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Level 2 Physics, 2018

91171 Demonstrate understanding of mechanics

9.30 a.m. Friday 9 November 2018
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 space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

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

TOTAL

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The examination commences on the following page.

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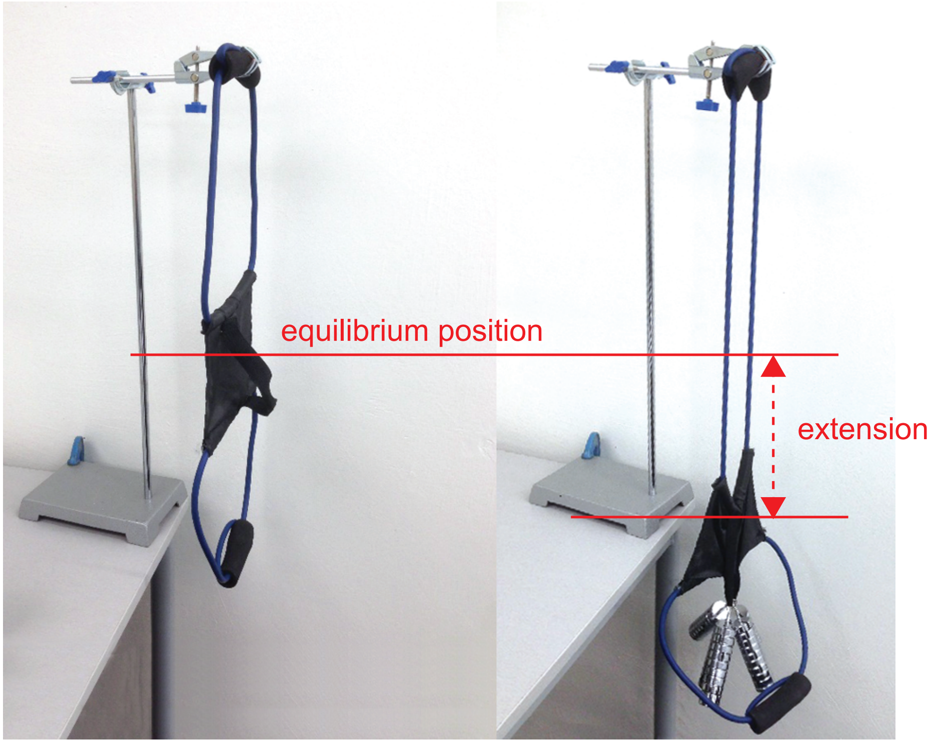
QUESTION ONE: THE WATER BALLOON LAUNCHER

A water balloon launcher is made from stretchy rubber that approximates a spring, as shown in the photos below.

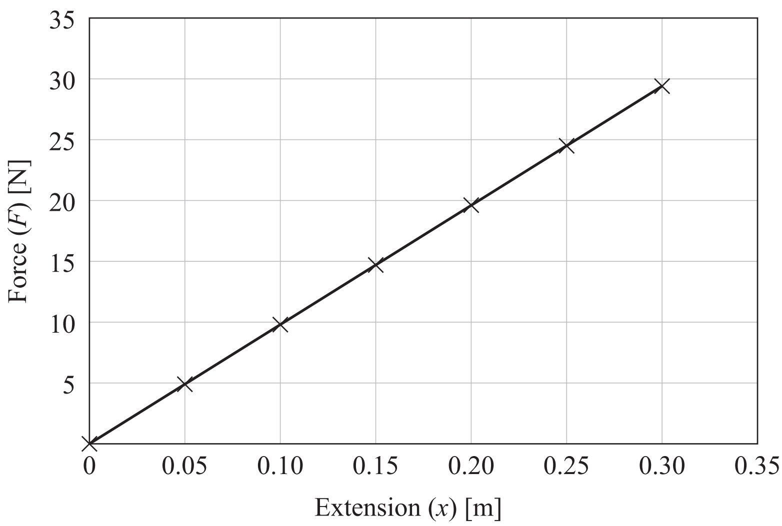


To determine the spring constant, Oliver, a Year 12 pupil, measured the distance that one side of the rubber extended, when various masses were attached to it.

