Unit 2 · Periodic Motion

HARDER PRACTICE QUESTIONS

Full marks 33

Write your answers on separate paper. Show your working. Take g = 9.8 m/s^2.

1 Spot the error [3]

Find the mistake in the working and correct it.

A particle moves in SHM with an amplitude of 3 cm and a frequency of 4 Hz. Aayush finds its greatest speed:
"$v_{max} = rf = 0.03 \times 4 = \mathbf{0.12\ m/s}$."

2 Read the data [5]

Answer from the data.

Shreya times a simple pendulum at five lengths and works out T^2:

Length l (m)	0.30	0.45	0.60	0.75	0.90
T^2 (s^2)	1.21	1.81	2.80	3.02	3.63

i. Plot T^2 against l (or picture the graph). Which reading doesn't fit the straight line through the origin? What should it be?
ii. Find the slope of the line from two good points.
iii. Find g.
iv. Why is it better to find g from the slope than from a single reading?

3 A real setting [4]

The numbers are made up.

When four passengers of total mass 240 kg get into a jeep, its body sinks 4.0 cm on its springs. The loaded body, with the passengers, has a mass of 1440 kg.

i. Find the spring constant of the jeep's springs, taken together.
ii. Find the period with which the loaded body would bounce on them after a bump, if there were no shock absorbers.

4 Show that [3]

For a particle moving as $y = r\sin \omega t$, show that its velocity is a quarter of a cycle ($\pi/2$) ahead of its displacement, and say where in the motion this puts the greatest speed.

5 Predict, then explain [3]

Write your prediction first, then explain it.

Two identical springs, each of spring constant k, are used to hold the same mass m, first in series (one below the other), then in parallel (side by side).

i. Predict: in which arrangement is the period longer?
ii. Find the ratio of the two periods.

6 Which explanation fits? [2]

Soldiers are ordered to break step when they march across a bridge. Kriti says it is because their weight is too much for the bridge when they march; Utsab says it is because of resonance. The same soldiers can stand on the bridge all together without danger. Which explanation does this support, and why?

7 Estimate it [3]

Treat each leg as a simple pendulum as long as the leg. The leg lengths are made up.

Estimate how long one swing of the leg (half a period) takes for an adult whose legs are 0.9 m long and for a child whose legs are 0.5 m long. Which walks with quicker steps, and by about what factor?

8 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

Sushant wrote: “In SHM the acceleration is greatest at the mean position, where the body moves fastest. A pendulum with a heavier bob swings more slowly. A mass on a spring oscillates about the point where the spring has its natural length.”

9 What if? [2]

A torsion pendulum has a solid disc of mass M and radius R. What happens to its period if the disc is replaced by a thin ring of the same mass and radius on the same wire? (A disc has $I = \frac{1}{2}MR^2$, a ring MR^2.)

10 Design it [3]

Describe how you would find the spring constant of a spring in two different ways, using some slotted masses, a meter scale and a stopwatch. Which quantity would you keep the same in the second method, and why should the two answers agree?

11 Make your own [2]

Design a simple pendulum that takes 1 s for each complete oscillation. How long should it be?