Physics

Question	Maximum Mark	Mark Awarded
#1	11	
#2	12	
#3	15	
#4	15	
#5	16	
#6	19	
#7	19	
Total	107	

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#1

10. A silver ring on a light rod swings as a pendulum with damped simple harmonic motion. The damping is caused by a stationary magnet as shown in the diagram.

(a) Explain why the motion of the pendulum is damped. [4]

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(b) Explain what, if anything, would happen to the motion of the pendulum if the bar magnet were reversed. [2]

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(c) The resistivity of silver is $1.59 \times 10^{-8}\,\Omega\text{m}$, the radius of the silver ring is 2.5 cm and the cross-sectional area of the silver wire of the ring is $2.4 \times 10^{-5}\,\text{m}^2$. Show clearly that the resistance of the silver ring is approximately $0.1 \times 10^{-3}\,\Omega$. [2]

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(d) The maximum current induced in the silver ring is 5.5 A. Calculate the maximum rate at which the magnetic flux density inside the ring changes. [3]

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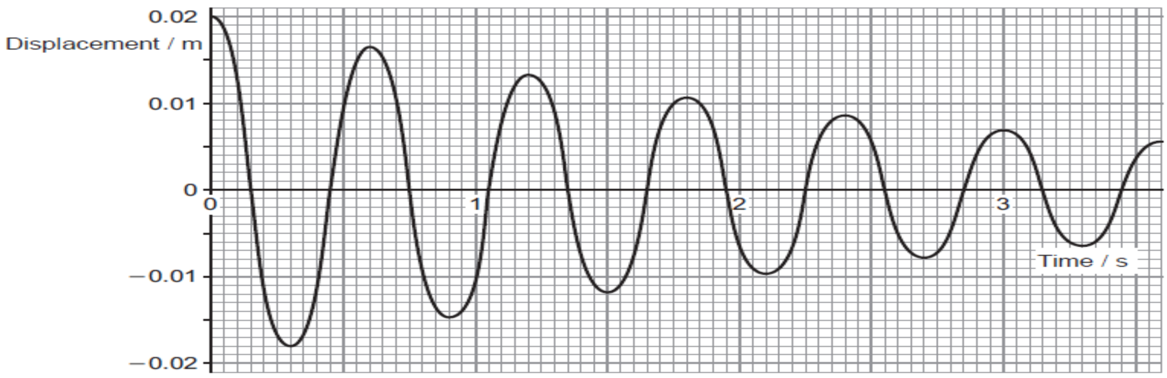
Question taken from Eduqas examination paper 842103, June 2018

#2

A metal sphere of mass 0.200 kg, hanging from a light spring of stiffness k = 22.0 N m^{-1}, is set oscillating up and down about its equilibrium position. A datalogger records the sphere's position and plots the graph shown below.



(a) State what feature of the graph shows that the sphere's oscillations are damped and identify the force responsible for this feature. [2]

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(b) Evaluate whether or not ordinary simple harmonic motion theory predicts the actual periodic time as shown on the graph convincingly. [4]

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(c) **Mark with a small circle** the point on the graph where the sphere's speed is the greatest. Use shm theory to calculate a value for this speed **and** explain whether this value is likely to be too high or too low. [4]

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(d) The amplitude, A, (in m) of the oscillations at time t is given by the equation:

$$A = 0.020\, e^{-\lambda t}$$

Determine the value of λ. [2]

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Question taken from Eduqas examination paper 842101, June 2017

#3

5. *(a)* Rachel investigates a simple pendulum consisting of a small metal sphere suspended by a thread. She determines its period to be 2.40 s.

