

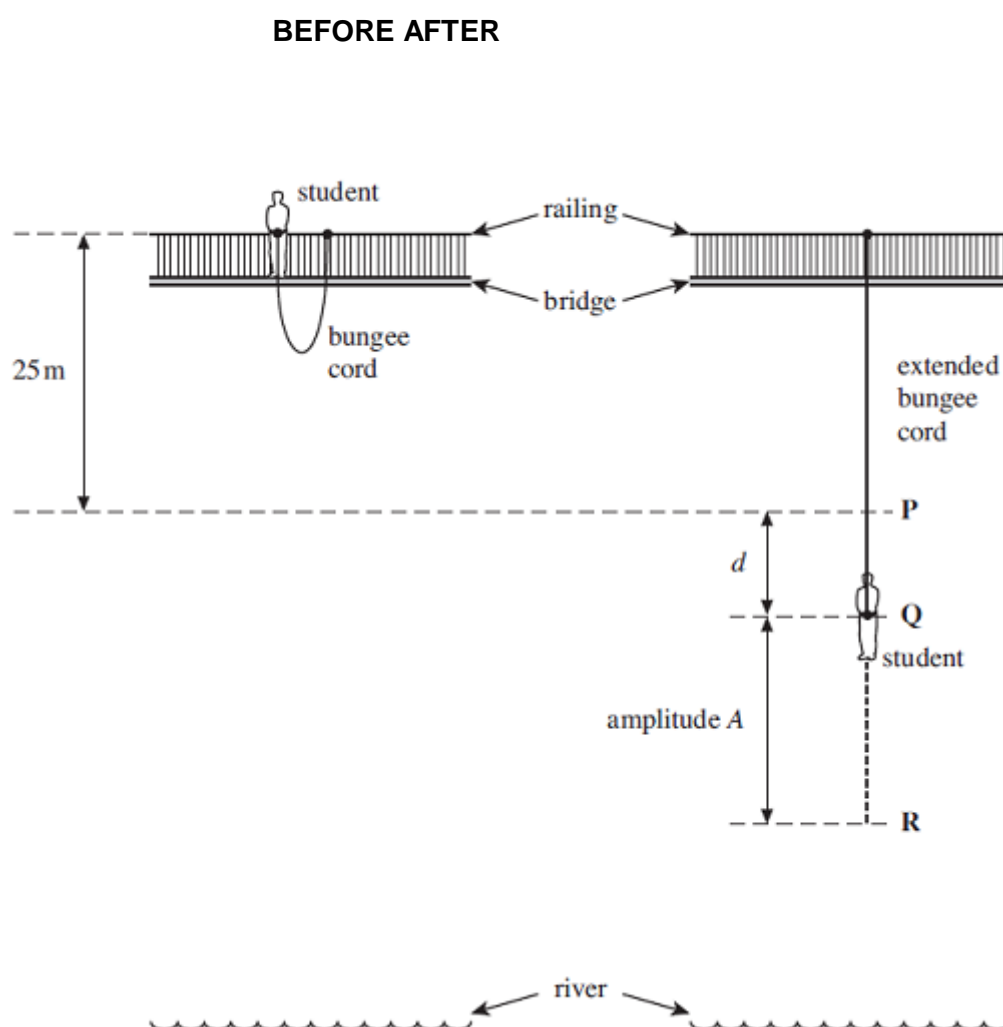
Name of the Student: _____

Max. Marks : 22 Marks

Time : 22 Minutes

Q1.

The two diagrams in the figure below show a student before and after she makes a bungee jump from a high bridge above a river. One end of the bungee cord, which is of unstretched length 25 m, is fixed to the top of a railing on the bridge. The other end of the cord is attached to the waist of the student, whose mass is 58 kg. After she jumps, the bungee cord goes into tension at point **P**. She comes to rest momentarily at point **R** and then oscillates about point **Q**, which is a distance d below **P**.



- (a) (i) Assuming that the centre of mass of the student has fallen through a vertical distance of 25 m when she reaches point **P**, calculate her speed at **P**.
You may assume that air resistance is negligible.

answer = _____ ms^{-1}

(2)

- (ii) The bungee cord behaves like a spring of spring constant 54 Nm^{-1} . Calculate the distance d , from **P** to **Q**, assuming the cord obeys Hooke's law.

answer = _____ m

(2)

- (b) As the student moves below **P**, she begins to move with simple harmonic motion for part of an oscillation.

- (i) If the arrangement can be assumed to act as a mass-spring system, calculate the time taken for one half of an oscillation.

answer = _____ s

(2)

- (ii) Use your answers from parts (a) and (b)(i) to show that the amplitude A , which is the distance from **Q** to **R**, is about 25 m.

(3)

- (c) Explain why, when the student rises above point **P**, her motion is no longer simple harmonic.

(2)

- (d) (i) Where is the student when the stress in the bungee cord is a maximum?

(1)

- (ii) The bungee cord has a significant mass. Whereabouts along the bungee cord is the stress a maximum? Explain your answer.

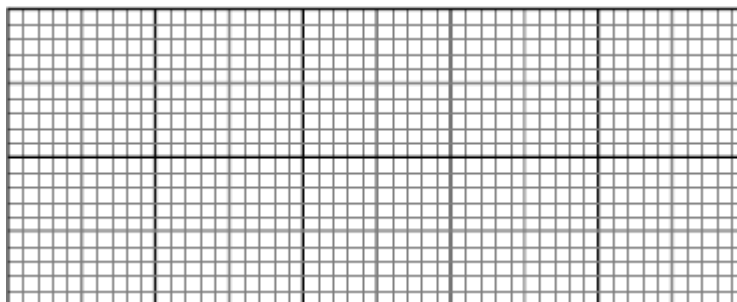
(2)
(Total 14 marks)

Q2.

A spring, which obeys Hooke's law, hangs vertically from a fixed support and requires a force of 2.0 N to produce an extension of 50 mm. A mass of 0.50 kg is attached to the lower end of the spring. The mass is pulled down a distance of 20 mm from the equilibrium position and then released.

- (a) (i) Show that the time period of the simple harmonic vibrations is 0.70 s.

- (ii) Sketch the displacement of the mass against time, starting from the moment of release and continuing for two oscillations. Show appropriate time and distance scales on the axes.



(5)

- (b) The mass-spring system described in part (a) is attached to a support which can be made to vibrate vertically with a small amplitude. Describe the motion of the mass-spring system with reference to frequency and amplitude when the support is driven at a frequency of

- (i) 0.5 Hz,

- (ii) 1.4 Hz.

(3)
(Total 8 marks)