Answer on Question #75485, Physics Mechanics Relativity

A simple pendulum may be used to determine a value for the acceleration of free fall g. Measurements are made of the length L of the pendulum and the period T of oscillation. The values obtained, with their uncertainties are shown as

T=(1.93+_0.03)s
L=(92+_1)cm
(its a plus and under is a minus)

a) calculate the percentage uncertainty in the measurement
i) the period T
ii) the length L

b) The relationship between T, L and g is given by

g= 4 Pi^2 (symbol of Pi) L/ T^2

Using your answer in (a), calculate the percentage uncertainty in the value of g

c) The values of L and the T are used to calculate a value of g as 9.751 ms^-2

i) by reference to the measurements of L and T, suggest why it would not be correct to quote the value of g as 9.751ms^-2

ii) Use your answer in (b) to determine the absolute uncertainty in g.
Hence state the value of g, with its uncertainty, to an appropriate number of significant figures.

Solution.

a) The percentage uncertainty in the measurement
i) the period T : $\frac{0.13}{1.93} = 1.5544\ \%$
ii) the length L : $\frac{1}{92} = 1.087\ \%$

b) $g = \frac{4 \cdot \pi^2 \cdot L}{T^2} = \frac{4 \cdot 3.14^2 \cdot 0.92}{1.93^2} = 9.7408\ \frac{m}{s^2}$

$$g_{min} = \frac{4 \cdot \pi^2 \cdot L}{T^2} = \frac{4 \cdot 3.14^2 \cdot 0.91}{1.96^2} = 9.3422\ \frac{m}{s^2}$$

$$g_{max} = \frac{4 \cdot \pi^2 \cdot L}{T^2} = \frac{4 \cdot 3.14^2 \cdot 0.93}{1.9^2} = 10.16\ \frac{m}{s^2}$$

g = 9.74+_0.4 $\frac{m}{s^2}$

The percentage uncertainty in the value of g : 0.4/9.74 = 4.1068 %

c) If a value of g as 9.751 ms^-2 :

T = 1.928

L = 0.919

i) Because the uncertainty is insignificant

ii) $g = \frac{g+g_{min}+g_{max}}{3} = 9.7477$

Δ g = 10.16-9.7477= 0.41

absolute uncertainty in g

g = 9.75+_0.41

Hence state the value of g, with its uncertainty, to an appropriate number of significant figures (2).