Year 12 Physics Practical Skills Examination (AT1) 2022-23 Marking Guideline

Part A (18 marks)

1. Results Table (4 marks):

One mark for every completed row for each string length. (1 x 4 marks)

(Sample data is shown below – allow for student's data to vary within reasonable limits)

Pendulum length, ℓ (m)	Time for 10 oscillations (s) (Trial 1)	Time for 10 oscillations (s) (Trial 2)	Average time for 10 oscillations (s)	Time for one Period, T (s)	Time Period squared, T^2 (s^2)
1.0	20.1	20.3	20.2	2.02	4.08
0.8	18.0	18.2	18.1	1.81	3.28
0.6	15.6	15.8	15.7	1.57	2.46
0.4	12.7	12.9	12.8	1.28	1.64

2. Graph and gradient (5 marks):

T^2 on vertical and ℓ on horizontal axis (both axes labelled and with units). 1 mark

Proper scaling of data ranges on both axes to produce a clear graph. 1 mark

4 data point visibly plotted on graph. 1 mark

A line of best fit (LOBF) drawn to average out random errors (watch out for a force fitted line through the origin if the data trend indicates otherwise). 1 mark

Calculation of the gradient of the LOBF using a rise/run method and not from a single point to the origin (calculation of rise/run should be evident). 1 mark

3. Analysis (9 marks):

a. $T = 2\pi\sqrt{\frac{l}{g}}$ $T^2 = 4\pi^2\frac{l}{g}$ $g = 4\pi^2\frac{l}{T^2}$ 1 mark

b. Equating the gradient to $4\pi^2/g$ (for reference, gradient should be around 4.0). 1 mark

Obtaining a value for 'g' based on candidate's calculations. 1 mark

c. Must state that systematic error is present if the extended LOBF does not pass through the origin (the pendulum equation indicates that it should). 1 mark

Must state that random error is present if all the data points do not lie exactly on the LOBF (Note: random error will always be present) 1 mark

By using a LOBF, data variation is averaged out thereby reducing random error 1 mark

d. Using the pendulum formula, the graph should be linear. 1 mark

From the pendulum formula, the gradient should now be $\frac{2\pi}{\sqrt{g}}$ 1 mark

e. There is no mass in the pendulum formula, so mass has no effect. 1 mark

Part B (18 marks)

Question 1: (10 marks)

a. A suitable aim: "To determine the spring potential energy as a function of spring compression distance" 1 mark

b. Calculates the spring constant from graph, k = 24 / 0.08 = 300 N/m 1 mark

Finding the spring's potential energy = $0.5kx^2 = 0.5 \times 300 \times (0.08)^2 = 0.96$ J 1 mark

Equating kinetic energy to the spring's potential energy ($0.5mv^2 = 0.96$) 1 mark

Correct answer for velocity v, ($0.5 \times 0.04 \times v^2 = 0.96$), v = 6.9 ms^{-1} 1 mark

(Note: answer for potential energy can also be found from the area under the curve)

c. Finding the peak height using any suitable method, h = 0.6 m (for example: $0.5mv_y^2 = mgh$, $0.5 \times (6.9\sin 30)^2 = 9.8 \times h$) 1 mark

Finding GPE at peak = mgh = $0.04 \times 9.8 \times 0.6 = 0.24$ J 1 mark

Correct explanation "At its peak, the projectile still has kinetic energy due to its horizontal velocity" (note: spring PE was = 0.96 J) 1 mark

d. Points are very close to the line of best fit, showing small random errors 1 mark

This together with no outliers, suggests that the data is reliable/precise 1 mark

(note: repeatability of data measurements is assumed since only averaged data values are plotted on graphs and not individual trials. Also, the question does not ask about accuracy of data so the mention of systematic error is not required)

Question 2: (8 marks)

a. Shows the relationship: $T_1 - mg = mv_1^2/r$ or $T_1 = mg + mv_1^2/r$ (T_1 – tension) 1 mark

Substitution & answer for speed: $30 = 0.5x9.8 + 0.5v_1^2/1.0$ and $v_1 = 7.1$ ms^{-1} 1 mark

b. Shows the energy relationships at position 2 with respect to position 1: $\frac{1}{2}mv_1^2 = mg\Delta h + \frac{1}{2}mv_2^2$ (students may include height from ground for both positions which is ok but not necessary) 1 mark

Determines the increase in height, $\Delta h = r + r\cos 45° = 1.0 + 1.0\cos 45° = 1.7$ m 1 mark

Substitution & answer for speed: $\frac{1}{2} \times 7.1^2 = 9.8x1.7 + \frac{1}{2}v_2^2$ (mass cancels) giving $v_2 = 4.1$ ms^{-1} 1 mark

c. Shows the energy relationship at position 2 with respect to ground: $\frac{1}{2}mv_2^2 + mgh_{gnd} = \frac{1}{2}mv_{gnd}^2$ 1 mark

Substitution and answer for speed: $\frac{1}{2} \times 4.1^2 + 9.8x(2.0 + 1.7) = \frac{1}{2}v_{gnd}^2$ (mass cancels) giving $v_{gnd} = 9.5$ ms^{-1} 1 mark

[**Alternative calculation:**]

Shows the energy relationship at position 1 with respect to ground: $\frac{1}{2}mv_1^2 + mgh_{gnd} = \frac{1}{2}mv_{gnd}^2$ [1 mark]

Substitution and answer for speed: $\frac{1}{2} \times 7.1^2 + 9.8x2.0 = \frac{1}{2}v_{gnd}^2$ (mass cancels) and $v_{gnd} = 9.5$ ms^{-1} [1 mark]

d. The circular motion is non-uniform because the projectile's speed is not constant as it moves in a vertical circle (do not accept because the velocity is changing) 1 mark