General Certificate of Education
June 2007
Advanced Level Examination

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

To be conducted between Thursday 1 March 2007 and
Monday 21 May 2007

For this paper you must have:
• 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** of the question.
- You will need a separate sheet of graph paper.
- *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 to be marked.

Information
- The maximum mark for this paper is 39.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.

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.

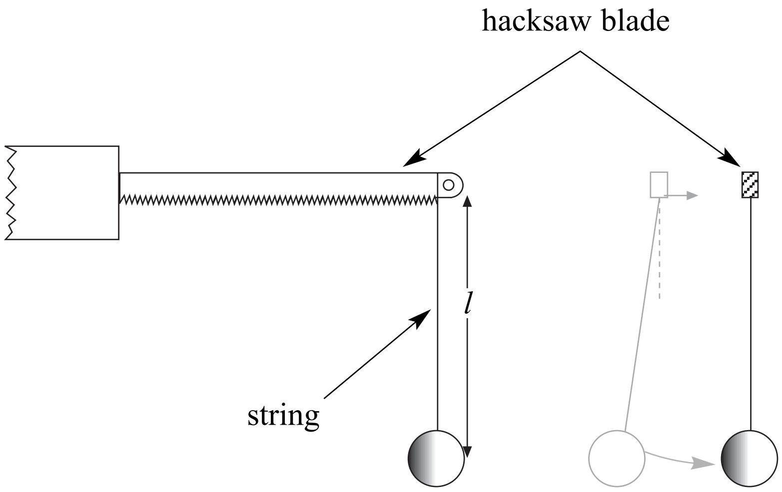
Answer **all** of the question.

1 This question is about a pendulum swinging from a non-rigid support.

You are provided with a pendulum bob which can be attached by a length of thread to the end of a flexible hacksaw blade.
Set up a pendulum suspended from the hacksaw blade as shown in **Figure 1.** You should attach the thread to the blade at the point where the teeth begin.

The teeth of the hacksaw blade have been left unprotected as this will help you to define the length of the thread accurately. However you should take care when using the arrangement because of the danger from the sharp edges.

Figure 1



Set the length, l, of the pendulum (measured to the centre of the bob) to 0.50 m.

(a) Displace the pendulum bob as shown in **Figure 1** and allow it to swing as a pendulum. The hacksaw blade will also move from side to side with the same time period as the pendulum. If there is an additional fast vibration of the blade, damp this out with your finger on the blade without touching the pendulum thread itself.

Determine the period of oscillation of the pendulum bob for small amplitude oscillations.
(2 marks)

(b) (i) Calculate the time period for a simple pendulum of length 0.50 m attached to a rigid support.
gravitational acceleration = 9.8 m s^{-2}

(ii) Comment on the values you have obtained in parts (a) and (b) (i) and explain any differences between them. *(5 marks)*

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Foundation Physics Mechanics Formulae

moment of force $= Fd$

$v = u + at$

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

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

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

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

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

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

Foundation Physics Electricity Formulae

$I = nAvq$

terminal p.d. $= E - Ir$

in series circuit, $R = R_1 + R_2 + R_3 + \ldots\ldots$

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

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

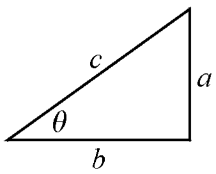
Geometrical and Trigonometrical Relationships

circumference of circle $= 2\pi r$

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

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

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



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

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

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

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

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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

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

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

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

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

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

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

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

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

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

$$\phi = BA$$

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

$$E = mc^2$$

Temperature and Molecular Kinetic Theory

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

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

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

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

$$\text{in parallel, } C = C_1 + \mathrm{C}_2$$

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

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

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

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

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

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

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

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

Momentum and Quantum Phenomena

$$Ft = \Delta(mv)$$

$$E = hf$$

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

$$hf = E_2 - E_1$$

(c) The displacement of the bob, x, from its equilibrium position is related to the time since the start of the motion, t, by the relationship

$$x = A \cos \omega t$$

(i) Explain the significance of A.

(ii) Name the physical quantity represented by ω and explain its meaning.

(4 marks)

(d) You are to take measurements of the time period, T, of the pendulum for a range of lengths of the pendulum sufficient to plot a graph.

(i) Record all your measured values in an appropriate table. You should include a further column in your table in which to record values of T^2.

(ii) Calculate and record corresponding values of T^2 in your table.

(13 marks)

(e) Plot a graph of T^2 (y-axis) against l (x-axis). *(5 marks)*

(f) It is suggested that T is related to l by the relationship

$$T^2 = \frac{4\pi^2}{g} l + \frac{4\pi^2}{g} k$$

where g is the gravitational acceleration and k is a constant.

Use your graph to calculate a value for g. *(5 marks)*

(g) (i) Calculate k.

(ii) State the S.I. unit of k.

(iii) Suggest the physical significance of k.

(5 marks)

END OF QUESTION

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