Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Education
June 2006
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) **PHB6/2**
Unit 6 Exercise 2

Wednesday 24 May 2006 9.00 am to 10.30 am

For this paper you must have:
- a calculator
- a ruler

Time allowed: 1 hour 30 minutes

For Examiner's Use			
Number	Mark	Number	Mark
1		PHB6 /1	
2			
Total (Column 1)			
Total (Column 2)			
TOTAL			
Examiner's Initials			

Instructions
- Use blue or black ink or ball-point pen.
- Answer **all** questions.
- *Formulae Sheets* are provided on pages 3 and 4. Detach this perforated page at the start of the examination.
- There are two questions in this paper.
45 minutes are allowed for Question 1 and 45 minutes for Question 2.
- Show all your working. Do all rough work in this book. Cross through any work you do not want marked.

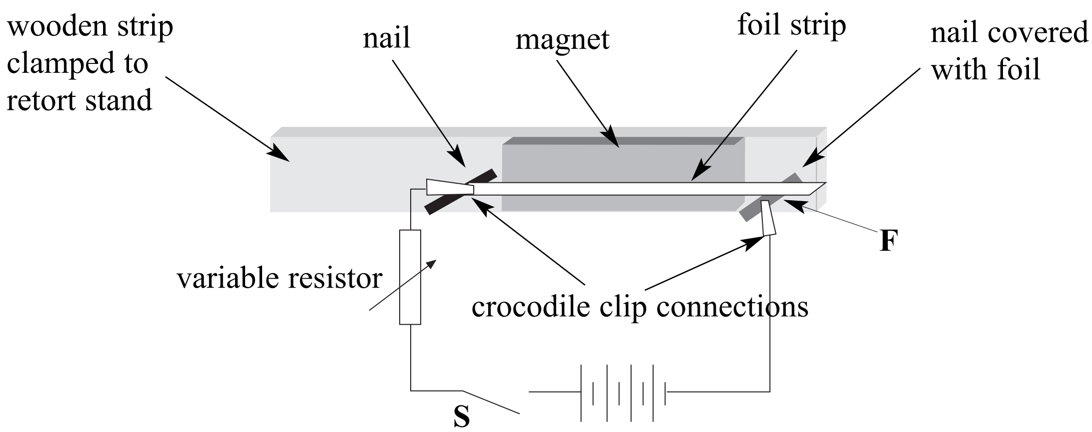
Information
- The maximum mark for this paper is 39.
4 of these marks will be awarded for the Quality of Written Communication.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
Questions 1(b) and 2(c) should be answered in continuous prose. Quality of Written Communication will be assessed in these answers.

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 in the spaces provided.

1 You have been provided with the apparatus shown in **Figure 1**.

Figure 1



The poles of the magnet are on its largest faces, i.e the face fixed to the wooden strip and the opposite face.

The foil strip should make contact with the foil-covered nail at **F** so that when the switch is closed there is a current in the foil strip.

Close the switch **S** and observe the motion of the strip. If the foil strip does not move, or stops moving, adjusting it slightly should start the motion. If no motion is observed consult your supervisor.

Open the switch when you have made the required observations.

(a) (i) Describe briefly the motion of the strip.

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(2 marks)

Detach this perforated page at the start of the examination.

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

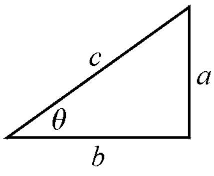
Geometrical and Trigonometrical Relationships

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

$$v = r\omega$$

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

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

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

$$\text{maximum } v = 2\pi f A$$

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

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

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

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

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

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

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

$$Ft = \Delta(mv)$$

$$E = hf$$

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

$$hf = E_2 - E_1$$

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

(ii) State the factors that affect the magnitude of the force that produces the initial motion.

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(3 marks)

(b) Explain why the strip moves in the way you have described in part (a)(i).

Two of the 7 marks are available for the quality of your written communication.

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(7 marks)

Question 1 continues on the next page

(c) (i) Close the switch and use the variable resistor to reduce slowly the potential difference across the strip. State the effect this has on the amplitude of the motion.

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(1 mark)

(ii) Suggest **two** factors, other than the potential difference across the strip, that you think might have an effect on the amplitude of the motion.

For each factor, state the effect it will have when this factor only is changed in the arrangement. Give a reason for the effect.

Factor 1

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Factor 2

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(6 marks)

2 You are provided with the circuit shown in **Figure 2**. You have also been provided with a red filter.

Figure 2

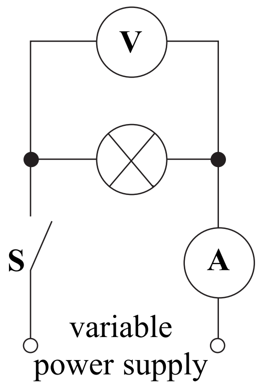
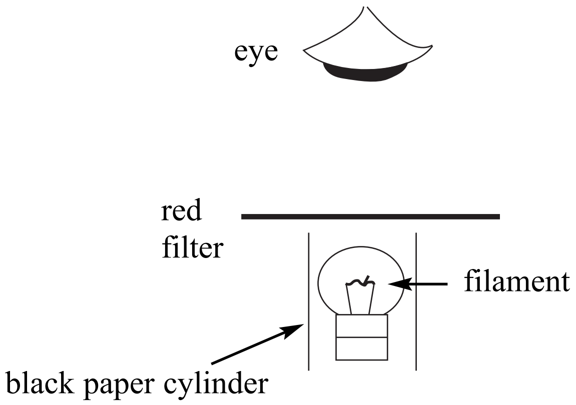


Figure 3



(a) The red filter transmits light of mean wavelength λ. View the filament of the lamp through the red filter, as shown in **Figure 3**.

(i) Close switch **S**.
Starting from a low value gradually increase the potential difference across the lamp and determine the current, I, and potential difference, V, when the lamp is just seen to glow when viewed through the filter.

(ii) Use your answers to part (a)(i) to calculate a value for the resistance R_{red} of the filament when the lamp just emits the red light transmitted by the filter.

Question 2 continues on the next page

(iii) Calculate the temperature T_{red} of the filament when it just emits red light using the formula

$$T_{red} = \frac{R_{red}}{R} T$$

where R is the resistance of the filament at room temperature T, in K.

The resistance R is given on the card near your apparatus.

You have been provided with a thermometer for measuring room temperature.

(6 marks)

(b) (i) Explain why the uncertainties in I and V are greater than the smallest changes detectable by the meters. Suggest how you would proceed to obtain more reliable values.

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(ii) State the absolute uncertainties in I and V. Hence determine the percentage uncertainty in the value of T_{red}.

You may ignore any uncertainty in T. The uncertainty in R is given on the card.

(iii) Suggest why the absolute uncertainty in T is so small that it can be ignored.

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(6 marks)

(c) It is suggested that the temperature of the filament measured as in part (a) is directly proportional to the mean frequency of the light transmitted by the filter.

Describe how you would extend this experiment to test this suggestion.

You should include in your description:

- any apparatus you would need in addition to that provided
- the procedure you would use, including a brief description of how you would determine the frequency of the transmitted light
- how you would use the measurements that you make to test the suggestion.

Two of the 8 marks are available for the quality of your written communication.

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(8 marks)

END OF QUESTIONS

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