

Name of the Student: _____

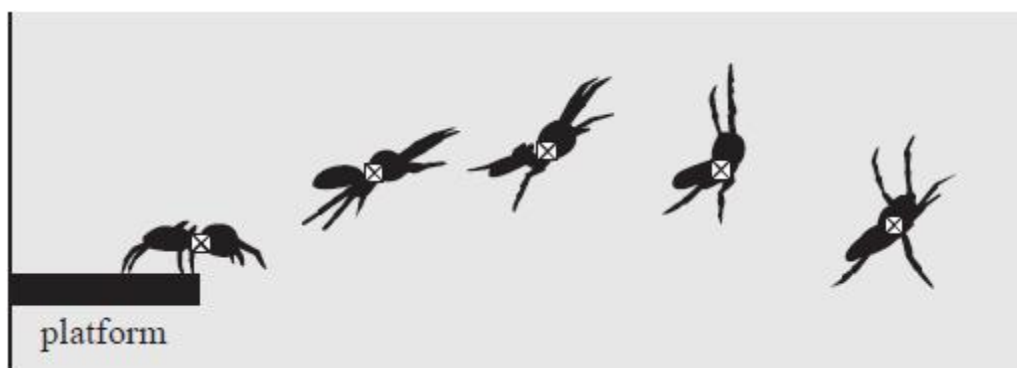
Max. Marks : 22 Marks

Time : 22 Minutes

Q1.

Scientists have been studying a type of jumping spider that can jump up to six times its body length.

The scientists photographed a spider at 0.02 s intervals, during a jump. The picture is taken from the photograph and is shown actual size.



(i) Deduce whether the images show that the motion in the x-direction is independent of the motion in the y-direction. You should take measurements using the cross marking the centre of gravity of the spider.

(4)

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(ii) Show that the initial velocity of the spider at the start of the jump is about 1 m s^{-1} . You should take measurements using the cross marking the centre of gravity of the spider.

(5)

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(iii) The spider achieves this jump by extending its two back legs by 3.0 mm.

Calculate the average force the spider exerts in each leg to achieve the jump.
mass of spider = 150 mg

(3)

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Average force =

(Total for question = 12 marks)

Q2.

In 2014 the Rosetta spacecraft reached the comet Churyumov-Gerasimenko.
Rosetta went into orbit around the comet.

The following table gives some data for the comet.

Mass / kg	1.0×10^{13}
Density / kg m^{-3}	470

The comet is irregular in shape but can be modelled as a spherical object.

(a) Show that a sphere with this mass and density has a radius of about 1700 m.

(3)

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(b) Calculate the gravitational field strength at the surface of the comet.

(2)

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Gravitational field strength =

(c) A probe was sent from the Rosetta spacecraft to land on the comet.
The probe bounced off the surface of the comet and took 1 hour and 50 minutes to return to the surface again.

Calculate the height above the surface of the comet that the probe would have reached. Assume that the acceleration of the probe is constant with the magnitude calculated in (b).

(2)

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Height =

(d) Explain, using gravitational field theory, how the actual height reached would compare with the value calculated in part (c).

You may assume there are no resistive forces such as air resistance.

(3)

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(Total for question = 10 marks)