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QUALIFY FOR THE FUTURE WORLD
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Level 2 Physics 2021

91171 Demonstrate understanding of mechanics

Credits: Six

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of mechanics.	Demonstrate in-depth understanding of mechanics.	Demonstrate comprehensive understanding of mechanics.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

Make sure that you have Resource Sheet L2–PHYSR.

In your answers use clear numerical working, words, and/or diagrams as required.

Numerical answers should be given with an appropriate SI unit.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–11 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

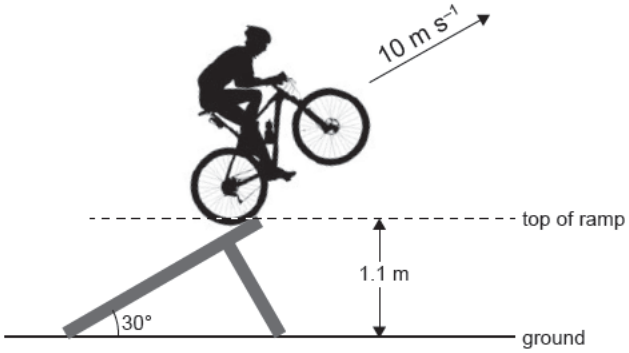
QUESTION ONE: THE RAMP

The picture on the right shows a bike rider going over a ramp.

The rider's speed at the top of the ramp is 10 m s^{-1}.

The angle between the ramp and the ground is 30°.

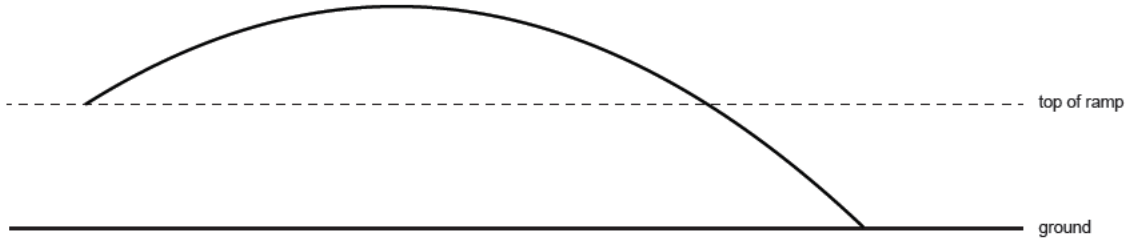
The top of the ramp is 1.1 m above the ground.



(a) Show that the vertical velocity of the rider just as they leave the top of the ramp is 5 m s^{-1}.

(b) Calculate the maximum height that the rider will reach above the **ground**.

(c) The diagram below shows the path of the rider when they leave the top of the 30° ramp at 10 m s^{-1}.



On the same diagram, and without further calculation, sketch the path of a rider who leaves the top of a 40° ramp at 10 m s^{-1}.

Assume the top of the ramps are in the same place.

If you need to redraw your response, use the diagram on page 8.

(d) For a rider leaving the top of a 30° ramp at 10 m s^{-1}:

(i) Calculate the **vertical** speed of the rider when they land on the ground.

(ii) Calculate the horizontal distance travelled from the ramp to where the rider lands on the ground.

QUESTION TWO: AROUND THE BEND

A rider rides around a circular bend of radius 7.0 m at a constant speed of 10 m s^{-1}.

