Q1.

A mass is hung from a spring and set into vertical oscillation of amplitude x_0. The total energy of oscillation is E_0.

Which of the following expressions gives the total energy of oscillation E when the amplitude has reduced to $\frac{1}{2}x_0$?

☐ **A** $E = 4E_0$

☐ **B** $E = 2E_0$

☐ **C** $E = \frac{1}{2}E_0$

☐ **D** $E = \frac{1}{4}E_0$

(Total for question = 1 mark)

Q2.

Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

A system is oscillating with simple harmonic motion. The energy of oscillation of the system doubles.

The amplitude of oscillation increases by a factor of

☐ **A** $\frac{1}{\sqrt{2}}$

☐ **B** $\frac{1}{2}$

☐ **C** 2

☐ **D** $\sqrt{2}$

(Total for question = 1 mark)

Q3.

A suspension bridge is being driven into oscillation as cars move across it. The energy of oscillation of the bridge doubles.

The amplitude of oscillation increases by a factor of

☒ **A** $\frac{1}{2}$

☒ **B** $\frac{1}{\sqrt{2}}$

☒ **C** $\sqrt{2}$

☒ **D** 2

(Total for question = 1 mark)

Q4.

Some sensitive scientific equipment is being transported by road. To protect the equipment, it is placed in a box which is mounted on springs. There are four springs, one at each corner of the box. Each spring has a force constant of 450 N m^{-1}.

The total mass of the equipment and the box is 4.3 kg.

The period T of a mass m attached to a spring of force constant k and set into oscillation is given by

$$T = 2\pi\sqrt{\frac{m}{k}}$$

(a) Calculate the natural frequency of oscillation of the box when it is carrying the equipment.

(3)

.....

.....

.....

.....

.....

.....

.....

Natural frequency = ...

(b) State what is meant by simple harmonic motion and why the oscillation of the box is an example of this.

(3)

.....

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q5.

The photograph shows a dancing "hula girl" toy. The toy uses energy from the Sun to make the girl dance. When the solar cell is illuminated the girl's arms move with simple harmonic motion.

(a) State the conditions for an object to move with simple harmonic motion.

(2)

.....

.....

.....

.....

(b) (i) The time *t* for 50 oscillations of the arms is measured three times and the values obtained are recorded in the table.

t_1/s	t_2/s	t_3/s
18.9	19.2	19.1

Show that the arms oscillate with a frequency of about 2.6 Hz.

(3)

.....

.....

.....

.....

.....

(ii) From the top to the bottom of the movement, the hands travel a distance of 0.75 cm.

Calculate the maximum speed of the hands.

(3)

.....

.....

.....

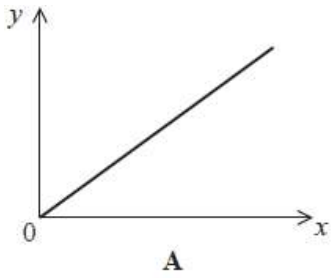
.....

.....

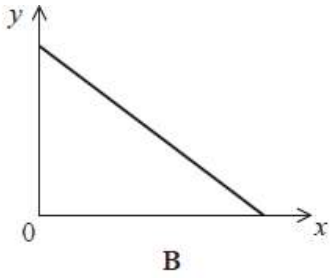
Maximum speed of hands = ...

(Total for question = 8 marks)

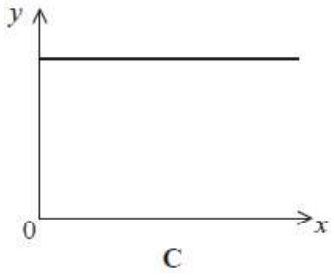
Q6.



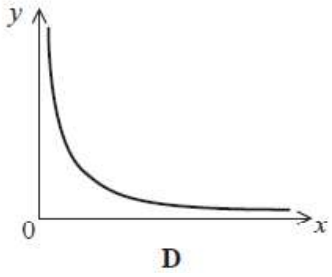
A



B



C



D

A mass moves with simple harmonic motion.

Which graph correctly shows how the time taken for one oscillation *y* varies with the frequency *x* of the oscillation?

☐ **A**

☐ **B**

☐ **C**

☐ **D**

(Total for question = 1 mark)

Q7.

A physics textbook gives the following statement about simple harmonic motion:

"Simple harmonic motion occurs when the acceleration of an object is proportional to the displacement from equilibrium."

(a) This statement is not a complete definition of simple harmonic motion.

Rewrite this statement to give a complete definition of simple harmonic motion.

(2)

.....

