OCR A A Level Simple Harmonic Motion 1 worksheet

35-40 minutes independent practice + 15-20 minutes review | 45 marks

Specification points covered

- 5.3.1(a) Define displacement, amplitude, period, frequency, angular frequency and phase difference in oscillations.
- 5.3.1(b) Use angular frequency $\omega = 2\pi/T = 2\pi f$.
- 5.3.1(c)(i) Define simple harmonic motion using $a = -\omega^2 x$.
- 5.3.1(c)(ii) Use techniques and procedures to determine the period or frequency of simple harmonic oscillations.
- 5.3.1(d) Use $x = A\cos(\omega t)$ or $x = A\sin(\omega t)$, selected from the initial conditions.
- 5.3.1(g) Use graphical methods to relate displacement and acceleration during SHM.

Aurora S-9 wing ground-vibration test

Engineers test the flexible wing tip of a high-altitude solar aircraft before flight. A fiducial marker moves vertically past a scale while a slow-motion camera records the motion.
Take upward displacement as positive. Show working, use SI units and choose sine or cosine from the stated position and direction at t = 0.

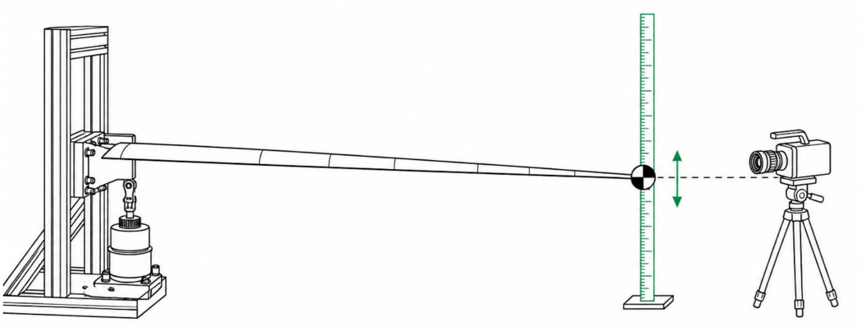

Figure 1: wing-tip optical measurement arrangement

1. The upper and lower turning positions of the wing-tip marker are 0.360 m apart. (a) Determine the amplitude. (b) Upward is positive. State the displacement when the marker is 0.120 m below equilibrium. (c) State one distinction between displacement and distance travelled. **[3 marks]**

Complete the Module 5 end-of-topic exam
Available with an upgraded or school account
www.physicsuk.co.uk

1. Angular frequency and the SHM condition

2. Slow-motion footage shows 18 complete oscillations in 12.0 s. Calculate the frequency, period and angular frequency of the wing tip. Explain why timing many oscillations gives a more reliable period than timing one oscillation. **[4 marks]**

3. State the condition for motion to be simple harmonic. Include the defining equation and explain the meaning of its negative sign. **[3 marks]**