Oliver's results are in displayed in the table and graph below.

Force *(F)* [N]	Extension from equilibrium position (*x*) [m]
4.9	0.05
9.8	0.10
14.7	0.15
19.6	0.20
24.5	0.25
29.4	0.30

Force vs extension for the balloon launcher



(a) Using the data and / or graph above, show that the spring constant (k) of one side of the stretchy rubber is 98 N m^{-1}.

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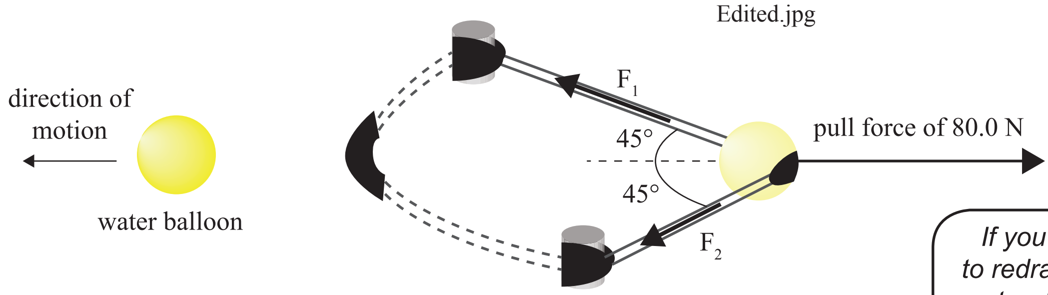
(b) Oliver then connected both sides of the water balloon launcher as shown below. The launcher was held stationary with an 80.0 N pull force. The free body force diagram of the launcher is shown below.

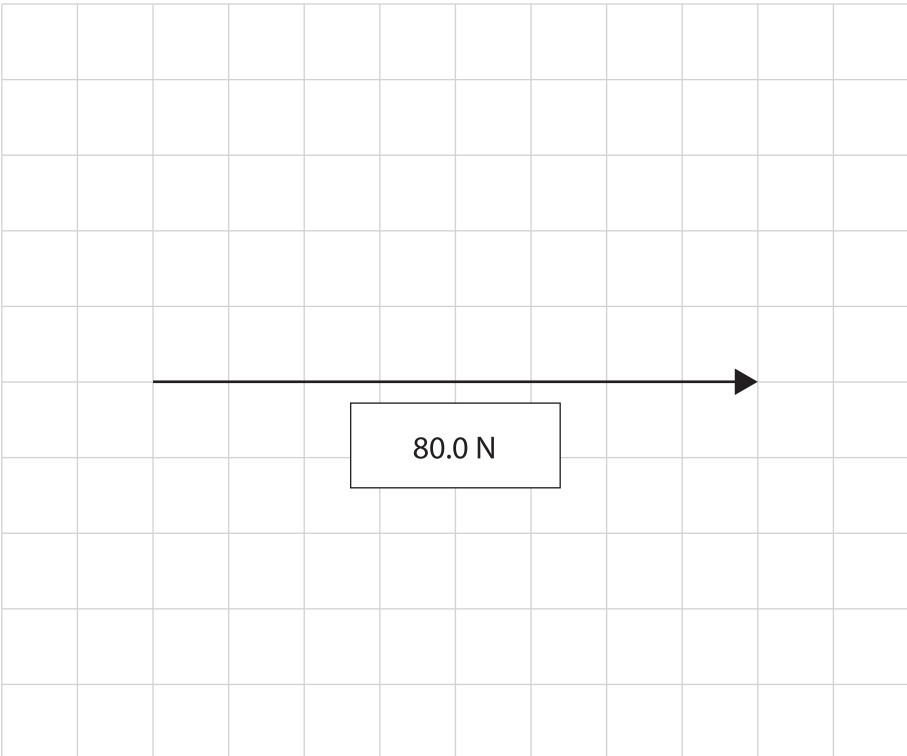
https://frugalfun4boys.com/wp-content/uploads/2016/07/Water-Balloon-Launcher-4-Edited.jpg



If you need to redraw your vector diagram, use the diagram on page 10.

