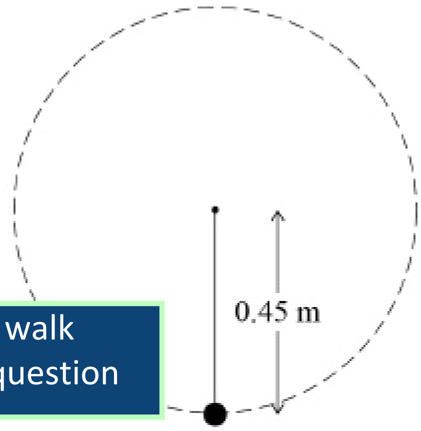
1

A bob of mass 0.50 kg is suspended from the end of a piece of string 0.45 m long.
The bob is rotated in a vertical circle at a constant rate of 120 revolutions per minute.



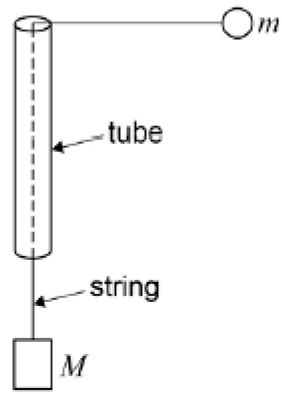
Click to see a walk through of this question

What is the tension in the string when the bob is at the bottom of the circle?

A	5.8 N	⬭
B	31 N	⬭
C	36 N	⬭
D	40 N	⬭

(Total 1 mark)

2 A string passes through a smooth thin tube. Masses m and M are attached to the ends of the string. The tube is moved so that the mass m travels in a horizontal circle of constant radius r and at constant speed v.



Which of the following expressions is equal to M ?

A $\frac{mv^2}{2r}$ ☐

B mv^2rg ☐

C $\frac{mv^2}{rg}$ ☐

D $\frac{mv^2g}{r}$ ☐

(Total 1 mark)

3 **Figure 1** shows a side view of an act performed by two acrobats. **Figure 2** shows the view from above.

Figure 1

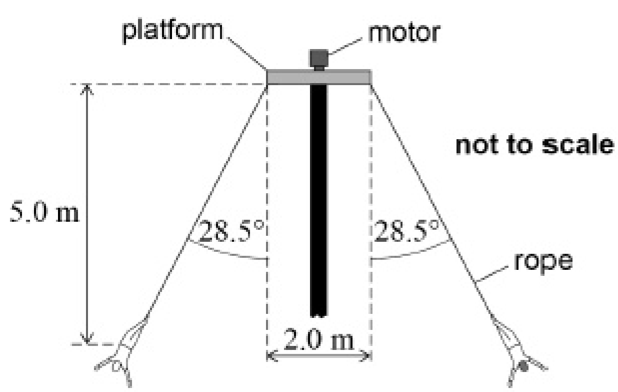
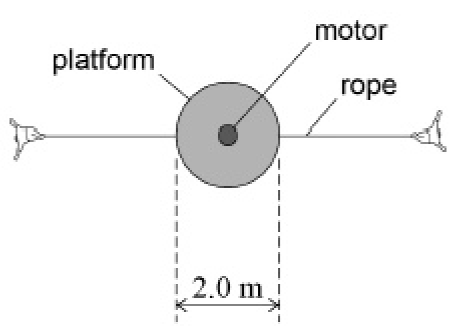


Figure 2



The acrobats, each of mass 85 kg, are suspended from ropes attached to opposite edges of a circular platform that is at the top of a vertical pole. The platform has a diameter of 2.0 m
A motor rotates the platform so that the acrobats move at a constant speed in a horizontal circle, on opposite sides of the pole.

When the period of rotation of the platform is 5.2 s, the centre of mass of each acrobat is 5.0 m below the platform and the ropes are at an angle of 28.5° to the vertical as shown in **Figure 1**.

(a) Show that the linear speed of the acrobats is about 4.5 m s^{-1}

(2)

(b) Determine the tension in each rope that supports the acrobats.

tension = ____________________ N

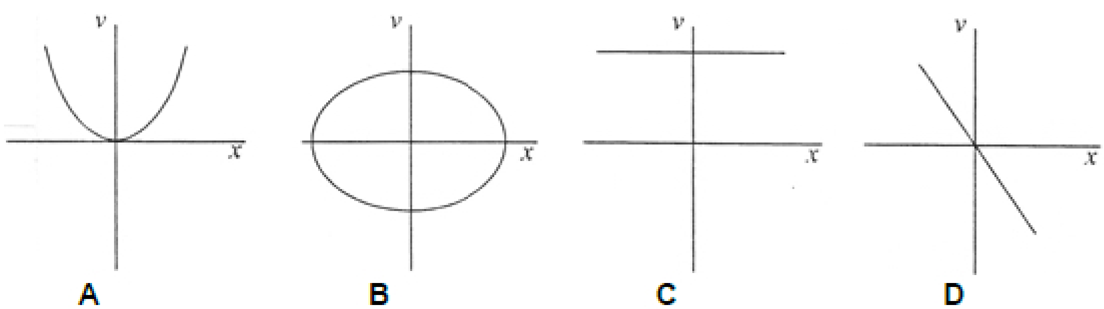
(3)

(c) Discuss the consequences for the forces acting on the pole when one acrobat has a much greater mass than the other.

