No part of the candidate evidence in this exemplar material may be presented in an external assessment for the purpose of gaining credits towards an NCEA qualification.

2

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NZQA

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Level 2 Physics, 2016

91171 Demonstrate understanding of mechanics

9.30 a.m. Tuesday 15 November 2016
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 – 8 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 10

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QUESTION ONE: MOTION

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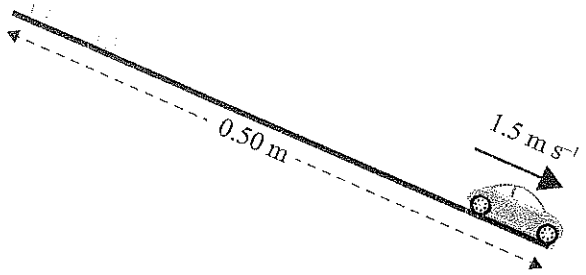


Sarah releases a red car, from rest, down a slope of length 0.50 m.

The red car accelerates steadily and reaches a speed of 1.5 m s^{-1} when it gets to the bottom of the slope.

(a) Calculate the acceleration of the red car as it moves down the slope.

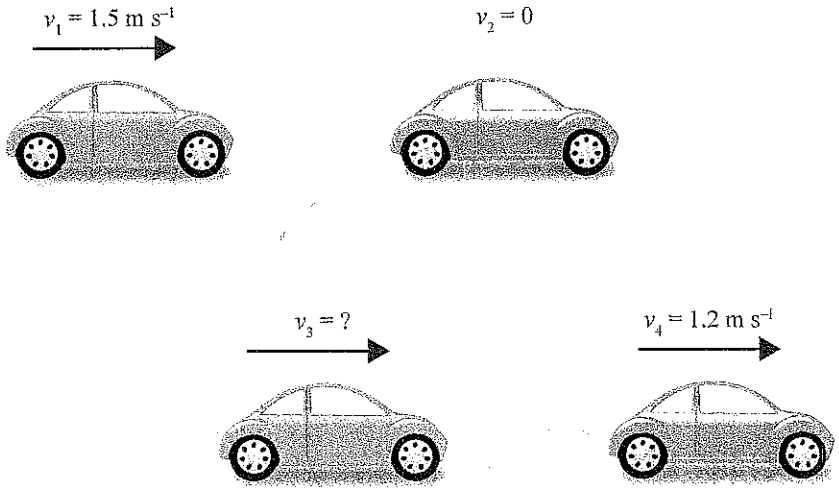
$v_f^2 = v_i^2 + 2ad$

$a = \sqrt{\frac{v_f - v_i}{d}}$

$a = 1.73$

na

At the bottom of the slope, the track is flat. The red car, moving with the speed of 1.5 m s^{-1}, collides with a stationary blue car. The mass of the red car is 0.050 kg, and the mass of the blue car is 0.040 kg.



(b) If the velocity of the blue car after the collision is 1.2 m s^{-1}, calculate the velocity of the red car after the collision.

$\Sigma P_i = \Sigma P_f$

$(m_1 v_1) + (m_2 v_2) = (m_1 v_1) + (m_2 v_2)$

$(0.05 \times 1.5) + (0.04 \times 0) = (0.05 \times v_1) + (0.04 \times 1.2)$

$0.075 = 0.05 v_1 + 0.048$

$v_1 = \frac{0.075}{0.05} = \frac{0.048}{0.05}$

$v_1 = 0.97$ ms^{-1}

a

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(c) If the duration of the collision was 0.08 seconds, calculate the average force that the red car exerts on the blue car.

$F = ma$

$F = 0.08 \times 1.73$

$F = 0.0865$

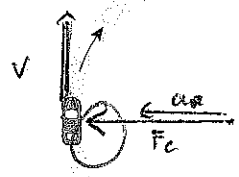
$\Delta p = F\Delta t$

$p = 0.0865 \times 0.08$

$p = 6.92 \times 10^{-03}$

na

(d) On another occasion the red car was going round a circular part of the track at a constant speed.



(i) Name the force acting on the car, and draw a labelled vector on the diagram above to show the direction of the force acting on the car at the instant shown.

Fc centripetal force (centre seeking force

(ii) Discuss the effect of the force on the size and direction of the velocity of the red car.