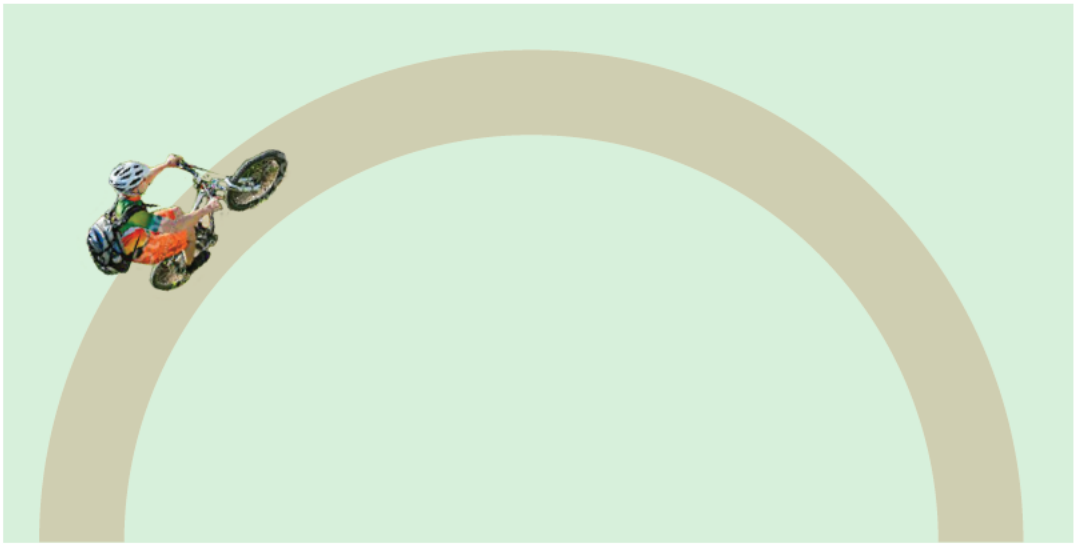
Source: https://nsmb.com/articles/cure-your-2006-posture-cone-training/

(a) If the combined mass of the rider and bike is 90 kg, calculate the centripetal force required.

(b) When the rider is in the position below, they bike across a **very** slippery part of the track.

Use physics principles to explain the path the rider takes when they bike across the very slippery part of the track.

Show this path on the diagram with an arrow.



If you need to redraw your response, use the diagram on page 8.

(c) Some trail bikes have a spring suspension system.

The spring constant is 40 000 N m^{-1}.

A rider of mass 80 kg sits on the bike, causing the spring to compress.

Source: www.bikeradar.com/features/shock-talk-the-coil-sprung-comeback/

Calculate how much energy is stored in the compressed spring.

(d) When a rider lands after a jump, they essentially have a collision with the ground.

Use physics principles to explain fully how a suspension system makes a bike safer for landing.

QUESTION THREE: ENERGY

A rider and bike with combined mass of 85 kg climb 4.0 m vertically in 3.0 s while biking up a track.

Source: www.singletracks.com/mtb-trails/keystone-bike-park-has-something-for-everyone/

(a) Calculate the average power required.

The rider bikes over a 4.0 m-long bridge and stops 3.0 m from the end.

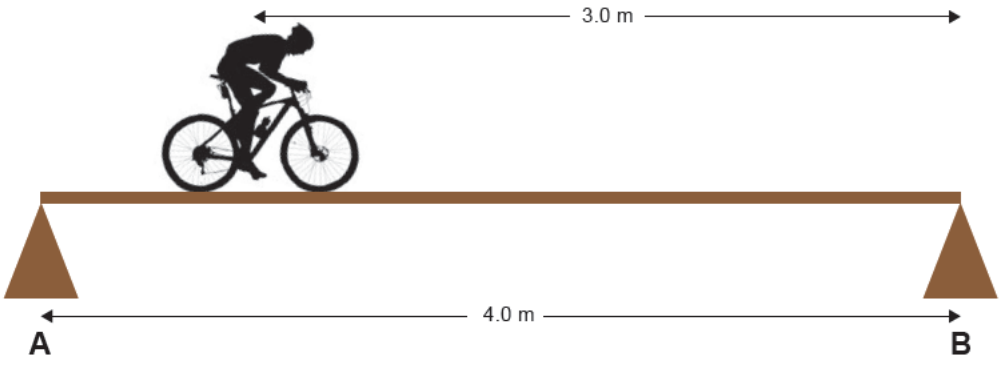
The bridge has a uniform mass of 700 kg.

The combined mass of the rider and bike is 85 kg.

Source: www.visitnsw.com/destinations/hunter/barrington-tops/gloucester/attractions/the-steps-barrington-mountain-bike-park

(b) State the conditions required for the bridge to be in equilibrium.

(c) Draw labelled arrows to represent all the forces acting on the bridge.