(3)

(Total 8 marks)

4 Which graph shows how the velocity v of a body moving with simple harmonic motion varies with its displacement x?



A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

5 A body performs simple harmonic motion.

What is the phase difference between the variation of displacement with time and the variation of acceleration with time for the body?

A 0 ⬭

B $\frac{\pi}{4}$ rad ⬭

C $\frac{\pi}{2}$ rad ⬭

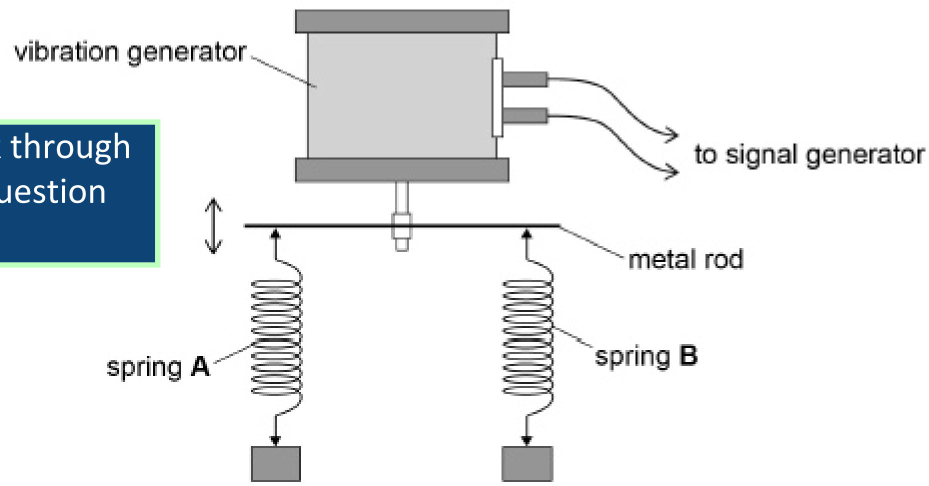
D π rad ⬭

(Total 1 mark)

6 A student is investigating forced vertical oscillations in springs.
Two springs, **A** and **B**, are suspended from a horizontal metal rod that is attached to a vibration generator. The stiffness of **A** is k, and the stiffness of **B** is $3k$.
Two equal masses are suspended from the springs as shown in **Figure 1**.

Figure 1

Click for a walk through of a similar question



The vibration generator is connected to a signal generator. The signal generator is used to vary the frequency of vibration of the metal rod. When the signal generator is set at 2.0 Hz, the mass attached to spring **A** oscillates with a maximum amplitude of 2.5×10^{-2} m and has a maximum kinetic energy of 54 mJ.

(a) Deduce the spring constant k for spring **A** and the mass m suspended from it.

k = ____________________ $N\ m^{-1}$

m = ____________________ kg

(4)

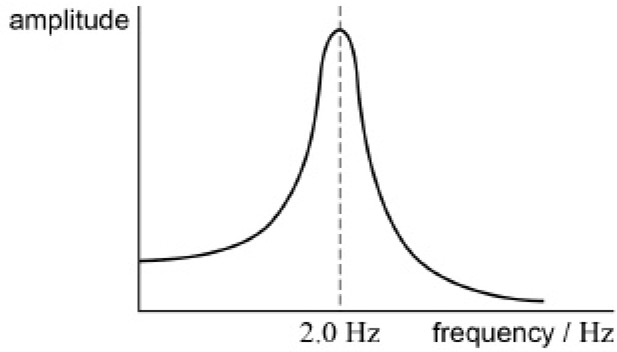
(b) Calculate the frequency at which the mass attached to spring **B** oscillates with maximum amplitude.

frequency = ____________________ Hz

(2)

(c) **Figure 2** shows how the amplitude of the oscillations of the mass varies with frequency for spring **A**.

Figure 2



The investigation is repeated with the mass attached to spring **B** immersed in a beaker of oil.

A graph of the variation of the amplitude with frequency for spring **B** is different from the graph in **Figure 2**.

