Q1. For a body performing simple harmonic motion, which one of the following statements is correct?

A The maximum kinetic energy is directly proportional to the frequency.

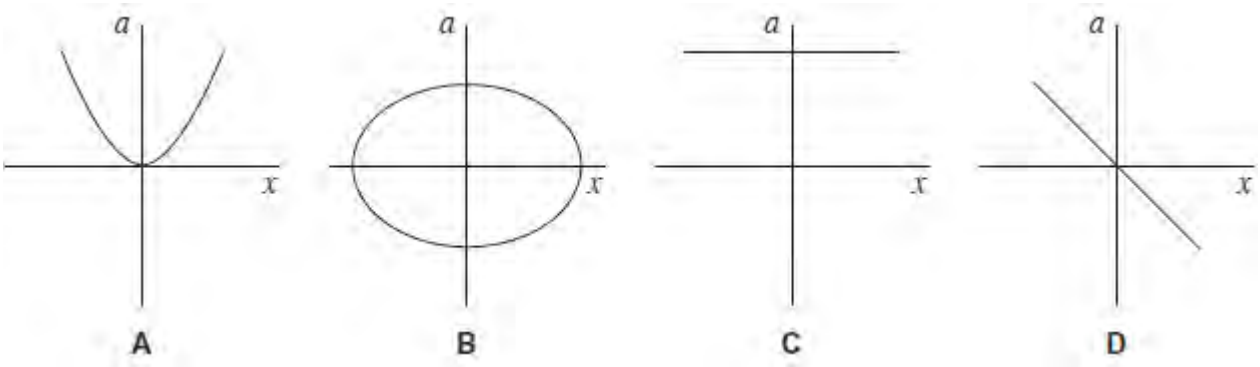
B The time for one oscillation is directly proportional to the frequency.

C The speed at any instant is directly proportional to the displacement.

D The maximum acceleration is directly proportional to the amplitude.

(Total 1 mark)

Q2. Which one of the following graphs shows how the acceleration, a, of a body moving with simple harmonic motion varies with its displacement, x?



(Total 1 mark)

Q3. A particle of mass 5.0×10^{-3} kg, moving with simple harmonic motion of amplitude 0.15 m, takes 47 s to make 50 oscillations.
What is the maximum kinetic energy of the particle?

A 2.0×10^{-3} J

B 2.5×10^{-3} J

C 3.9×10^{-3} J

D 5.0×10^{-3} J

(Total 1 mark)

Q4. The frequency of a body moving with simple harmonic motion is doubled. If the amplitude remains the same which of the following is also doubled?

A The time period. ⬭

B The total energy. ⬭

C The maximum velocity. ⬭

D The maximum acceleration. ⬭

(Total 1 mark)

Q5. A particle oscillates with undamped simple harmonic motion.

The acceleration of the particle

A is always in the opposite direction to its velocity. ⬭

B decreases as the potential energy increases. ⬭

C is proportional to the frequency. ⬭

D is least when the speed is greatest. ⬭

(Total 1 mark)

Q6. Which line, **A** to **D**, in the table gives the amplitude and frequency of a body performing simple harmonic motion whose displacement x at time t is given by the equation $x = P \cos Qt$?

	Amplitude	**Frequency**
A	$\frac{P}{2}$	$\frac{Q}{2\pi}$
B	P	$2\pi Q$
C	P	$\frac{Q}{2\pi}$

D	$2P$	$\frac{Q}{2\pi}$

(Total 1 mark)

Q7.(a) (i) Name the **two** types of potential energy involved when a mass–spring system performs vertical simple harmonic oscillations.

.....

.....

(1)

(ii) Describe the energy changes which take place during one complete oscillation of a vertical mass-spring system, starting when the mass is at its lowest point.