Draw a closed labelled **scale** vector diagram on the grid below.

The 80.0 N horizontal force vector has been drawn for you.

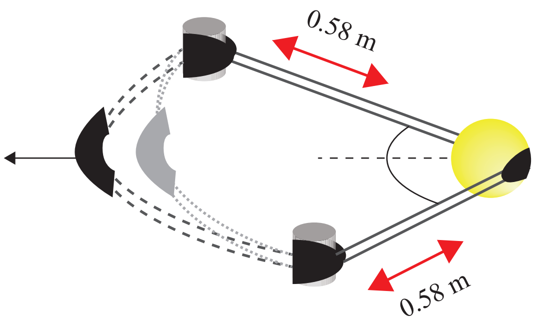


Scale: 1 division = 10 N

Using the above grid or another method, calculate the magnitude of force F_1.

F_1 = ____________________

(c) The water balloon launcher is pulled back so each stretchy rubber pair is **extended** by a distance of 0.58 m.



Calculate the **total** elastic potential energy stored in the two sides of stretchy rubber.

(d) (i) Using the information already calculated above, describe how to calculate the launch speed of the balloon.

No calculations are required.

(ii) Describe TWO changes that could be made to increase the launch speed of the water balloon, stating any assumptions.

Discuss why these changes would give the desired effect.

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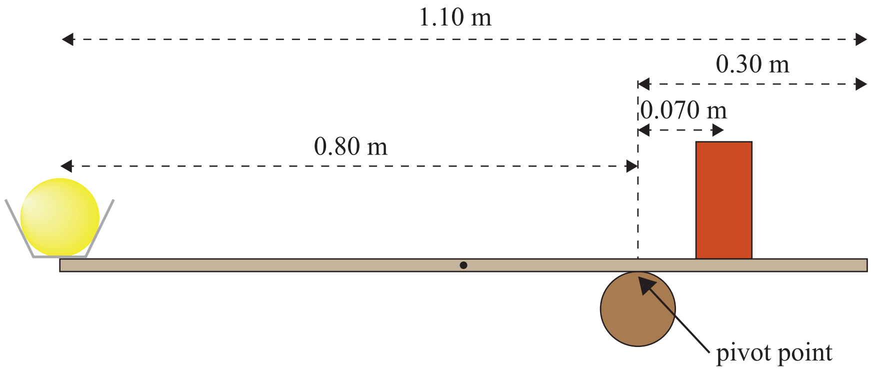
QUESTION TWO: ALTERNATIVE LAUNCHERS

Oliver's brother Jimmy also wanted to launch water balloons. He made a launcher using a uniform 1.10 m long wooden beam that has a mass of 0.30 kg. He placed his water balloon in a holder that had a combined mass of 0.19 kg on the far left-hand end of the beam, 0.80 m from the pivot point. To get the launcher level (state of equilibrium), he added a brick to the right-hand side of the pivot point.

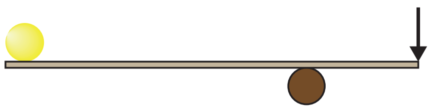
(a) In the diagram below, draw and label ALL forces acting on the wooden beam.



If you need to redraw your labelled forces, use the spare diagram on page 10.

(b) Calculate the mass of the brick on the right side required for the beam to be level.

(c) Jimmy decides to launch his balloon by jumping on the right hand end of the wooden beam. It takes a time of 0.140 s to launch a 0.180 kg water balloon. The average force the balloon experiences is 20.0 N.



By first showing the change of momentum (impulse) of the balloon is 2.8 kg m s^{-1}, calculate the speed of the balloon the instant it leaves the launcher.

