Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Education
June 2008
Advanced Level Examination

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

Monday 19 May 2008 1.30 pm to 3.00 pm

For this paper you must have:
- a ruler
- a calculator
- a formulae sheet insert.

Time allowed: 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer all questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- 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 to be marked.

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Question	Mark	Question	Mark
1		PHB6/1	
2			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Information
- The maximum mark for this paper is 40.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- Questions 1(e), 2(e)(i) and 2(e)(ii) should be answered in continuous prose. In these questions you will be marked on your ability to use good English, to organise information clearly and to use specialist vocabulary where appropriate.
- The *Formulae Sheet* is provided as a loose insert to this question paper.

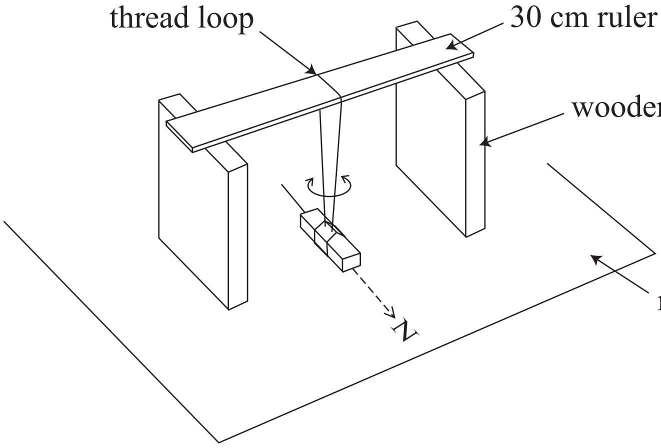
Advice
- Before commencing the first part of any question, read the question through completely.
- Ensure that **all** measurements taken, including repeated readings, gradients, derived quantities, etc., are recorded to an appropriate number of significant figures with due regard to the accuracy of 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 the question.

Areas outside the box will not be scanned for marking

Answer **all** questions in the spaces provided.

1 This question is about a bar magnet oscillating in the Earth's magnetic field.

Figure 1



1 (a) Set up the apparatus as shown in **Figure 1**. The suspended magnet should be at rest a centimetre or two above, and parallel with, the marked line showing the direction of magnetic north. This line is drawn on a sheet of paper fixed to the bench. **The N pole of the magnet should point north**.

Displace the magnet and release it so that it oscillates through a small angle in the horizontal plane about a vertical axis through its centre.
Measure T_N, the period of oscillation of the magnet, and hence find its frequency of oscillation f_N .

(3 marks)

Areas outside the box will not be scanned for marking

1 (b) Lift the ruler with the magnet and turn them around so that the magnet is at rest **with its S pole pointing north**.

Find the new frequency of oscillation, f_S.

(2 marks)

1 (c) (i) Calculate f_N^2 and estimate the absolute uncertainty in your answer.

1 (c) (ii) Assuming that the absolute uncertainty in f_S^2 is the same as that for f_N^2, state the absolute uncertainty in $f_N^2 - f_S^2$.

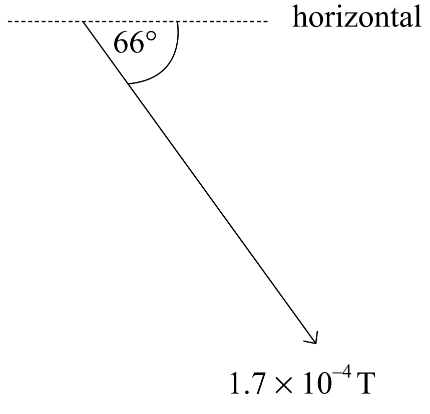
1 (c) (iii) Calculate $f_N^2 - f_S^2$ and the percentage uncertainty in your answer.

(5 marks)

1 (d) In the U.K., the flux density of the Earth's magnetic field is 1.7×10^{-4} T in a direction approximately 66° below the horizontal as shown in **Figure 2**.

Calculate B_H, the horizontal component of the Earth's magnetic field.

Figure 2



(2 marks)

Question 1 continues on the next page

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1 (e) It can be shown that

$$f_N^{\,2} - f_S^{\,2} = kB_H ,$$

where k is a constant.

Since $f_N^{\,2} - f_S^{\,2}$ depends on B_H, this experiment could be used as the basis for a method for investigating the variation in B_H around the World.