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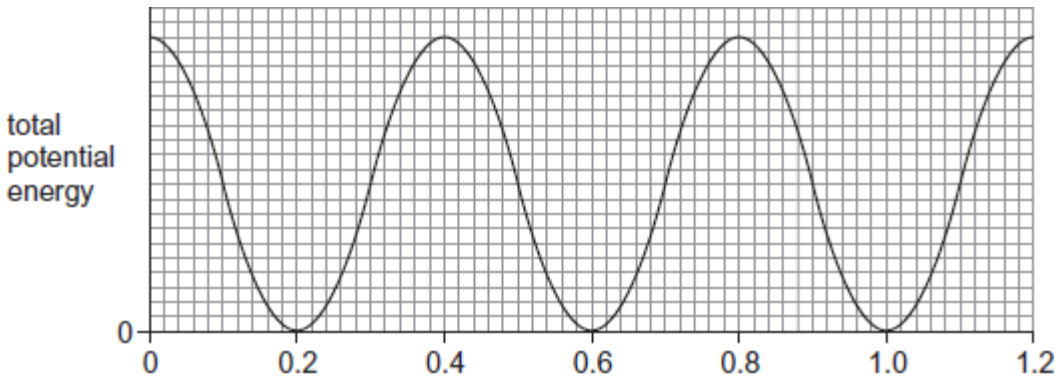
(2)

(b) **Figure 1** shows how the **total** potential energy due to the simple harmonic motion varies with time when a mass-spring system oscillates vertically.

Figure 1



time / s

(i) State the time period of the simple harmonic oscillations that produces the energy–time graph shown in **Figure 1**, explaining how you arrive at your answer.

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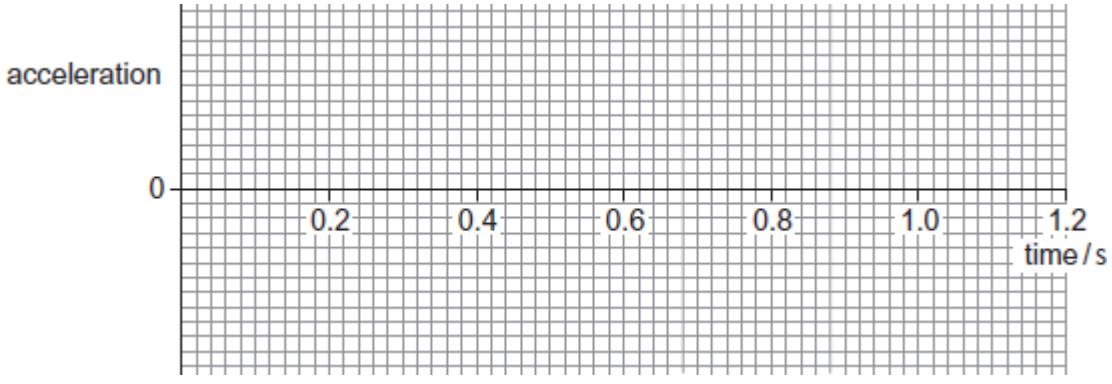
.....

.....

(2)

(ii) Sketch a graph on **Figure 2** to show how the acceleration of the mass varies with time over a period of 1.2 s, starting with the mass at the highest point of its oscillations. On your graph, upwards acceleration should be shown as positive and downwards acceleration as negative. Values are not required on the acceleration axis.

Figure 2



(2)

(c) (i) The mass of the object suspended from the spring in part (b) is 0.35 kg. Calculate the spring constant of the spring used to obtain **Figure 1**. State an appropriate unit for your answer.

spring constant ..... unit .....

(3)

(ii) The maximum kinetic energy of the oscillating object is 2.0×10^{-2} J. Show that the amplitude of the oscillations of the object is about 40 mm.

(4)
(Total 14 marks)

Q8. A particle of mass *m* oscillates in a straight line with simple harmonic motion of constant amplitude. The total energy of the particle is *E*. What is the total energy of another particle of mass 2*m*, oscillating with simple harmonic motion of the same amplitude but double the frequency?

A *E*

B 2*E*

C 4*E*

D 8*E*

(Total 1 mark)

Q9. (a) A simple pendulum is given a small displacement from its equilibrium position and performs *simple harmonic motion*.

State what is meant by simple harmonic motion.

.....

.....

.....

.....