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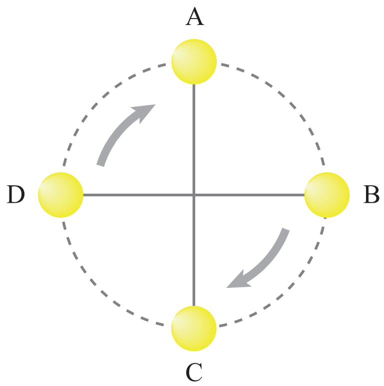
(d) At a later time, Oliver tried launching a water balloon by connecting it to a string and swinging it around his head in a horizontal circle at a constant speed, and releasing it.



Jimmy

(i) At which point would Oliver need to release the string, so that the balloon would travel directly to the right?

(ii) Jimmy, who is standing to the right of the circle, wants to catch the fast-moving water balloon without it bursting.

Explain, using physics principles, why Jimmy pulls his hand back in the process of catching the water balloon.

QUESTION THREE: PROJECTILE MOTION

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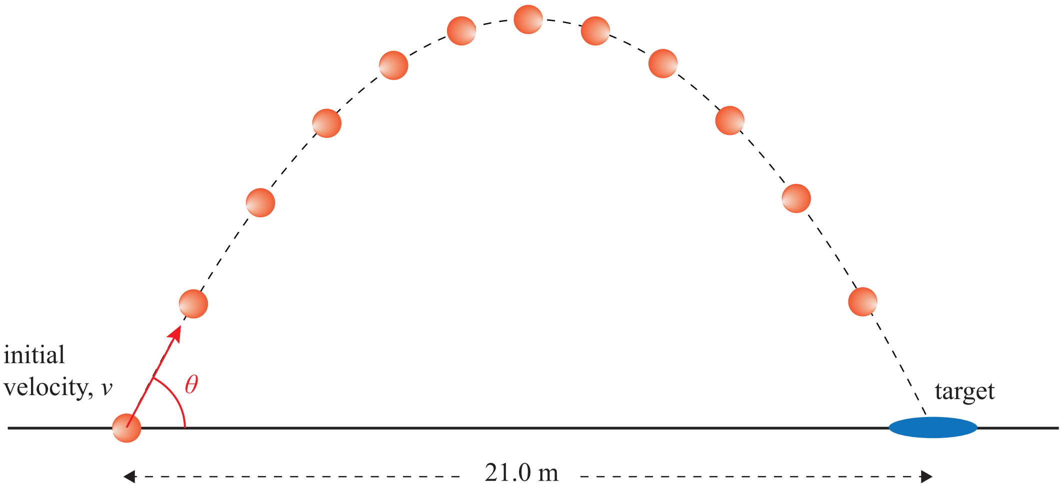
A water balloon is launched, travelling a horizontal distance of 21.0 m. The water balloon is in the air for 2.80 s.



(a) Calculate the horizontal velocity of the balloon.

(b) Show that the initial velocity of the water balloon is 15.6 m s^{-1}.

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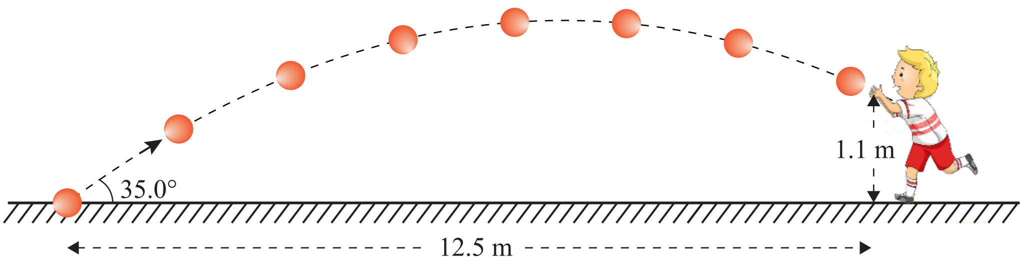
(c) If the same water balloon was launched at the same initial velocity on 'planet X' where the acceleration due to gravity (g) was 3.7 m s^{-2}, would the water balloon go the same horizontal distance?

