2

SUPERVISOR'S USE ONLY

91171

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NEW ZEALAND QUALIFICATIONS AUTHORITY
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QUALIFY FOR THE FUTURE WORLD
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Level 2 Physics, 2015

91171 Demonstrate understanding of mechanics

9.30 a.m. Tuesday 17 November 2015
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.

Achievement

TOTAL 9

ASSESSOR'S USE ONLY

QUESTION ONE: PROJECTILES

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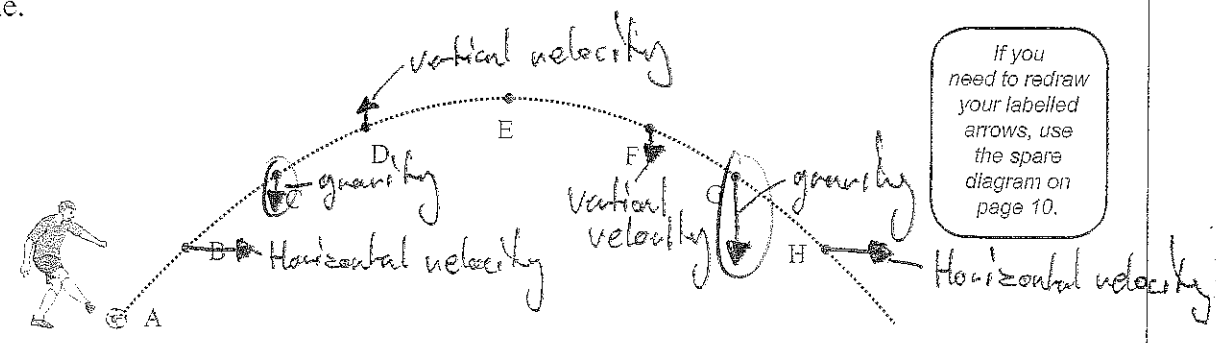
Roy kicks a ball. The diagram below shows the trajectory of the ball. You may assume air resistance to be negligible.



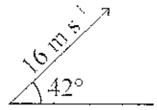
If you need to redraw your labelled arrows, use the spare diagram on page 10.

a

(a) On the diagram draw **labelled arrows of appropriate length** to show the following:

- the force on the ball at position C and at position G
- the horizontal component of the velocity of the ball at position B and at position H
- the vertical component of the velocity of the ball at position D and at position F.

(b) The ball is kicked with an initial velocity of 16 m s^{-1}, at an angle of 42° to the ground.



Calculate the initial horizontal and vertical components of the velocity of the ball at position A.

Horizontal: 16ms^{-1} ~~x~~ Cos 42° = ~~[illegible]~~ 11.89 ms^{-1}

Vertical: 16 ~~x~~ sin 42° = ~~[illegible]~~ 10.71 ms^{-1}

a

(c) State the horizontal and vertical components of the velocity of the ball at position E.

Explain your answers.

balls Horizontal velocity remains at 11.89 ms^{-1} while vertical velocity = 0ms^{-1} at point E

a

(d) Calculate the horizontal distance the ball travels before returning to the level from which it was kicked.

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$v_f^2 = v_i^2 + 2ad$ $\quad d = \dfrac{v_f^2 - v_i^2}{2a}$

$\dfrac{11.84}{2 \times 9.8} = 58.261\,m$

na

A3

QUESTION TWO: ICE SKATING

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Janet and Roy are ice skating.

(a) At one point, Roy is standing still, and Janet glides up to him from behind and grabs him by the shoulders. Janet's velocity as she glides up to Roy is 5.0 m s^{-1}, and together they glide off at a velocity of 2.2 m s^{-1} in the same direction as Janet was gliding (assume that both Janet's and Roy's skates are pointing in the direction of travel). Roy has a mass of 65 kg.

http://sport-kid.net/ice-skating-fall-couple.html

(i) State the law of physics that applies to this situation.

momentum

na

(ii) Calculate Janet's mass.

$p = mv$ $\quad m = \frac{p}{v}$ $\quad \Delta p = 2.8$

$\Delta p = F\Delta t$

na

(iii) Explain why you can use the assumptions you made when calculating Janet's mass.

na

After removing her skates, Janet jumps down to the ground from a high bench.

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(b) Write a comprehensive explanation of what Janet needs to do while landing, so that she does not hurt herself.

Use a formula to explain your answer.

