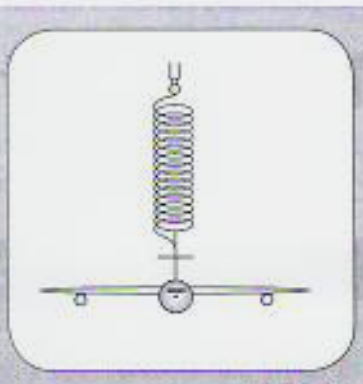
③ + ④ are needed

3 a The diagram shows a toy consisting of a light plastic aeroplane suspended from a long spring.



i The aeroplane is pulled down 0.040 m and released. It undergoes a vertical harmonic oscillation with a period of 1.0 s. The oscillations are lightly damped. Sketch a graph of the displacement y of the aeroplane against time t from the moment of release to time $t = 4.0$ s. [3]

ii The aeroplane is replaced by a heavier model made of the same plastic having the same fuselage but larger wings. State and explain two changes which this substitution will make to the displacement against time graph that you have drawn for part i. [4]

Sketch is needed

Hint

b The top end of the spring in the diagram is then vibrated with a small constant amplitude. The motion of the aeroplane changes as the frequency of the oscillation of the top end of the spring is increased slowly from zero through resonance to 2.0 Hz.

Explain the conditions for resonance to occur and describe the changes in the motion of the aeroplane as the frequency changes from zero to 2.0 Hz. [5]

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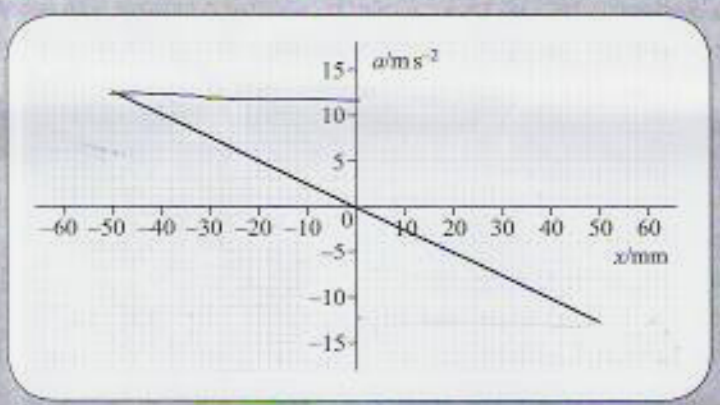
Answer

4 A mass oscillates on the end of a spring in simple harmonic motion. The graph of the acceleration a of the mass against its displacement x from its equilibrium position is shown in the graph.



a i Define *simple harmonic motion*. [2]

ii Explain how the graph shows that the object is oscillating in simple harmonic motion. [2]

Answer must be in metres

b Use data from the graph:

i to find the amplitude of the motion [1]

ii to show that the period of oscillation is 0.40 s [3]

Hint

c i The mass is released at time $t = 0$ at displacement $x = 0.050$ m. Draw a graph of the displacement of the mass until $t = 1.0$ s. [3]

Hint

graph needs details.

ii State a displacement and time at which the system has maximum kinetic energy. [2]

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Answer