(2)

(b) (i) Calculate the frequency of the oscillations of a simple pendulum of length 984 mm. Give your answer to an appropriate number of significant figures.

frequency ..... Hz

(3)

(ii) Calculate the acceleration of the bob of the simple pendulum when the displacement from the equilibrium position is 42 mm.

acceleration ..... ms^{-2}

(2)

(c) A simple pendulum of time period 1.90 s is set up alongside another pendulum of time period 2.00 s. The pendulums are displaced in the same direction and released at the same time.

Calculate the time interval until they next move in phase. Explain how you arrive at your answer.

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.....

.....

time interval ..... s

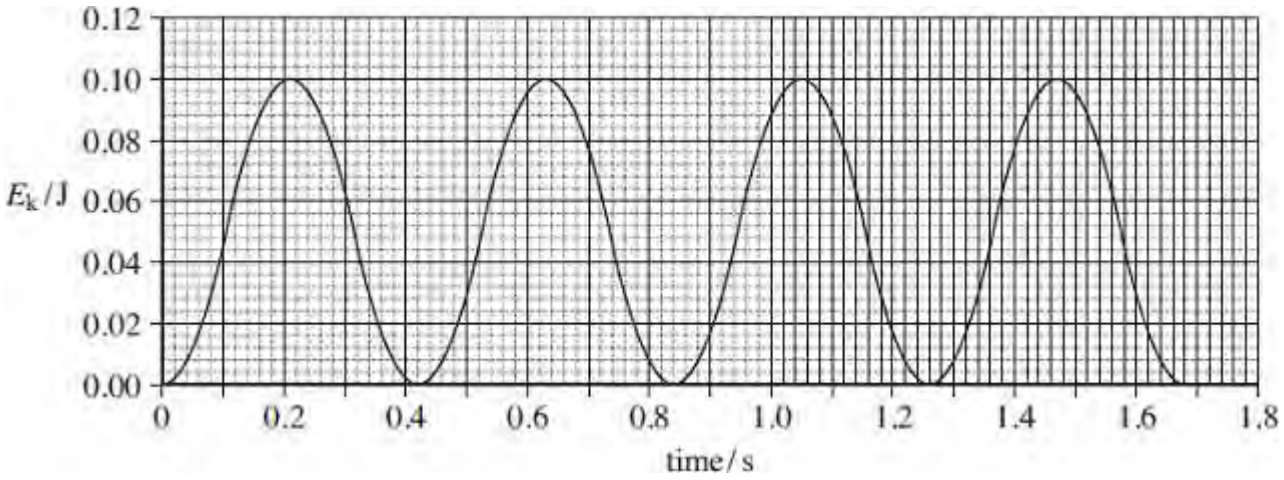
(3)

(Total 10 marks)

Q10.(a) **Figure 1** shows how the kinetic energy, E_k, of an oscillating mass varies with time

when it moves with simple harmonic motion.

Figure 1



(i) Determine the frequency of the oscillations of the mass.