Explain **two** differences in the graph for spring **B**.

Difference 1 ____

____

____

Difference 2 ____

____

____

(4)

(Total 10 marks)

7 (a) State the conditions for simple harmonic motion.

____

____

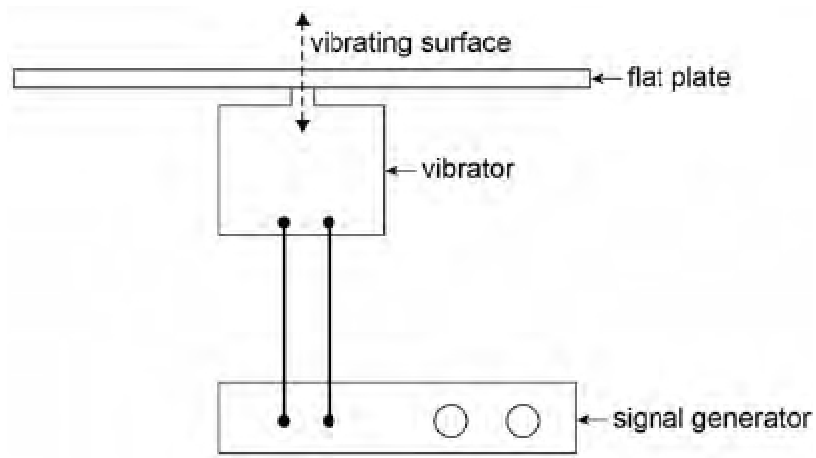
____

____

(2)

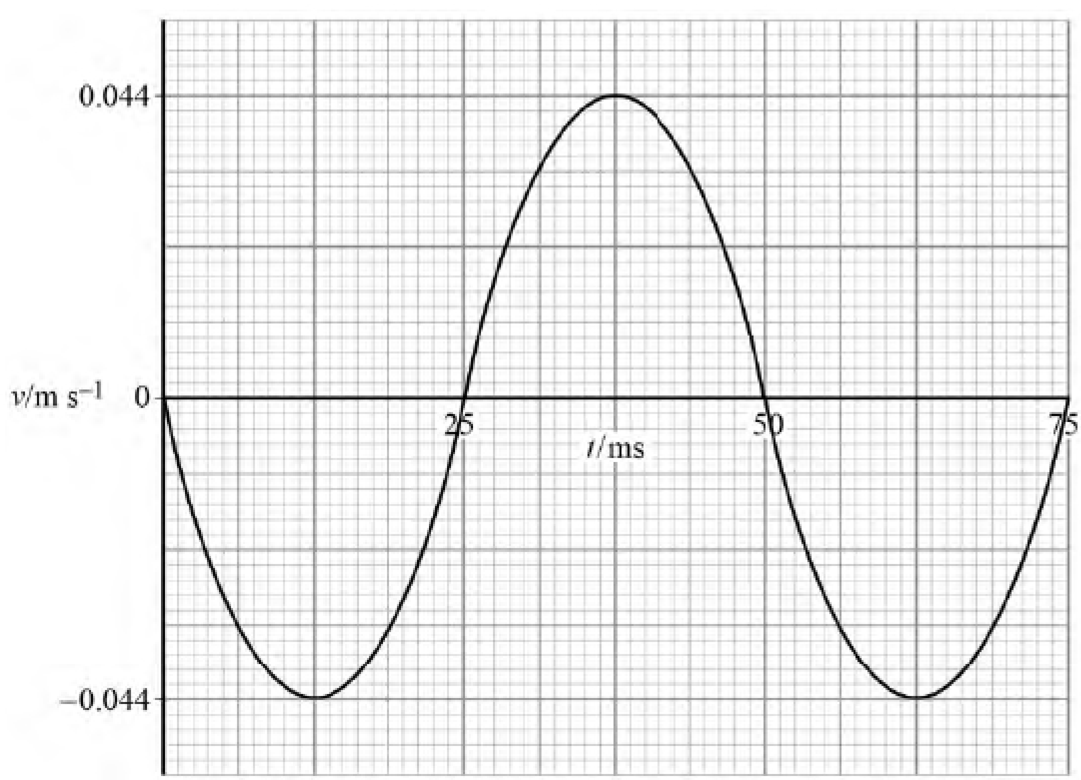
(b) A rigid flat plate is made to vibrate vertically with simple harmonic motion. The frequency of the vibration is controlled by a signal generator as shown in **Figure 1**.

Figure 1



The velocity−time (v−t) graph for the vibrating plate at one frequency is shown in **Figure 2**.