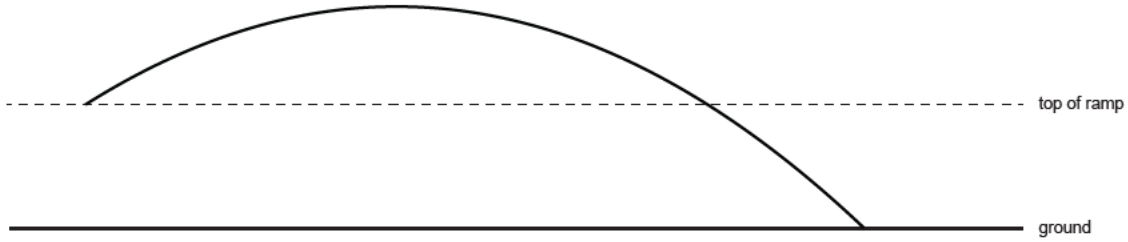


If you need to redraw your response, use the diagram on page 9.

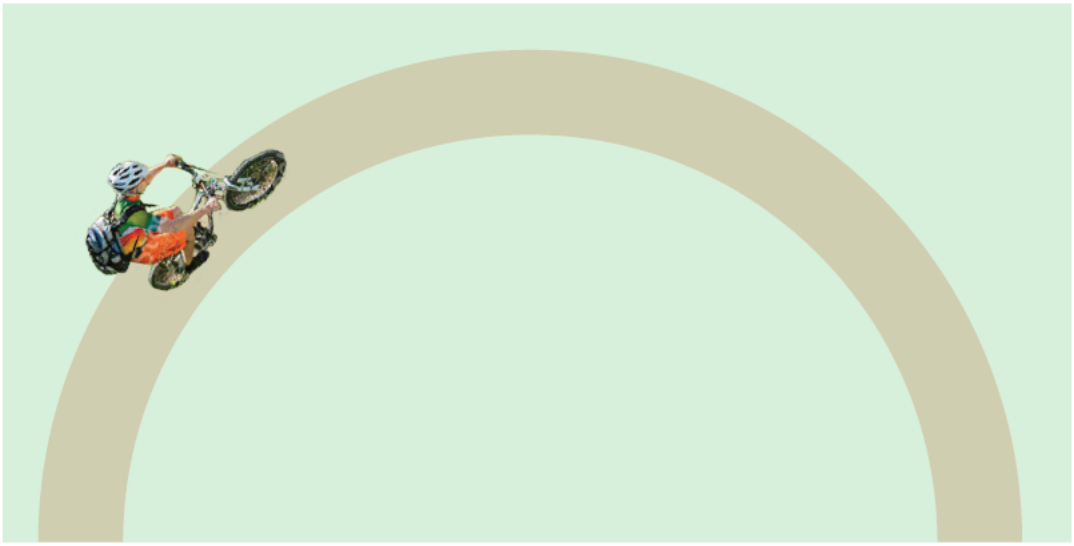
(d) Calculate the values of ALL the forces acting on the bridge.

SPARE DIAGRAMS

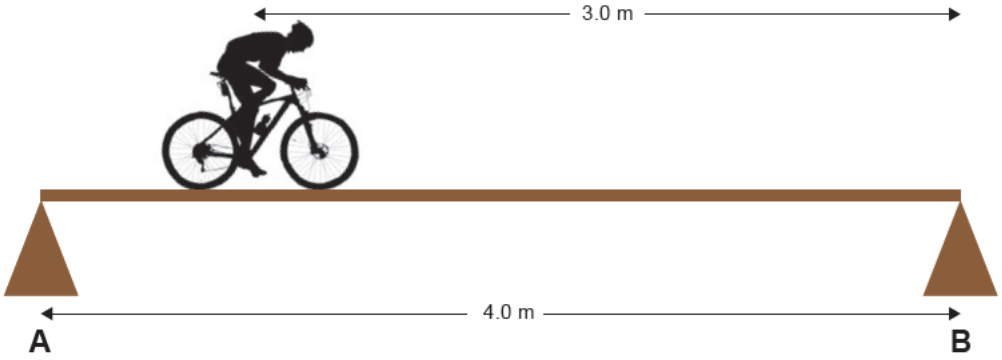
If you need to redraw your response to Question One (c), use the diagram below. Make sure it is clear which answer you want marked.



If you need to redraw your response to Question Two (b), use the diagram below. Make sure it is clear which answer you want marked.



If you need to redraw your response to Question Three (c), use the diagram below. Make sure it is clear which answer you want marked.



Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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