As P=mv to decrease Janets momentum she must decrease her speed she can do this by bending her legs to absorb the impact this will lower her momentum towards the ground and allow her to not hurt herself as by decreasing her velocity she is decreasing her momentum we can see this by the formula P=mv

a

(c) When Janet jumps down, is her momentum conserved?

Explain.

Janets momentum is conserved as she bends her knees to absorb the impact of the fall.

na

N1

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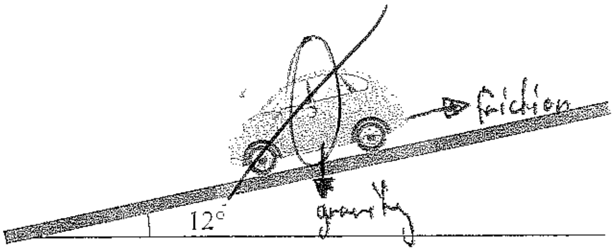
QUESTION THREE: JANET'S CAR AND SPRINGS

Janet arrives home. She parks the car on a slope that is at 12° to the horizontal, as shown in the diagram below.

(a) Draw **labelled arrows** to show the **individual forces** acting on the car.



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

a

(b) Explain in terms of forces acting on the car, how the car remains stationary on the slope.

You may draw a vector diagram to help your explanation.

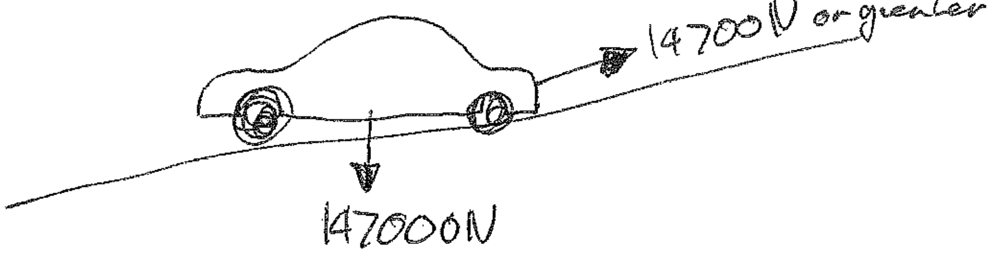
The brakes on Janets car are applying so much friction force to the wheels of the car that they are un able to move keeping the car stationary ~~as~~ even though the car wants to move due to the force of gravity which is constantly trying to push the car down with the 12° slope ~~unless~~ as long as the friction force is greater than the force of gravity acting on the car the car will remain stationary

a

(c) The mass of the car is 1500 kg.

Carry out calculations to show how forces keep the car stationary while it is parked on the slope.

You may draw a vector diagram to help your calculation.



1500 × 9.8 = 14700 N of force acting downward so an equal or opposite force must be applied of 14700N friction force ~~that~~ from the brakes in order to keep the car in a stationary position

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a

(d) The sofa in Janet and Roy's house has springs. When Roy sits on the sofa, the springs compress by 0.075 m.

Calculate the elastic potential energy stored in the springs. (Roy has a mass of 65 kg.)

~~$E_p = \frac{1}{2}kx^2$~~ ~~$E_k = \frac{1}{2}$~~ $\Delta E_p = mg\Delta h$

$65 \times 9.8 \times 0.075 =$

$47.78\,J$

ne

N2

QUESTION FOUR: CIRCULAR MOTION AND TORQUES

ASSESSOR'S USE ONLY

(a) Janet swings a ball tied on a string in a horizontal circle above her head.

Explain why the ball is accelerating even though it is swinging at constant speed.

http://www.shutterstock.com

As the ball is traveling in a circular motion the ball is constantly accellerating towards the center of the circle it is being swung in

a

(b) The length of the string is 0.75 m. It takes 0.84 seconds for the ball to go around her head once.

Calculate the acceleration of the ball.

$a = \frac{v}{t}$ $v = \frac{d}{t}$ $\frac{4.712m}{0.84} = 5.61 ms^{-1}$

$C = 2\pi r$ $2 \times \pi \times 0.75 = 4.712m$

$a = \frac{v}{t}$ $\frac{5.61 ms^{-1}}{0.84} = 6.68 ms^{-2}$

a

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(c) Name the force that causes the ball to accelerate as it goes in a circle.

Explain why the force causes the ball to accelerate.