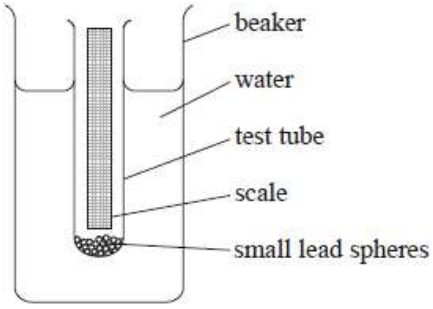
.....

.....

.....

.....

(b) A test tube is loaded with small lead spheres so that it floats vertically in a beaker of water as shown.



The test tube is displaced downwards and released. After release the test tube moves with simple harmonic motion.

(i) A student uses a stopwatch to measure the period of oscillation *T* of the test tube.

Describe the procedure she should follow to obtain an accurate value for *T*.

(3)

.....

.....

.....

.....

.....

.....

.....

(ii) The maximum displacement of the test tube from the equilibrium position is 2.0 cm.

Calculate the maximum velocity of the test tube.

T = 0.57 s

(3)

.....

.....

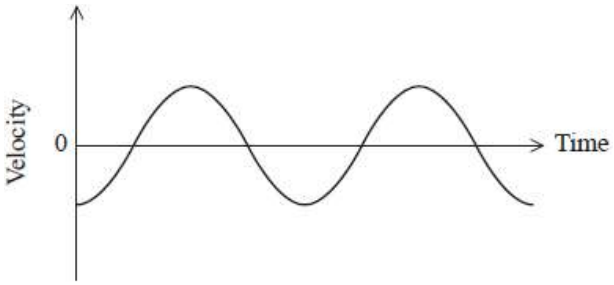
.....

.....

.....

Maximum velocity = ...

(iii) The idealised graph below shows how the velocity of the test tube varies with time.



Add to this graph to show how the acceleration of the test tube varies with time.

(2)

(iv) Explain why the amplitude of the oscillation would decrease with time.

(2)

.....

.....

.....

.....

.....

(Total for question = 12 marks)

Q8.

A mass is hung from a spring and set into vertical oscillation. The amplitude of oscillation halves after 10 cycles.

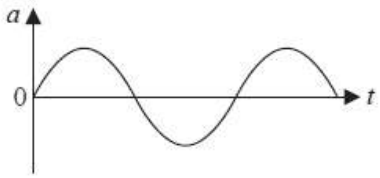
The ratio of the total energy of the system at the start to the total energy of the system after 10 cycles is

- ☒ **A** ¼
- ☒ **B** ½
- ☒ **C** 2
- ☒ **D** 4

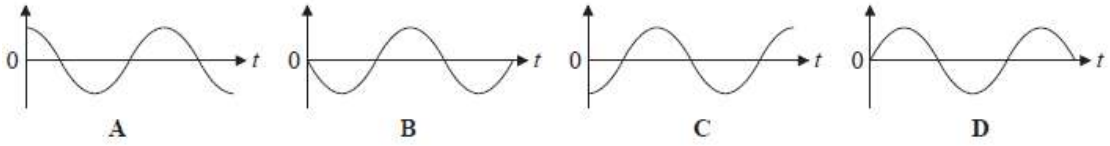
(Total for question = 1 mark)

Q9.

The graph shows how the acceleration *a* varies with time *t* for an object undergoing simple harmonic motion.



The following graphs show how other quantities for the object may vary over the same time period.



Choose the graph that shows the variation of displacement with time.

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for question = 1 mark)

Q10.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A mass was hung from the end of spring 1 and set into vertical oscillation. Another mass was hung from the end of spring 2 and also set into vertical oscillation.

The maximum velocity, angular frequency and amplitude of the mass on each spring are summarised in the table below.

	spring 1	spring 2
Maximum velocity	v_1	v_2
Angular frequency	ω	2ω
Amplitude	A	$A/2$

Which of the following statements about the maximum velocities is correct?

☒ **A** $v_1 = \frac{v_2}{4}$

☒ **B** $v_1 = \frac{v_2}{2}$

☒ **C** $v_1 = v_2$

☒ **D** $v_1 = 2v_2$

(Total for question = 1 mark)

Q11.

Two systems are oscillating with simple harmonic motion. The angular frequency and amplitude of each oscillating system are summarised in the table below.

	System 1	System 2
angular frequency	ω	$\frac{\omega}{2}$
amplitude	A	$2A$

The maximum acceleration of system 1 is a_1 and the maximum acceleration of system 2 is a_2.

Which of the following expressions is correct?

☐ **A** $a_1 = \frac{a_2}{2}$

☐ **B** $a_1 = a_2$

☐ **C** $a_1 = 2a_2$

☐ **D** $a_1 = 4a_2$

(Total for question = 1 mark)