Figure 2

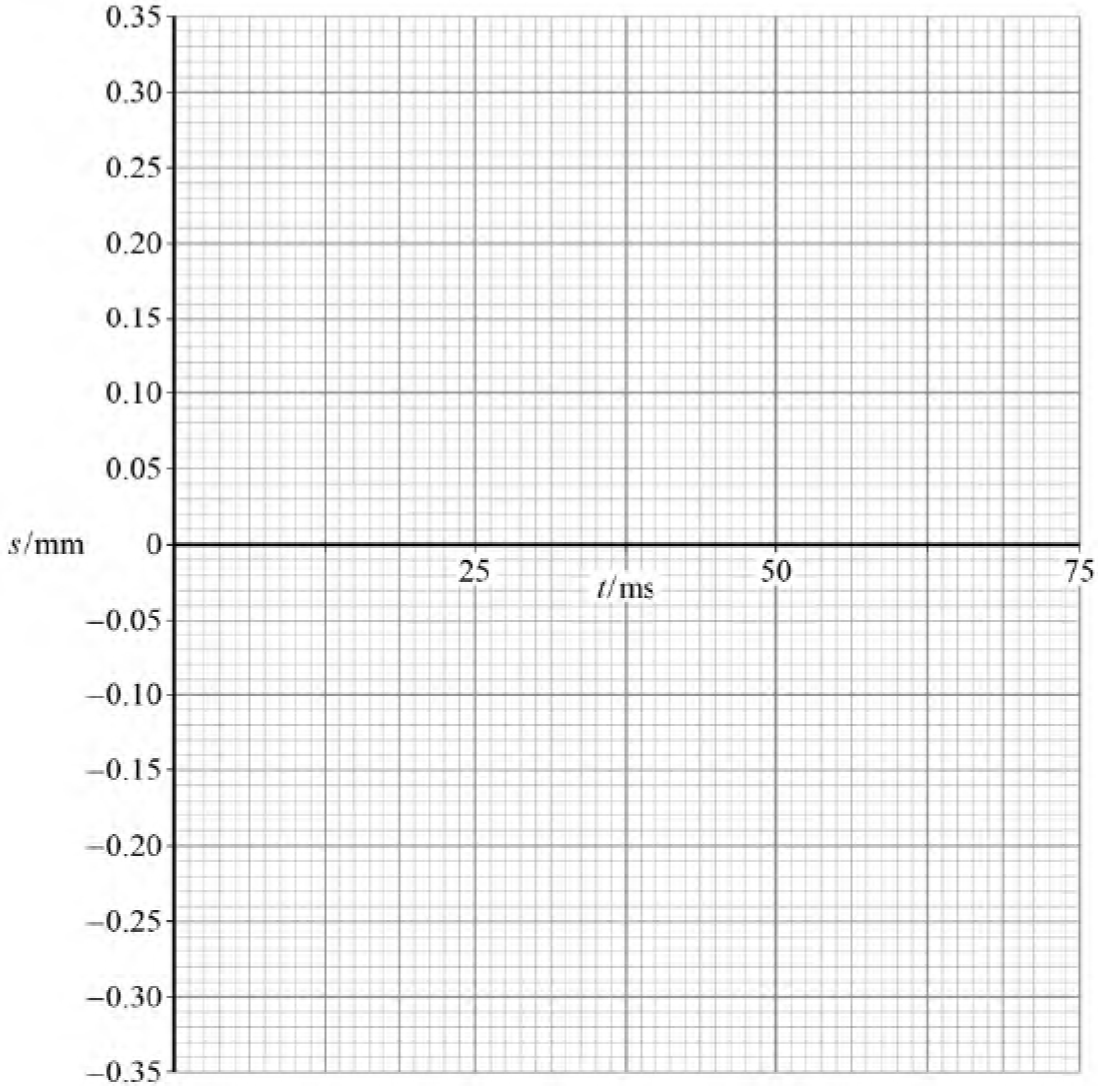


Show that the maximum displacement of the plate is 3.5×10^{-4} m.

(2)

(c) Draw on **Figure 3** the displacement−time (s−t) graph between 0 and 75 ms.

Figure 3



(1)

(d) State **one** time at which the plate has maximum potential energy.

time = ______________________ s

(1)

(e) A small quantity of fine sand is placed onto the surface of the plate. Initially the sand grains stay in contact with the plate as it vibrates. The amplitude of the vibrating surface remains constant at 3.5×10^{-4} m over the full frequency range of the signal generator. Above a particular frequency the sand grains lose contact with the surface.

Explain how and why this happens.

____

____

____

____

____

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____

(3)

(f) Calculate the lowest frequency at which the sand grains lose contact with the surface of the plate.

frequency = ______________________ Hz

(2)

(Total 11 marks)