AP Physics C: Mechanics
2000 Student Samples

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PHYSICS C

Section II, MECHANICS

Time—45 minutes

3 Questions

Directions: Answer all three questions. The suggested time is about 15 minutes for answering each of the questions, which are worth 15 points each. The parts within a question may not have equal weight. Show all your work in this booklet in the spaces provided after each part, NOT in the green insert.

Mech 1.

You are conducting an experiment to measure the acceleration due to gravity g_0 at an unknown location. In the measurement apparatus, a simple pendulum swings past a photogate located at the pendulum's lowest point, which records the time t_{10} for the pendulum to undergo 10 full oscillations. The pendulum consists of a sphere of mass m at the end of a string and has a length ℓ. There are four versions of this apparatus, each with a different length. All four are at the unknown location, and the data shown below are sent to you during the experiment.

ℓ (cm)	t_{10} (s)	T (s)	T^2 (s^2)
12	7.62	.762 s	.581
18	8.89	.889 s	.790
21	10.09	1.009 s	1.018
32	12.08	1.208 s	1.459

(a) For each pendulum, calculate the period T and the square of the period. Use a reasonable number of significant figures. Enter these results in the table above.

$T = \frac{t_{10}}{\#\text{ of oscillations}} = \frac{7.62\text{ s}}{10} = .762\text{ s}$

$\frac{8.89}{10} = .889\text{ s}$

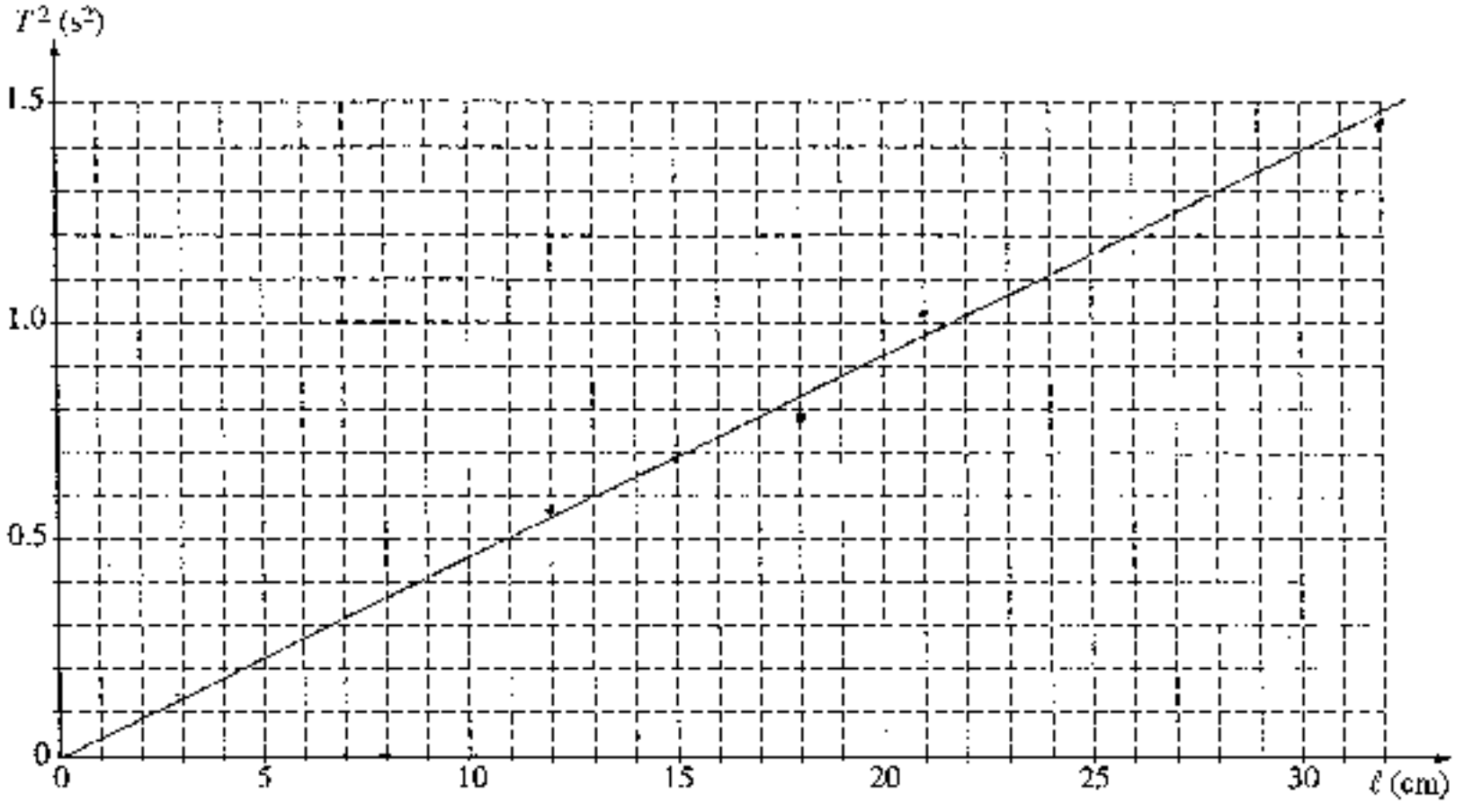
etc...