frequency of oscillation ..... Hz

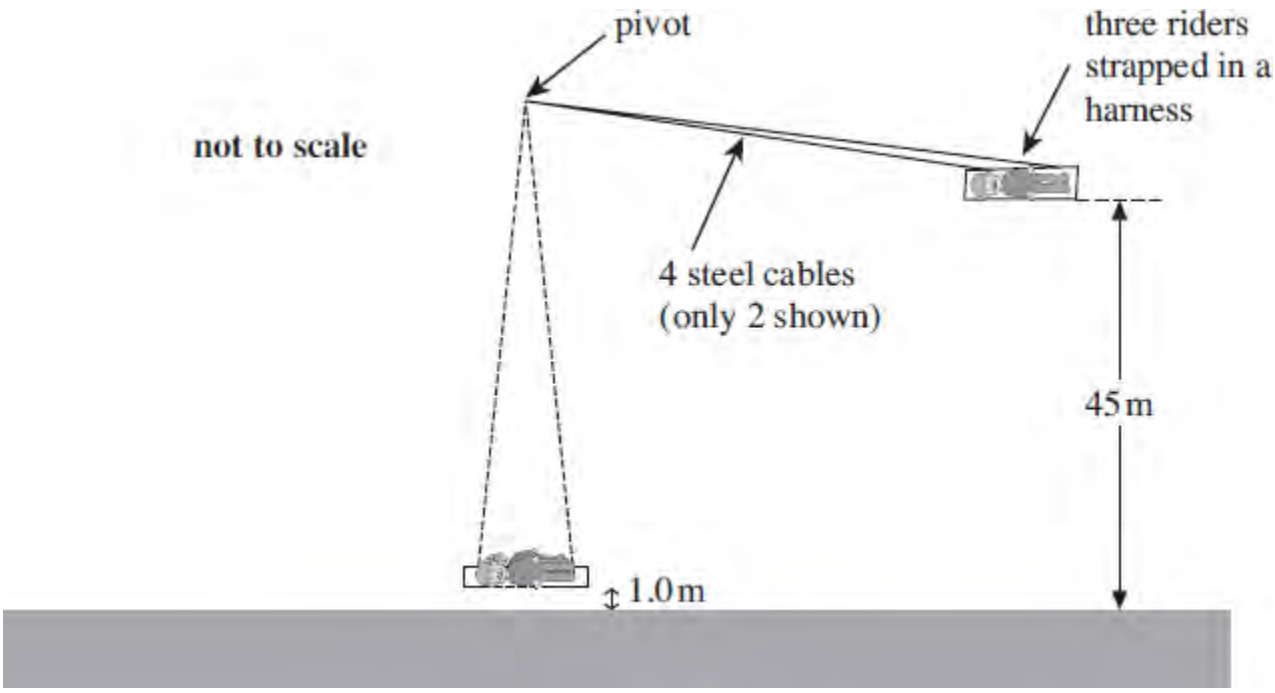
(2)

(ii) Sketch, on **Figure 1**, a graph showing how the potential energy of the mass varies with time during the first second.

(2)

(b) **Figure 2** shows a ride called a 'jungle swing'.

Figure 2



The harness in which three riders are strapped is supported by 4 steel cables. An advert for the ride states that the riders will be released from a height of 45 m above the ground and will then swing with a period of 14.0 s. It states that they will be 1.0 m above the ground at the lowest point and that they will travel at speeds of 'up to 120 km per hour'.

(i) Treating the ride as a simple pendulum, show that the distance between the pivot and the centre of mass of the riders is about 49 m.

(2)

(ii) The riders and their harness have a total mass of 280 kg.
Calculate the tension in each cable at the lowest point of the ride, assuming that the riders pass through this point at a speed of 120 km h^{-1}. Assume that the cables have negligible mass and are vertical at this point in the ride.

tension in each cable ..... N

(4)

(iii) Show that the maximum speed stated in the advert is an exaggerated claim. Assume that the riders are released from rest and neglect any effects of air resistance.

(4)

(iv) The riders lose 50% of the energy of the oscillation during each half oscillation. After one swing, the speed of the riders as they pass the lowest point is 20 m s^{-1}.

Calculate the speed of the riders when they pass the lowest point, travelling in the same direction after two further complete oscillations.

speed of riders ..... ms^{-1}

(3)
(Total 17 marks)

Q11. A particle of mass 0.20 kg moves with simple harmonic motion of amplitude 2.0×10^{-2} m. If the total energy of the particle is 4.0×10^{-5}J, what is the time period of the motion?