Velocity will be straight ahead but car will accelerate because the car is acted upon by an ~~up~~ unbalanced force Fc due to friction with the wheels and the track allowing the car to turn in the circular path p

na

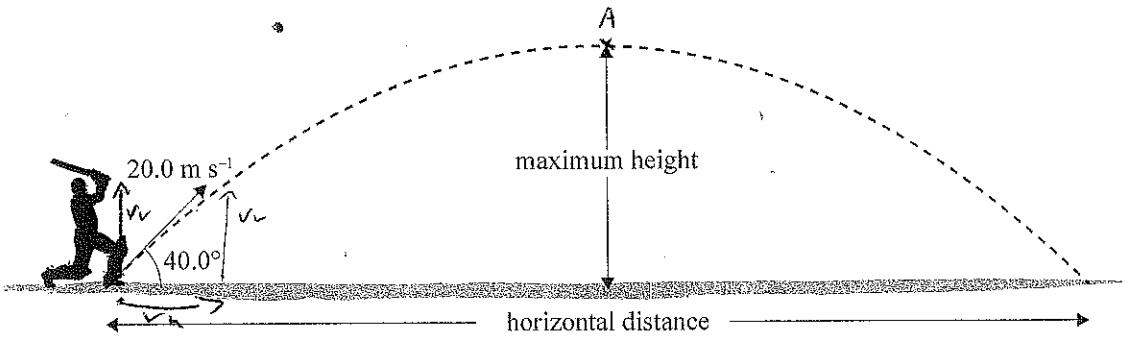
N1

QUESTION TWO: PROJECTILE MOTION

ASSESSOR'S USE ONLY

During a cricket game a batsman hits the ball at an angle of 40.0° with the ground at a velocity of 20.0 m s^{-1}, as shown below.

wwww.wallpaperzworld.com/Cricket-Batsman-wallpaper_1576_original-view



(a) Show that the initial vertical component of the ball's velocity is 12.9 m s^{-1}.

$V_v = \sin 40 \times 20$

$V_v = 12.85$

$12.9\ ms^{-1}$ ✓

$V_i = 20 \quad V_f = 0 \quad a = 9.8 \quad V_v = 12.9$

Q

(b) Calculate the time it takes the ball to reach its maximum height.

$V_f = V_i + at$

$t = \frac{V_i - V_f}{a}$

$t = \frac{12.9 - 0}{9.8}$ ✓ $\quad t = 1.3$ seconds ✓

M

(c) Calculate the horizontal distance travelled by the ball before it hits the ground.

$V_h = \cos 40 \times 20$

$V_h = 15.3\ ms^{-1}$

$d = \frac{V_i + V_f}{2} t$

$d = \left(\frac{15.3 + 0}{2}\right) \times 1.3$

$d = 9.945 \times 2$

$d = 19.90$ m ✓

A

(d) Give a comprehensive explanation of the effect of the force(s) acting on the ball during its flight. Assume air resistance is negligible.

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In your answer you should:

- describe the horizontal motion
- discuss the effect of force(s) on horizontal motion
- describe the vertical motion
- discuss the effect of force(s) on vertical motion.

horizontal motion will remain constant throughout the flight because there is no air resistance. ✓

there are no forces on the horizontal motion during it's flight ✓

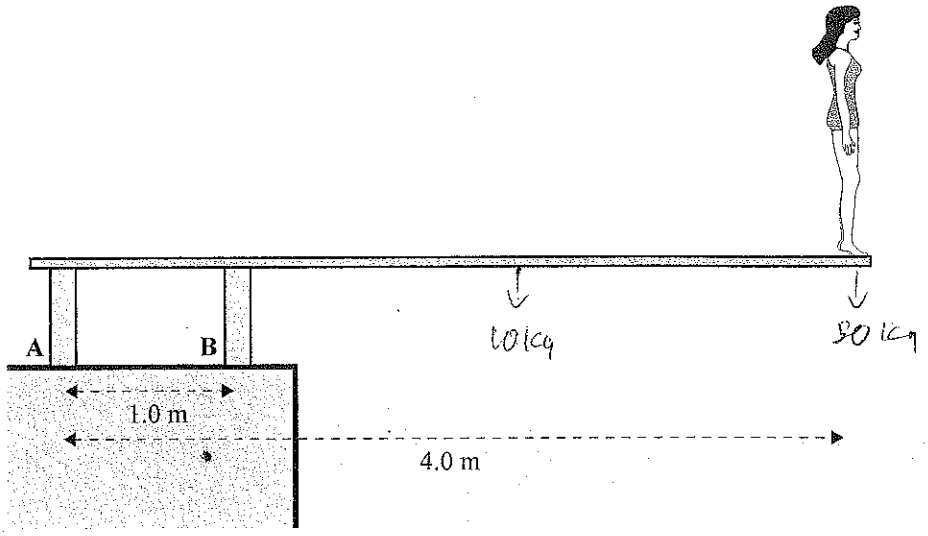
vertical motion the ball will decelerate as it travels up due to gravity. once it reaches the top peak of its parable (point A) it stops for a breife moment vertical velocity = 0. after that breife moment the ball starts to accelerate back down to earth at 9.8 ms^{-2} due to gravity ✓✓