$T^2 = (.762\text{ s})^2 = .581\text{ s}^2$

etc...

GO ON TO THE NEXT PAGE.

(b) On the axes below, plot the square of the period versus the length of the pendulum. Draw a best-fit straight line for this data.



(c) Assuming that each pendulum undergoes small amplitude oscillations, from your fit determine the experimental value g_{exp} of the acceleration due to gravity at this unknown location. Justify your answer.

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$T^2 = \frac{4\pi^2\ell}{g} \qquad g = \frac{4\pi^2\ell}{T^2} = \frac{4\pi^2}{m} \quad (1)$$

From graph: $m = \frac{\Delta(T^2)}{\Delta\ell} = \frac{1.48\ s^2 - 0\ s^2}{.32\ m - 0\ m} = 4.63\ \frac{s^2}{m}$

Substitute m into (1):

$$g = \frac{4\pi^2}{m} = \frac{4\pi^2}{4.63\ \frac{s^2}{m}} = \boxed{8.53\ \frac{m}{s^2}}$$

GO ON TO THE NEXT PAGE.

(d) If the measurement apparatus allows a determination of g_y that is accurate to within 4%, is your experimental value in agreement with the value 9.80 m/s^2 ? Justify your answer.

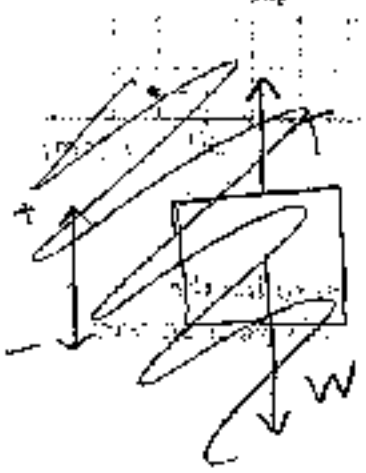
$$\%\text{ diff} = \frac{\text{exp} - \text{act}}{\text{act}}(100\%)$$

$$= \frac{8.53 - 9.80}{9.80}(100\%)$$

$$= -12.9\%$$

No, the value is not in agreement, it is about 13% different.

(e) Someone informs you that the experimental apparatus is in fact near Earth's surface, but that the experiment has been conducted inside an elevator with a constant acceleration a. Assuming that your experimental value g_{exp} is exact, determine the magnitude and direction of the elevator's acceleration.