(i) Calculate the length of the pendulum. [2]

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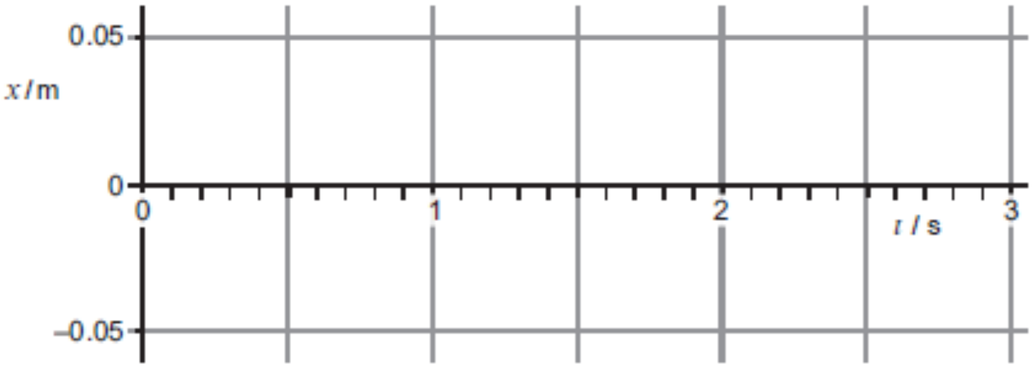
(ii) Rachel now displaces the sphere by 0.050 m to one side of its equilibrium position and releases it at time t = 0.



I. Sketch a graph of displacement, x, against time, t, for the sphere between t = 0 and t = 3.00 s on the grid provided. Take the initial value of x to be positive. [2]

II. Use an appropriate equation to calculate the sphere's displacement at t = 1.60 s. [2]

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III. Calculate the sphere's velocity at t = 1.60 s. [2]

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IV. State the next time at which the sphere has the same velocity. [1]

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(b) Explain what is meant by *resonance*, and how its effects can be reduced in a particular case where resonance should be avoided. [6 QER]

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Question taken from Eduqas examination paper 842101, June 2018

#4

5. (a) Define *simple harmonic motion.* [2]

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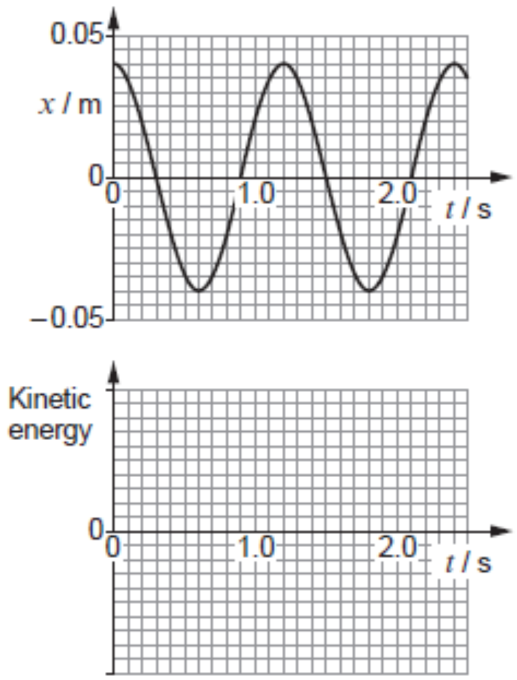
(b) A metal sphere of mass 0.175 kg hangs from a spring whose top end is clamped. The sphere is set oscillating up and down, and a displacement-time graph is plotted.



GRID FOR *(b)*(iii)

(i) Calculate the stiffness constant, k, of the spring. [3]

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(ii) Calculate the maximum kinetic energy of the sphere. [3]