A $\frac{\pi}{4}$ seconds

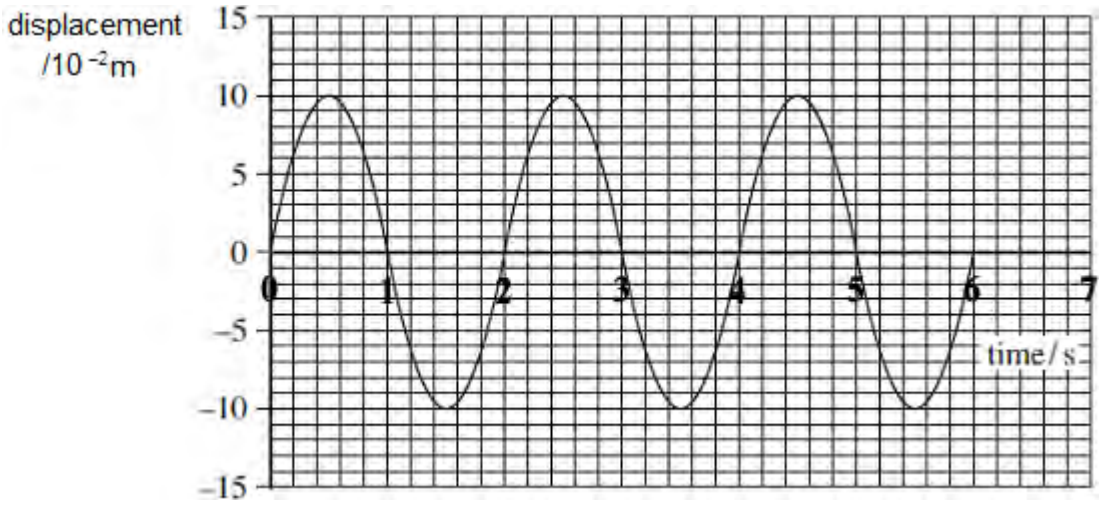
B $\frac{\pi}{2}$ seconds

C π seconds

D 2π seconds

(Total 1 mark)

Q12. The graph shows the variation in displacement with time for an object moving with simple harmonic motion.



What is the maximum acceleration of the object?

A 0.025 m s^{-2}

B 0.99 m s^{-2}

C 2.5 m s^{-2}

D 9.8 m s^{-2}

(Total 1 mark)

Q13. Which one of the following statements is true when an object performs simple harmonic motion about a central point O?

A The acceleration is always directed away from O.

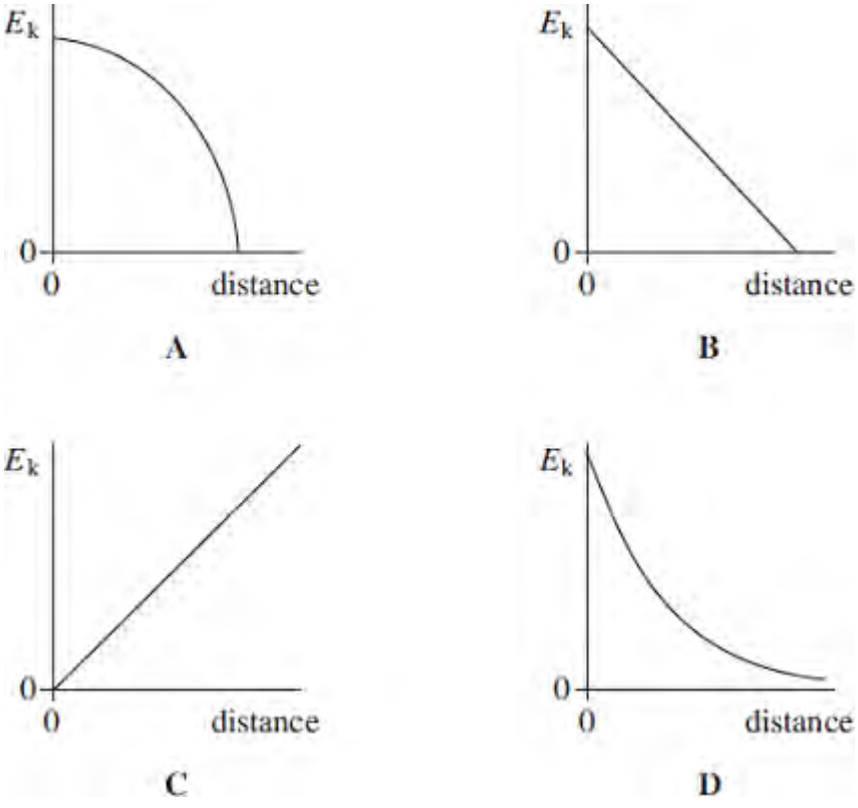
B The acceleration and velocity are always in opposite directions.

C The acceleration and the displacement from O are always in the same direction.

D The graph of acceleration against displacement is a straight line.

(Total 1 mark)

Q14. A body executes simple harmonic motion. Which one of the graphs, **A** to **D**, best shows the relationship between the kinetic energy, E_k, of the body and its distance from the centre of oscillation?



(Total 1 mark)