State the physical factors which affect the period of oscillation of the magnet and hence explain how the experiment could be made more sensitive to changes in B_H.

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

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(8 marks)

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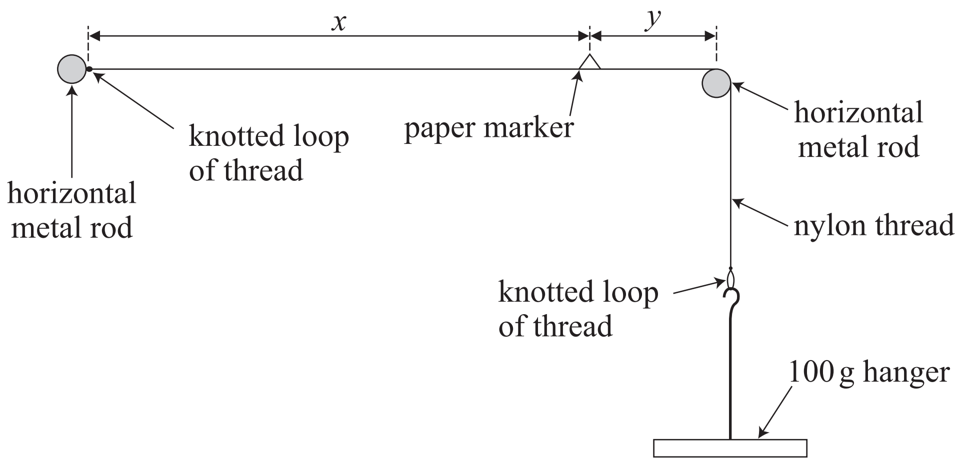
2 This question is about elastic deformation of threads and wires.

Figure 3



2 (a) The apparatus shown in **Figure 3** has been set up for you. Measure and record the length, x, of the nylon thread, and the distance y.

(2 marks)

2 (b) Carefully increase the tension in the thread by adding five 100 g masses to the hanger, one at a time. Measure and record the distance y with the extra load of 500 g in place.

(1 mark)

Question 2 continues on the next page

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2 (c) Carefully remove the 100 g masses one at a time until only the hanger is keeping the thread under tension once more.

2 (c) (i) Use the micrometer provided to measure the diameter of the thread.

2 (c) (ii) Use your readings from parts (a), (b) and (c)(i) to find the increase in stress and the increase in strain when the nylon thread was stretched by adding all five 100 g masses to the hanger.

gravitational field strength = 9.81 N kg^{-1}

2 (c) (iii) How would doubling the length x affect your answers to part (c)(ii)?

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(7 marks)

2 (d) When a thread or wire is stretched, show that the Young modulus, E, for the material can be found from the formula

$$E = \frac{Fl}{A\Delta l}$$

where F is the stretching force, l is the unstretched length, A is the cross-sectional area and Δl is the increase in length.

(2 marks)

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2 (e) Two of the 8 marks in this question are available for the quality of your written communication.

2 (e) (i) If steel wire were to be used for the experiment instead of nylon thread, describe what changes should be made to the size of the sample under test to improve the accuracy of the measurement of the strain in the sample.

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2 (e) (ii) Describe and explain what other changes could be made to the apparatus and to the method to find an accurate value for the Young modulus of steel.

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(8 marks)

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END OF QUESTIONS

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General Certificate of Education
June 2008
Advanced Level Examination

PHYSICS (SPECIFICATION B) **PHB6**
Unit 6

Formulae Sheet

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	$-\frac{1}{3}e$	$+\frac{1}{3}$
$\overline{\text{u}}$	$-\frac{2}{3}e$	$-\frac{1}{3}$
$\overline{\text{d}}$	$+\frac{1}{3}e$	$-\frac{1}{3}$

Lepton Numbers

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

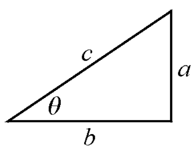
Geometrical and Trigonometrical Relationships

circumference of circle $= 2\pi r$

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

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

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



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

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

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

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

This insert page should **not** be sent to the examiner

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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

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

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

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

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

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

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

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

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

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

$$\phi = BA$$

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

$$E = mc^2$$

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

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

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

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

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

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

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

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

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

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

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

Momentum and Quantum Phenomena

$$Ft = \Delta(mv)$$

$$E = hf$$

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

$$hf = E_2 - E_1$$

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