General Certificate of Education
June 2006
Advanced Level Examination

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

To be conducted between Wednesday 1 March 2006 and
Wednesday 24 May 2006

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** 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.
- 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** questions.

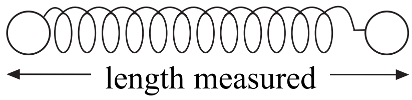
1 You are going to investigate the friction acting between string and plastic when the string is wrapped around a plastic cylinder.

(a) You have been provided with a spring that is attached to a wooden strip with a scale.

(i) Measure l_0 , the length of the spring with no load.

The length measured throughout the experiment is the total length including the loops at each end, as shown in **Figure 1**.

Figure 1



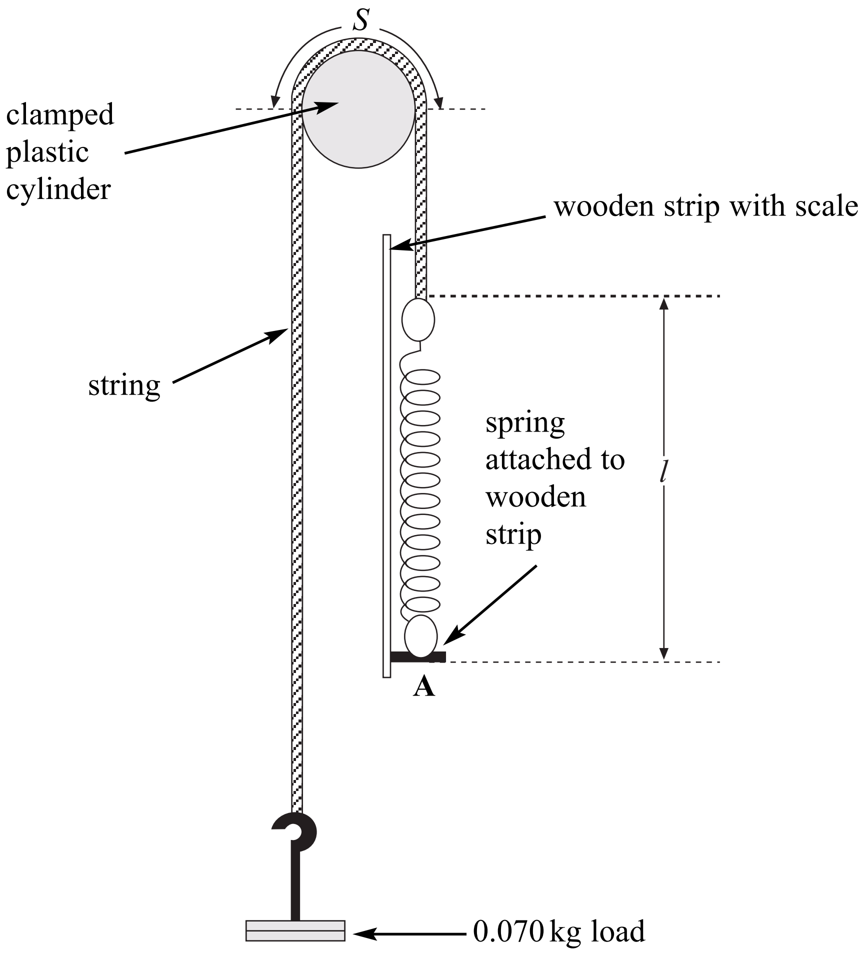
(ii) Measure L, the length of the spring when a load of 0.070 kg is suspended from it.

(iii) Use your data to determine the force needed to stretch the spring by 1 mm.

gravitational field strength = 9.8 N kg^{-1} *(4 marks)*

(b) Arrange the apparatus as shown in **Figure 2**. Note that the load suspended from the string is 0.070 kg.

Figure 2



Detach this perforated page at the start of the examination.

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, $R = R_1 + R_2 + R_3 + ...$

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

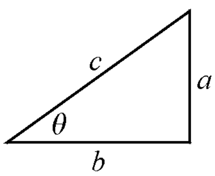
Geometrical and Trigonometrical Relationships

circumference of circle $= 2\pi r$

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

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

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



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

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

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

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

Turn over

Detach this perforated page at the start of the examination.