Complete the Module 5 end-of-topic exam

Available with an upgraded or school account

www.physicsuk.co.uk

2. Acceleration-displacement evidence

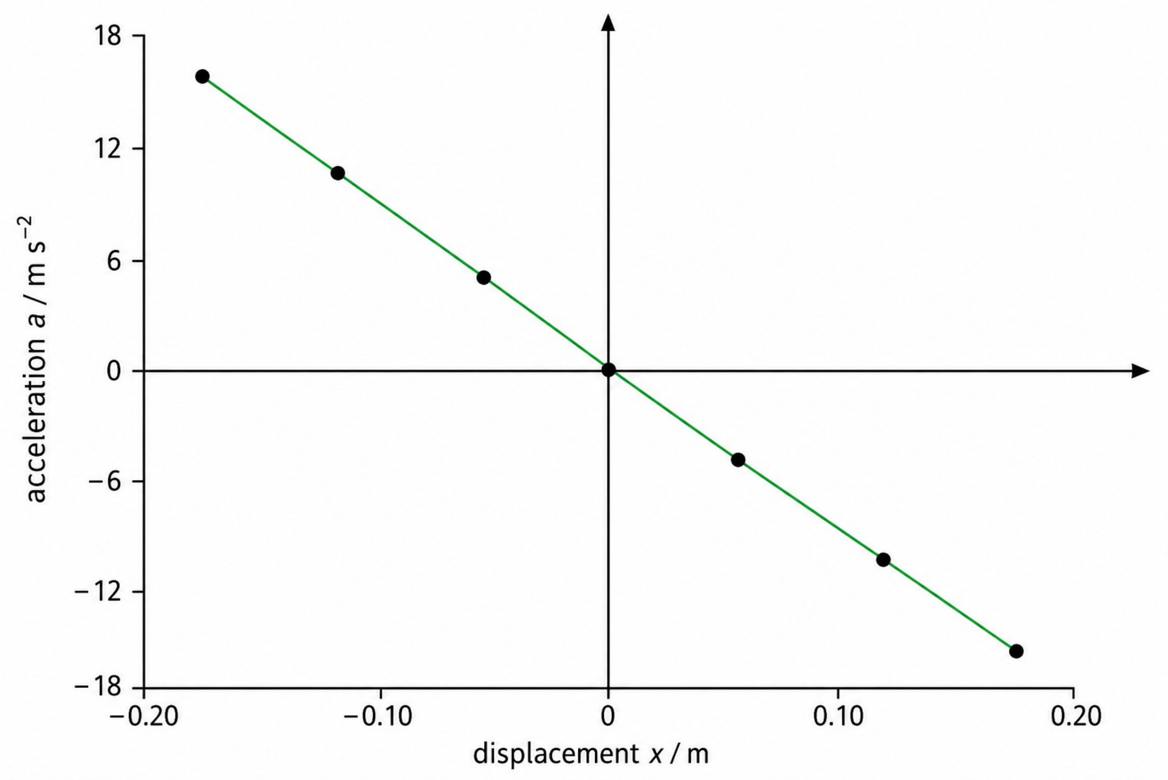

Figure 2: acceleration a against displacement x for Run A

4. Figure 2 shows acceleration a plotted against displacement x for the free wing-tip oscillation. (a) Use widely separated points on the line to determine its gradient, including the unit. (b) Hence calculate the angular frequency and frequency. (c) Explain how the graph supports the claim that the motion is simple harmonic. [6 marks]

Complete the Module 5 end-of-topic exam

Available with an upgraded or school account

www.physicsuk.co.uk

3. Free oscillation from a turning point

5. Run A begins when the wing tip is released from rest at its upper turning point. The amplitude is 0.180 m and the frequency is 1.50 Hz. (a) Explain why a cosine model is suitable and write an equation for displacement x at time t. (b) Calculate x at t = 0.250 s. **[5 marks]**

6. For Run A, calculate the first time after release at which the wing tip passes through equilibrium. Then calculate the acceleration at t = 0.250 s and state its direction. **[3 marks]**

Complete the Module 5 end-of-topic exam

Available with an upgraded or school account

www.physicsuk.co.uk

4. Trigger position, phase and driven motion

7. In Run B, a shaker drives the wing at 1.20 Hz with amplitude 0.125 m. The timer is triggered as the marker passes through equilibrium moving upward. (a) Write the displacement equation. (b) Calculate the displacement at t = 0.150 s. (c) Calculate the first time after the trigger at which the marker reaches its upper turning point. [5 marks]

8. A repeat of Run B is timed from the instant the marker passes through equilibrium moving downward. Write the new displacement equation and explain why describing an oscillator as 'driven' does not, by itself, decide whether sine or cosine should be used. [2 marks]

9. Run C is a free oscillation of the same wing, but its amplitude is 0.090 m. Compare its period with Run A and calculate its maximum acceleration. State the physical principle used in the comparison. [3 marks]

10. A stroboscope flashing at 1.50 Hz makes the marker appear stationary. Explain what this observation suggests and why the observation alone does not prove that the wing frequency is exactly 1.50 Hz. [2 marks]

Complete the Module 5 end-of-topic exam

Available with an upgraded or school account

www.physicsuk.co.uk

5. Practical: measuring and testing SHM

11. Scaffolded six-mark practical. Describe how slow-motion video can be used to determine the amplitude and frequency of the wing-tip motion and test whether it is consistent with SHM. Organise your answer around: the fiducial marker and scale; camera position and time base; release or drive conditions; measurements, repeats and uncertainty; calculation of A, T, f and ω; and a graph or model that tests $a = -\omega^2 x$.
[6 marks]

Complete the Module 5 end-of-topic exam
Available with an upgraded or school account
www.physicsuk.co.uk

6. Language precision

12. A student writes, 'At the upper turning point, the velocity is accelerating downwards and is greatest.' Rewrite this statement using precise language for velocity and acceleration. [3 marks]

Review and improve

- ☐ I select sine or cosine from the initial position and direction, not from the word 'driven' alone.
- ☐ I use a negative acceleration-displacement gradient to identify SHM and obtain ω.
- ☐ I describe quantities precisely: velocity changes; acceleration has magnitude and direction.

Complete the Module 5 end-of-topic exam
Available with an upgraded or school account
www.physicsuk.co.uk