If elevator was in freefall, g felt by occupant is zero. If elevator accends, g felt by occupants is greater than 9.80

Because $g_{exp} = 8.53 \frac{m}{s^2}$, $a_{elev} = 9.8 \frac{m}{s^2} - 8.53 \frac{m}{s^2}$

$0 < a_{elev} < 9.8$ $\Rightarrow$ $= 1.27 \frac{m}{s^2} \downarrow$

B1

PHYSICS C

Section II, MECHANICS

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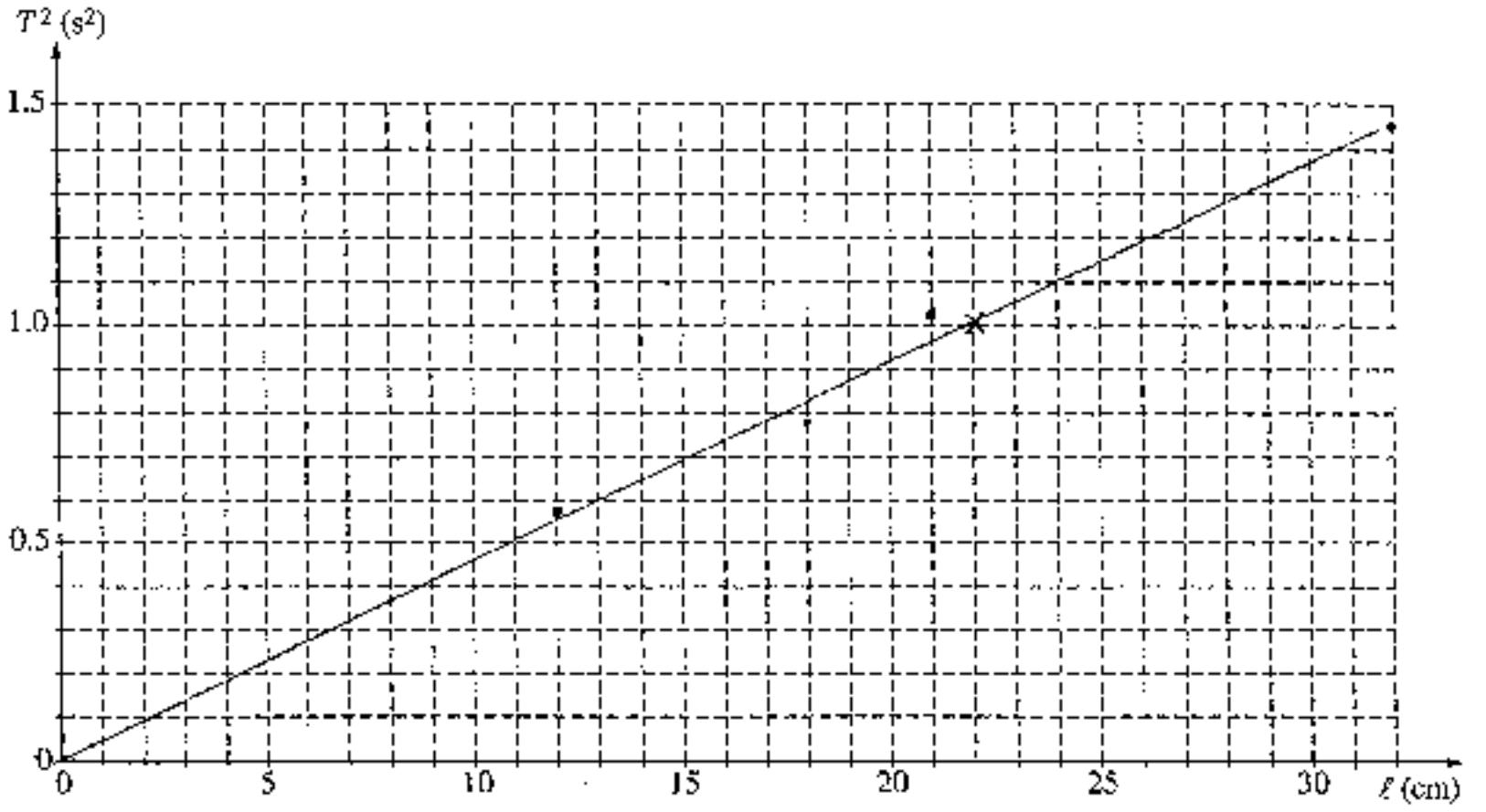
Mech 1.