Circular Motion and Oscillations

$$v = r\omega$$

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

$$x = A\cos 2\pi f t$$

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

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

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

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

Fields and their Applications

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

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

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

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

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

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

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

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

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

$$\phi = BA$$

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

$$E = mc^2$$

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

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

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

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

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

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

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

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

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

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

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

Momentum and Quantum Phenomena

$$Ft = \Delta(mv)$$

$$E = hf$$

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

$$hf = E_2 - E_1$$

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

When the wooden strip is pulled downwards at **A** the spring stretches so that it exerts a force F on the string. You are now going to obtain data to determine how the force F, in N, needed to start the load moving varies with S, the length of string in contact with the plastic cylinder.

The circumference of the cylinder is given on a card near your apparatus. State this value in your answer book.

In the arrangement in **Figure 2** the string is in contact with half the circumference of the plastic cylinder.

(i) Calculate S for the arrangement in **Figure 2**.

(ii) You are to stretch the spring and measure, as accurately as possible, the length, l, of the spring when the string just slips on the plastic cylinder and the 0.070 kg load starts to move.

Gradually increase the length of the spring by pulling on the wooden strip.

Do some rough trials and plan how you will measure the length, l, of the spring.

In view of your trials explain briefly why it is important to repeat this measurement.

(iii) Measure and record the length l, of the spring which just causes the 0.070 kg load to move.

(iv) Calculate the extension $(l - l_0)$ of the spring and hence, using your answer to part (a)(iii), calculate the force F, in N, needed to move the load.

(6 marks)

Turn over for the next part of the question

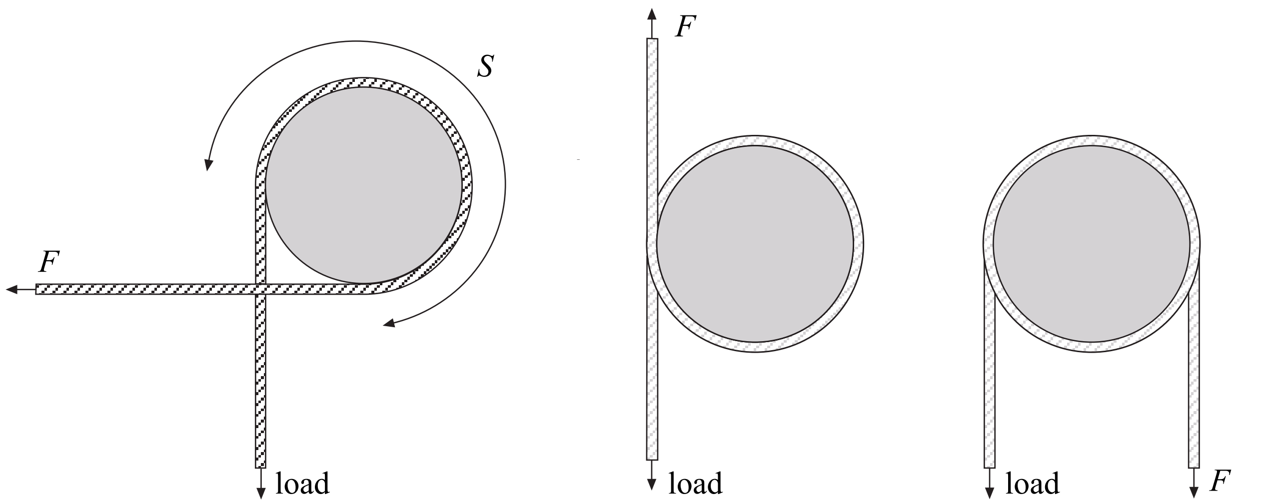
(c) Draw up a table in which to record the corresponding values of S, l, $(l–l_0)$ and F. Also include a column in which to record values for ln(F/N) i.e. $\log_e(F/\mathrm{N})$.

Repeat the procedure in parts (b)(ii) and (b)(iii) to determine F for at least 5 further values of S. Give your values of S in mm.

Some examples of other arrangements with different values of S are shown in **Figure 3**. Do not use arrangements with more than 1¾ turns.

(12 marks)

Figure 3



$S = 0.75 \times$ circumference $S =$ circumference $S = 1.5 \times$ circumference

(d) Plot the graph of ln(F/N) against S/mm. Draw the best-fit straight line through your plotted points.

(6 marks)

(e) Theory suggests that the equation representing the relationship between F and S is

$$F = K\,e^{\frac{\mu S}{R}}$$

where μ is the coefficient of friction for the string and plastic,
R is the radius of the cylinder in mm,
and K is a constant.

(i) Explain whether your data support the theory.

(ii) Determine a value for μ.

(iii) Determine a value for K. State the unit for K.

(11 marks)

END OF QUESTIONS

There are no questions printed on this page

There are no questions printed on this page