Clearly explain your answer.

(d) Back on earth, Jimmy wants to catch a water balloon. He stands 12.5 m from the launch position, and his hands are 1.1 m above the top of the launcher.



The water balloon is launched at an angle of 35.0° to the horizontal. The horizontal component of the velocity is 10.0 m s^{-1}.

By first showing that the vertical component of the velocity is 7 m s^{-1}, determine if the water balloon will arrive at the right position for Jimmy to catch it.

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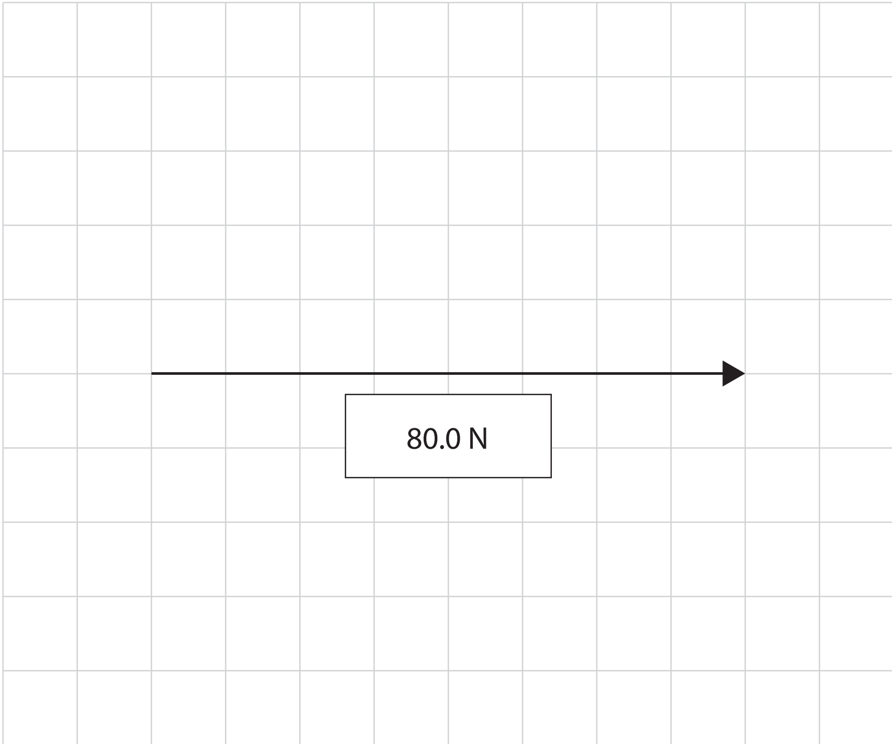
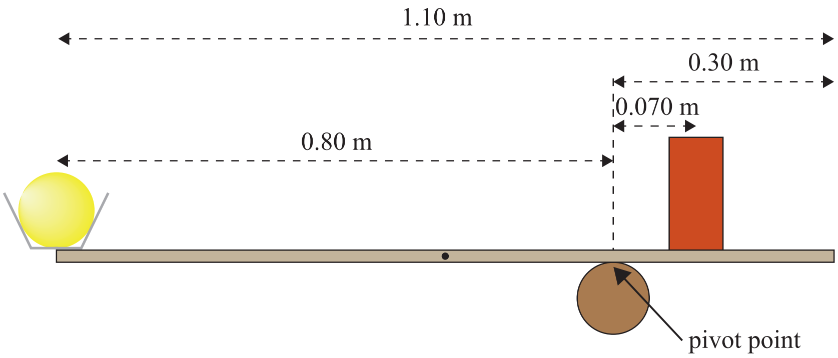
SPARE DIAGRAMS

If you need to redraw your vector diagram for Question One (b), use the grid below. Make sure it is clear which diagram you want marked.



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



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

QUESTION NUMBER

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