NZQA

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Level 2 Physics, 2019

91171 Demonstrate understanding of mechanics

9.30 a.m. Friday 8 November 2019
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

ASSESSOR'S USE ONLY

QUESTION ONE: THE HOCKEY MATCH

Nicole is playing for her school hockey team. During the game she passes the ball to her teammate Josie, who is some distance away. To do this she has to raise the ball high enough to give it flight and low enough to keep it safe. She hits the ball with a velocity of 22 m s^{-1} at an angle of 30°.
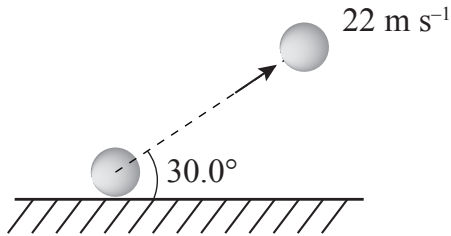
22 m s^{-1}

30.0°

(a)   Show that the initial vertical velocity of the ball is 11 m s^{-1}.

(b)   Describe and explain the motion of the ball. You should refer to any forces acting on it as it moves through the air.

You may include a diagram to support your explanation.

(c) Josie shoots a goal. The ball hits the back of the net with a horizontal speed of 22 m s^{-1}. The impact makes the net stretch by 15 cm. The ball has a mass of 160 g.

By considering the transfer of energy from ball to net, calculate the spring constant of the net.

(d) Josie was 44 m away from Nicole when Nicole passed the ball to Josie in parts (a) and (b).

Will the ball reach Josie before it bounces?
Justify your answer using appropriate calculations.

QUESTION TWO: HALF TIME AT THE HOCKEY MATCH

The teams are waiting for the second half of the game.

While waiting, the referee swings her whistle in a horizontal circle above her head. Each rotation takes 1.40 seconds. The metal whistle has a mass of 40.0 g and it is swung in a circle of radius 0.500 m at a constant speed.

Plan view of swinging whistle
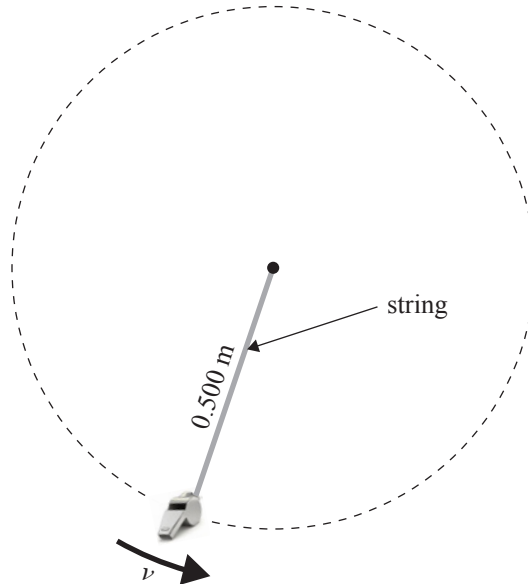
(a)   Show that the speed of the whistle is 2.24 m s^{-1}.

(b) By determining the horizontal forces on the whistle, explain why it continues to move in a circular motion at a constant speed.

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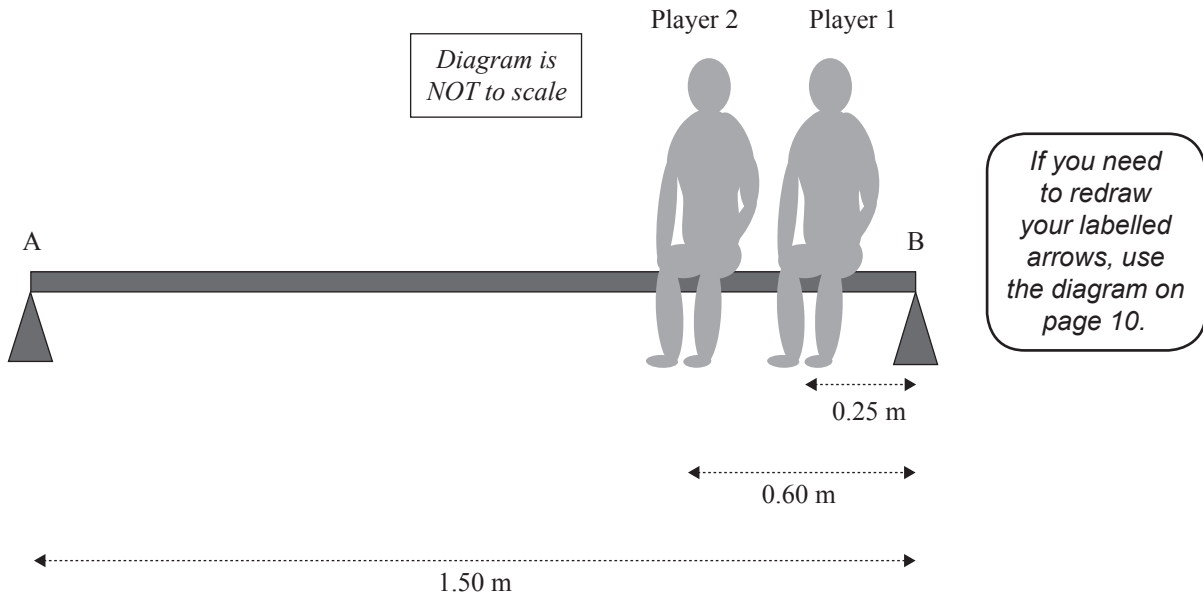(c) The speed of the whistle is reduced to 1.0 m s^{-1}.