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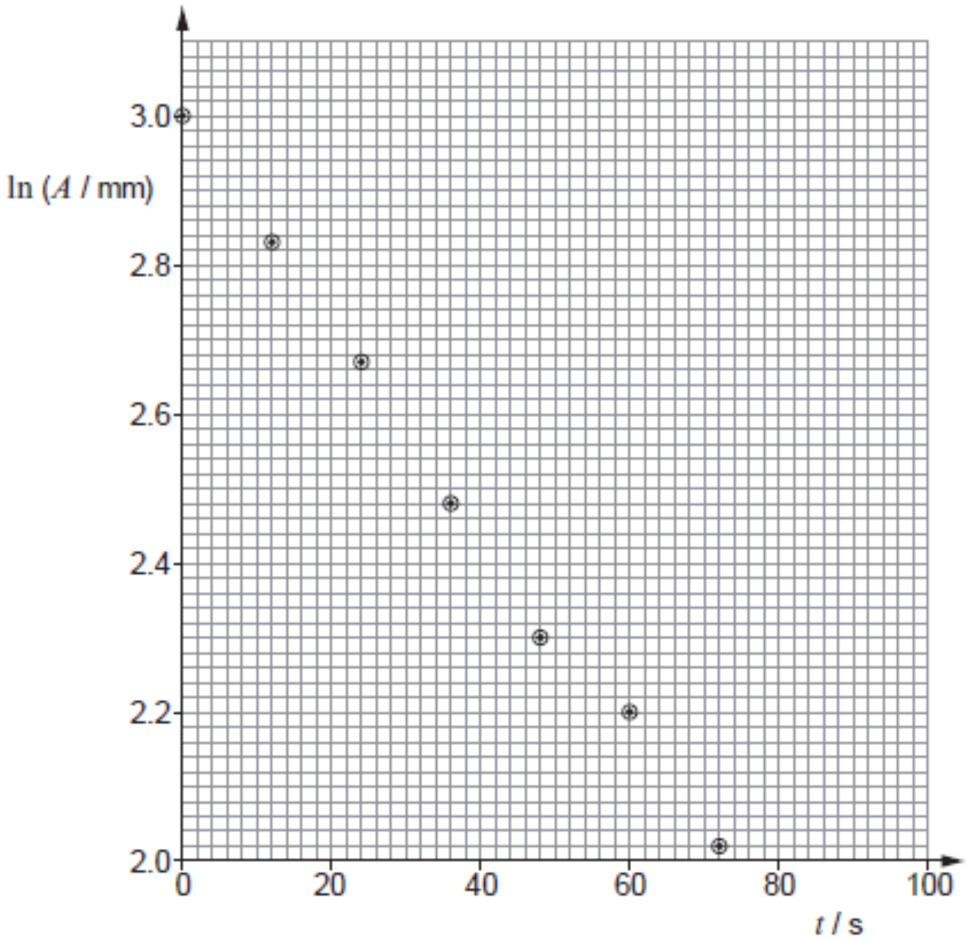
(iii) Carefully sketch a graph of the sphere's kinetic energy against time **on the axes provided on the opposite page**. A vertical scale is **not** needed. [3]

(c) Over several oscillations it is clear that the amplitude of the sphere's motion is decreasing. Evgeniya suspects that the amplitude is decreasing exponentially, according to the equation:

$$A = A_0 e^{-\lambda t}$$

To check this idea she uses readings of the amplitude, A, taken at regular intervals to plot ln (A / mm) against time, t.



Evgeniya claims that the points she has plotted support the exponential decrease of amplitude. Justify her claim and determine a value for λ. [5]

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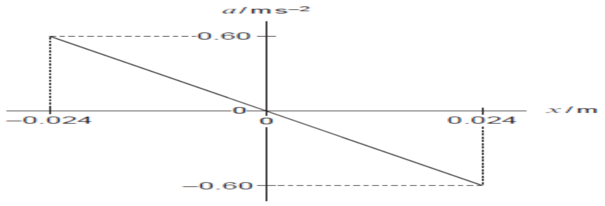
Question taken from Eduqas examination paper 842101, June 2019

#5

(a) The acceleration, a, of a body is plotted against its displacement, x, from a fixed point.

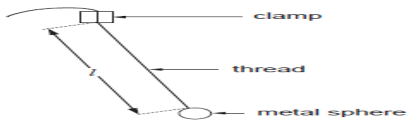


(i) State the features of the **graph** that show the body is performing *simple harmonic motion*. [2]