You are conducting an experiment to measure the acceleration due to gravity g_0 at an unknown location. In the measurement apparatus, a simple pendulum swings past a photogate located at the pendulum's lowest point, which records the time t_{10} for the pendulum to undergo 10 full oscillations. The pendulum consists of a sphere of mass m at the end of a string and has a length ℓ. There are four versions of this apparatus, each with a different length. All four are at the unknown location, and the data shown below are sent to you during the experiment.

ℓ (cm)	t_{10} (s)	T (s)	T^2 (s^2)
12	7.62	.762	.581
18	8.89	.889	.790
21	10.09	1.01	1.02
32	12.08	1.21	1.46

(a) For each pendulum, calculate the period T and the square of the period. Use a reasonable number of significant figures. Enter these results in the table above.

(b) On the axes below, plot the square of the period versus the length of the pendulum. Draw a best-fit straight line for this data.



(c) Assuming that each pendulum undergoes small amplitude oscillations, from your fit determine the experimental value g_{exp} of the acceleration due to gravity at this unknown location. Justify your answer.

$T_p = 2\pi\sqrt{\frac{l}{g}}$, so $T_p^2 = 4\pi^2 \cdot \frac{l}{g}$

$g = \frac{4\pi^2 l}{T^2}$ $\quad \frac{l}{T^2} \approx 22$ (marked "x" above)

$g = 22 \cdot 4\pi^2 = 88\pi^2 = 869 \frac{cm}{s}$

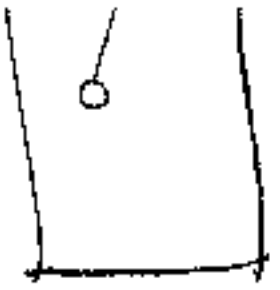
$\left(= 8.69 \frac{m}{s}\right)$

(d) If the measurement apparatus allows a determination of g_0 that is accurate to within 4%, is your experimental value in agreement with the value 9.80 m/s^2 ? Justify your answer.

$\frac{9.80 - 8.69}{9.80}$ = 11.3% error

not w/in 4%, so g_{exp} is not in agreement

(e) Someone informs you that the experimental apparatus is in fact near Earth's surface, but that the experiment has been conducted inside an elevator with a constant acceleration a. Assuming that your experimental value g_{exp} is exact, determine the magnitude and direction of the elevator's acceleration.



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Mech 1.

You are conducting an experiment to measure the acceleration due to gravity g_u at an unknown location. In the measurement apparatus, a simple pendulum swings past a photogate located at the pendulum's lowest point, which records the time t_{10} for the pendulum to undergo 10 full oscillations. The pendulum consists of a sphere of mass m at the end of a string and has a length ℓ. There are four versions of this apparatus, each with a different length. All four are at the unknown location, and the data shown below are sent to you during the experiment.