Determine the size of the new horizontal force on the whistle, and explain the likely result of reducing the speed on the motion of the whistle.

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(d) The team is waiting on the sideline. Two players sit on the bench, as shown.

The bench is 1.50 m long and has a mass of 10 kg. Each player has a mass of 60 kg. Player 1 is 0.25 m from the support B, Player 2 is 0.60 m away from support B.

Player 2   Player 1

Diagram is NOT to scale

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

A

B

0.25 m

0.60 m

1.50 m

(i) Draw labelled arrows showing all the forces acting on the bench.

(ii) By first determining the torques about point B, calculate the support forces at each end of the bench.

What assumptions have you made?

QUESTION THREE: THE SECOND HALF

www.ahockeyworld.net/the-way-you-choose-the-penalty-corner-formation/

Later in the hockey match, Nicole takes a penalty corner. She hits the stationary ball towards her teammates.

(a)   State Newton's third law, which refers to the forces during the collision between the ball and Nicole's stick.

(b)   When hitting the stationary ball for the penalty corner, Nicole hits with a stick-velocity of 18 m s^{-1}. After hitting the ball, the stick continues forward at 12 m s^{-1}.

The mass of the stick is 600 g and the mass of the ball is 160 g.

Calculate the velocity of the ball.

What assumption(s) are made in your calculation?

Goalkeepers are heavily protected, including the use of leg guards as shown.

(c)   The ball of mass 160 g is shot towards the goal, but hits the goalkeeper's leg guards instead. The ball has an initial velocity of 30 m s^{-1} and the time of the impact is 0.02 s. It rebounds with a velocity of 10 m s^{-1}.
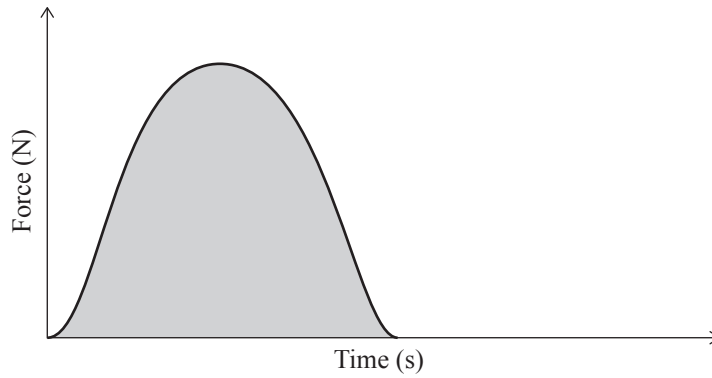
Calculate the average force of the impact.

(d) The graph below shows the force of impact over time when **no** leg guards are worn.

Force (N)

Time (s)

(i) Add a second graph to the diagram to show the effect that leg guards would have on the graph shape.

(ii) Justify your answer by using physics principles to explain how the leg guards benefit the goalkeeper.

SPARE DIAGRAMS

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

Player 2   Player 1

Diagram is NOT to scale

A   B

0.25 m

0.60 m

1.50 m
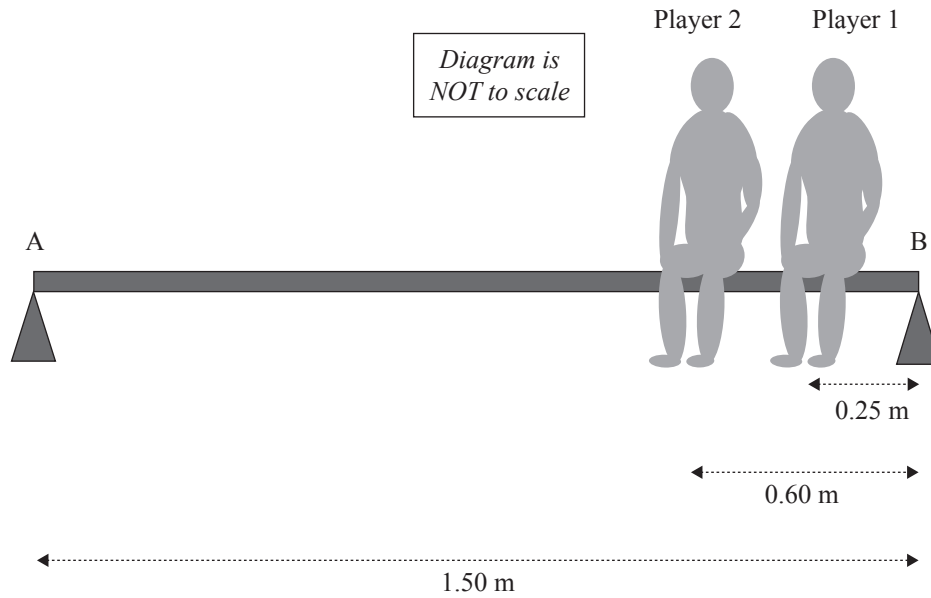
If you need to redraw your graph for Question Three (d)(i), use the diagram below. Make sure it is clear which diagram you want marked.

Force (N)

Time (s)

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

QUESTION
NUMBER

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

91171

QUESTION
NUMBER