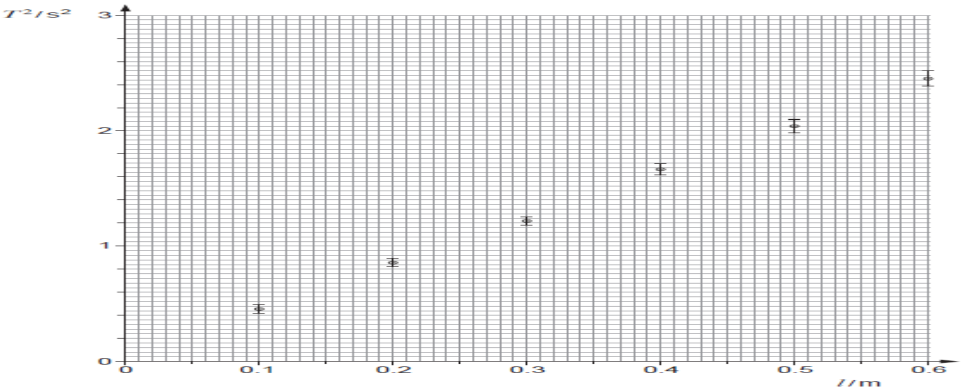
(ii) Determine the *amplitude* of the motion. [1]

(iii) Calculate the *periodic time* of the motion. [3]

(b) Charlotte performed an experiment to determine the acceleration due to gravity, g, using a simple pendulum.



Using a metre ruler she measured the length, l, shown in the diagram. She then recorded the time for 10 small amplitude oscillations, repeated the timing and calculated values for the mean periodic time, T, and its uncertainty. She repeated the procedure for another five values of l. She plotted her values of T^2 against l on the following grid.



(i) State why you would not expect the line of best fit to pass exactly through the origin. [1]

(ii) Determine a value for the acceleration due to gravity, g, together with its **percentage** uncertainty. Give your reasoning clearly. [6]

(c) A tennis ball attached by a **spring** to a fixed point is displaced vertically from its equilibrium position and released. It performs *damped oscillations*.

(i) What observed feature of the oscillations shows them to be damped? [1]

(ii) Explain in terms of *forces* how the damping comes about. [2]

(d) Explain what is meant by *critical damping*, **and** state one application of critical damping (or of damping that is close to critical). [3]

Question taken from Eduqas examination paper 842101, November 2020

#6

Two students, Simon and Natalie are investigating the mechanical properties of a steel wire of length 2.5 m and cross-sectional area 1.0 mm^2.

(a) They are given the following information.
[Young modulus, $E_{steel} = 2.0 \times 10^{11}\,N\,m^{-2}$, Stress, σ_{steel} (at elastic limit) = $1.0 \times 10^{8}\,N\,m^{-2}$].

(i) Show that the maximum extension possible for the wire without the elastic limit being exceeded is 1.25 mm. [2]

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(ii) Simon believes that this maximum extension (1.25 mm) of the steel wire depends on the radius of the wire. Natalie disagrees. Discuss who is correct, explaining carefully how you arrive at your answer. [3]

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(b) Natalie suspends a mass, m, from the wire vertically. The wire can be considered to be weightless.

(i) Show that the force per unit extension, k, of the wire is 80 kN m^{-1}. [3]

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(ii) Determine the mass, m, that causes an equilibrium extension of 1.0 mm. [2]

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(c) This mass is given a small downward displacement and released from rest. The mass oscillates with simple harmonic motion (SHM) **provided that the maximum extension of the wire never exceeds the elastic limit**.

(i) Calculate the period of this oscillation. [2]

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(ii) Calculate the maximum possible velocity of the mass, m. [3]

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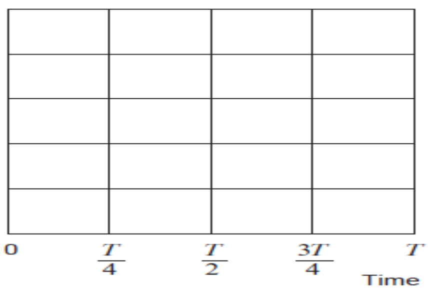
(iii) Assuming the mass is released when the wire is at maximum extension without exceeding the elastic limit, sketch a graph showing how the stress in the wire varies with time **for one complete oscillation** from the moment of release of the mass. Indicate appropriate numerical values on the stress axis of your graph.
Space for calculations. [4]



Question taken from Eduqas examination paper 842102, November 2020