The force is called centripical force the force causes the ball to accelleate as the ball wants to travel in a straight line it must accelerate towards the centre of the circle in order for it to continue on its circular path.

a

(d) Janet's study table has two panels, one at each end. Janet has a pile of books on her table.

Use the details given below to calculate the support force provided by panel A of the study table.

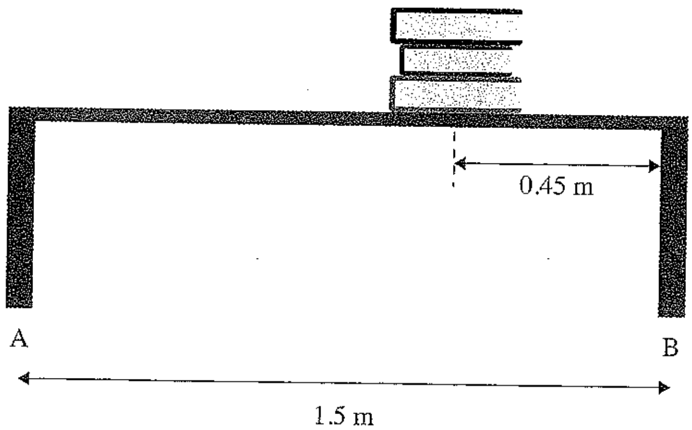
Mass of table = 37 kg

Length of table = 1.5 m

Mass of books = 7.4 kg

The weight of the books acts at a distance of 0.45 m from end B of the table.

Assume Janet's study table is uniform.



F = ma

37 + 7.4 = 44.4 × 9.8 = 435.12 N

τ = Fd B = 435.12 N × 0.45m = 195.8 Nm⁻¹

A = 435.12 N × 1.05m = 456.9 Nm⁻¹

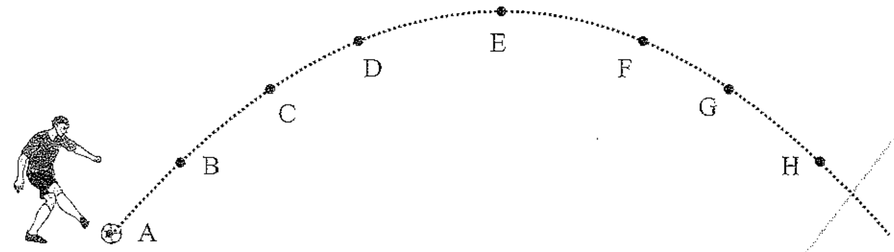
na

456.9 Nm⁻¹

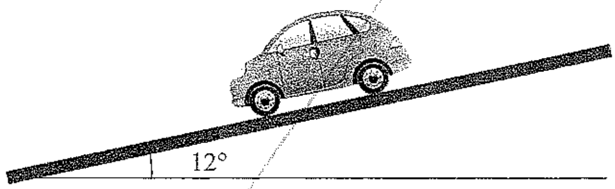
A3

SPARE DIAGRAMS

If you need to redraw your labelled arrows on the diagram from Question One (a), draw them on the diagram below. Make sure it is clear which diagram you want marked.



If you need to redraw your labelled arrows on the diagram from Question Three (a), draw them on the diagram below. Make sure it is clear which diagram you want marked.



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

QUESTION NUMBER

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

QUESTION NUMBER

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Achievement exemplar for 91171 2015		Total score	09
Q	**Grade score**	**Annotation**	
1	A3	This candidate shows adequate evidence for Achievement. The annotated diagram of the projectile trajectory is clearly labelled but lacks care with arrow length. The solution to the single-step numerical problem is clear. The statement of the sizes of the vertical and horizontal components of projectile motion is correct but unexplained. The multi-step calculation proves too challenging	
2	N1	This response shows no evidence for Achievement. The candidate has some idea of the concept of impulse but fails to follow through the discussion	
3	N2	This response does not reach the Achievement level. The candidate recognises two forces correctly for the free body force diagram and is able to calculate one of those forces. No understanding of the concept of equilibrium is demonstrated. Elastic potential energy is confused with gravitational potential energy	
4	A3	The candidate provides sufficient evidence for Achievement in this question. Reasonable understanding of the relationship between circular motion and centripetal force is shown. The initial step in the first calculation is well done but followed by use of an incorrect formula for calculating the acceleration. The opening premise in the torque calculation shows confusion	