suggest why shining light onto an LED might be expected to generate a small voltage between its terminals. *(2 marks)*

(d) Using scissors to cut off lengths of tube, obtain a series of values of voltages generated (V/mV) corresponding to a wide range of values of d. Record these values in an appropriate table. You should include two further columns in your table in which to record values of log (V/mV) and log (d/cm). *(12 marks)*

(e) Calculate and record corresponding values of log (V/mV) and log (d/cm) in your table. *(2 marks)*

(f) Plot a graph of log (V/mV) against log (d/cm). Draw the best straight line taking into account all your plotted points. *(5 marks)*

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Foundation Physics Mechanics Formulae

moment of force $= Fd$

$$v = u + at$$

$$s = ut + \tfrac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$s = \tfrac{1}{2}(u + v)t$$

for a spring, $F = k\Delta l$

energy stored in a spring $= \tfrac{1}{2}F\Delta l = \tfrac{1}{2}k(\Delta l)^2$

$$T = \frac{1}{f}$$

Foundation Physics Electricity Formulae

$$I = nAvq$$

terminal p.d. $= E - Ir$

in series circuit, $R = R_1 + R_2 + R_3 + ...$

in parallel circuit, $\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3} + ...$

output voltage across $R_1 = \left(\dfrac{R_1}{R_1 + R_2}\right) \times$ input voltage

Waves and Nuclear Physics Formulae

fringe spacing $= \dfrac{\lambda D}{d}$

single slit diffraction minimum $\sin\theta = \dfrac{\lambda}{b}$

diffraction grating $n\lambda = d\sin\theta$

Doppler shift $\dfrac{\Delta f}{f} = \dfrac{v}{c}$ for $v << c$

Hubble law $v = Hd$

radioactive decay $A = \lambda N$

Properties of Quarks

Type of quark	Charge	Baryon number
up u	$+\frac{2}{3}e$	$+\frac{1}{3}$
down d	$-\frac{1}{3}e$	$+\frac{1}{3}$
$\bar{u}$	$-\frac{2}{3}e$	$-\frac{1}{3}$
$\bar{d}$	$+\frac{1}{3}e$	$-\frac{1}{3}$

Lepton Numbers

Particle	Lepton number L		
	L_e	L_μ	L_τ
e^-	1		
e^+	–1		
ν_e	1		
$\bar{\nu}_e$	–1		
μ^-		1	
μ^+		–1	
ν_μ		1	
$\bar{\nu}_\mu$		–1	
τ^-			1
τ^+			–1
ν_τ			1
$\bar{\nu}_\tau$			–1

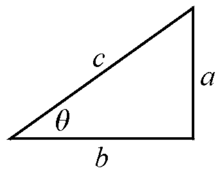
Geometrical and Trigonometrical Relationships

circumference of circle $= 2\pi r$

area of a circle $= \pi r^2$

surface area of sphere $= 4\pi r^2$

volume of sphere $= \tfrac{4}{3}\pi r^3$



$$\sin\theta = \frac{a}{c}$$

$$\cos\theta = \frac{b}{c}$$

$$\tan\theta = \frac{a}{b}$$

$$c^2 = a^2 + b^2$$

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Circular Motion and Oscillations

$$v = r\omega$$

$$a = -(2\pi f)^2 x$$

$$x = A\cos 2\pi ft$$

$$\text{maximum } a = (2\pi f)^2 A$$

$$\text{maximum } v = 2\pi fA$$

$$\text{for a mass-spring system, } T = 2\pi\sqrt{\frac{m}{k}}$$

$$\text{for a simple pendulum, } T = 2\pi\sqrt{\frac{l}{g}}$$

Fields and their Applications

$$\text{uniform electric field strength, } E = \frac{V}{d} = \frac{F}{Q}$$

$$\text{for a radial field, } E = \frac{kQ}{r^2}$$

$$k = \frac{1}{4\pi\varepsilon_0}$$

$$g = \frac{F}{m}$$

$$g = \frac{GM}{r^2}$$

$$\text{for point masses, } \Delta E_p = GM_1M_2\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

$$\text{for point charges, } \Delta E_p = kQ_1Q_2\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

$$\text{for a straight wire, } F = BIl$$

$$\text{for a moving charge, } F = BQv$$

$$\phi = BA$$

$$\text{induced emf} = \frac{\Delta(N\phi)}{t}$$

$$E = mc^2$$

Temperature and Molecular Kinetic Theory

$$T/\mathrm{K} = \frac{(pV)_T}{(pV)_{tr}} \times 273.16$$

$$pV = \tfrac{1}{3} Nm\langle c^2\rangle$$

$$\text{energy of a molecule} = \tfrac{3}{2} kT$$

Heating and Working

$$\Delta U = Q + W$$

$$Q = mc\Delta\theta$$

$$Q = ml$$

$$P = Fv$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{power input}}$$

$$\text{work done on gas} = p\Delta V$$

$$\text{work done on a solid} = \tfrac{1}{2} F\Delta l$$

$$\text{stress} = \frac{F}{A}$$

$$\text{strain} = \frac{\Delta l}{l}$$

$$\text{Young modulus} = \frac{\text{stress}}{\text{strain}}$$

Capacitance and Exponential Change

$$\text{in series, } \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\text{in parallel, } C = C_1 + C_2$$

$$\text{energy stored by capacitor} = \tfrac{1}{2} QV$$

$$\text{parallel plate capacitance, } C = \frac{\varepsilon_0\varepsilon_r A}{d}$$

$$Q = Q_0 e^{-t/RC}$$

$$\text{time constant} = RC$$

$$\text{time to halve} = 0.69\, RC$$

$$N = N_0 e^{-\lambda t}$$

$$A = A_0 e^{-\lambda t}$$

$$\text{half-life, } t_{\frac{1}{2}} = \frac{0.69}{\lambda}$$

Momentum and Quantum Phenomena

$$Ft = \Delta(mv)$$

$$E = hf$$

$$hf = \Phi + E_{k(max)}$$

$$hf = E_2 - E_1$$

$$\lambda = \frac{h}{mv}$$

(g) It is suggested that V is related to d by the relationship

$$V = cd^{-k}$$

where c and k are constants.

From your graph determine values for c and k, making it clear how you arrive at your values.
(7 marks)

(h) Suggest **two** physical factors that might affect the value of V for a given value of d. State how each factor you have given would affect the value of V. *(4 marks)*

(i) In the expression: $V = cd^{-k}$, d should actually be the distance from the filament of the lamp to the effective surface of the LED not the length of the tube.
Explain how you would determine d more precisely. *(3 marks)*

END OF QUESTIONS

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