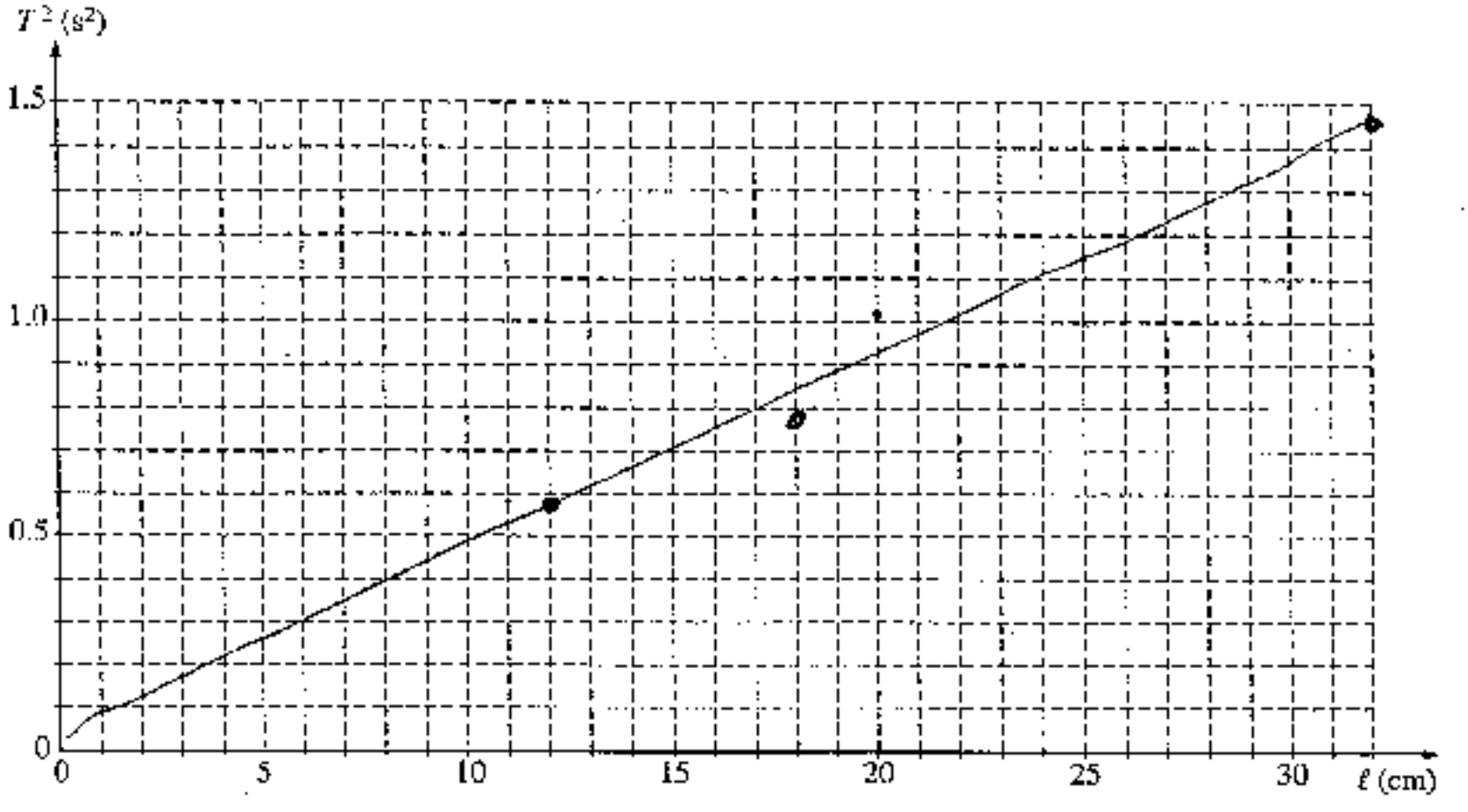
ℓ (cm)	t_{10} (s)	T (s)	T^2 (s^2)
12	7.62	.762	.580644
18	8.89	.889	.790321
21	10.09	1.009	1.018081
32	12.08	1.208	1.459264

(a) For each pendulum, calculate the period T and the square of the period. Use a reasonable number of significant figures. Enter these results in the table above.

$$T_p = 2\pi\sqrt{\frac{\ell}{g}}$$

$$\frac{t_{10}}{10} = T_p$$

(b) On the axes below, plot the square of the period versus the length of the pendulum. Draw a best-fit straight line for this data.



(c) Assuming that each pendulum undergoes small amplitude oscillations, from your fit determine the experimental value g_{exp} of the acceleration due to gravity at this unknown location. Justify your answer.

$T_p = 2\pi\sqrt{\frac{\ell}{g}}$

$T_p^2 = 2^2\pi^2\frac{\ell}{g}$

@ $\ell = 12$ $T_p^2 = .580644$

$.580644 = 4\pi^2 \times .12 \frac{}{g}$

$g = 8.16 \text{ m/s}^2$

(d) If the measurement apparatus allows a determination of g_a that is accurate to within 4%, is your experimental value in agreement with the value 9.80 m/s^2 ? Justify your answer.

Nope. I calculated g to be 8.16 m/s^2

$$\frac{9.8-8.16}{9.8}\times 100 = 16\% \text{ error}$$

(c) Someone informs you that the experimental apparatus is in fact near Earth's surface, but that the experiment has been conducted inside an elevator with a constant acceleration a. Assuming that your experimental value g_{exp} is exact, determine the magnitude and direction of the elevator's acceleration.