M

M6

QUESTION THREE: TORQUES AND ENERGY

ASSESSOR'S USE ONLY



Sarah stands at the end of a diving board of total length 4.0 m. The diving board is fixed to two supports, **A** and **B**, which are 1.0 m apart. The mass of the board is 10 kg and Sarah's mass is 50 kg. Assume the mass of the board is evenly distributed.

(a) Calculate the torque exerted by Sarah about support **B**.

Give units with the answer.

$F = mg$ $F = 98$ kg $F = mg$ $F = 490$

$T_c = \Sigma F d$

$T_c = (98 \times 3) + 490 \times 3$

$T_c = 1470$

na

(b) What is the direction of the force supplied by support **A**?

Explain your answer.

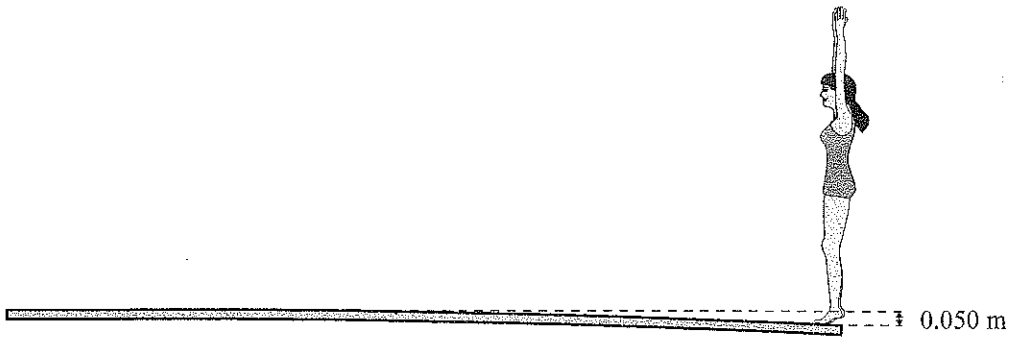
No calculations are required.

Support force A would be clock wise because if Support force B was taken away it will fall in a clock wise direction

na

ASSESSOR'S USE ONLY

(c) The diving board sags 0.050 m when Sarah stands still on the end of the board.



Calculate the spring constant of the board (assuming the board acts like a spring).

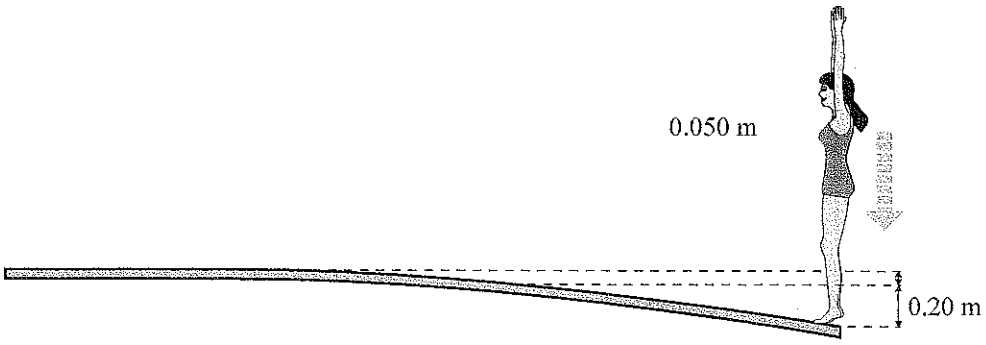
$F = -kx$

$x = \frac{F}{-k}$

$x = 9800$ //

M

(d) Sarah then jumps up and lands on the board, depressing it by a further 0.20 m before she dives into water, as shown below.



Calculate Sarah's speed when she lands on the board, causing it to depress it by a further 0.20 m.

$E_p = \frac{1}{2} k x^2$

~~$E_p = \frac{1}{2} \times 0.2 \times 9800$~~

~~$E_p = 980$~~

$E_p = \frac{1}{2} \times 9800 \times 0.2^2$

$E_p = 196$

$E_p = E_k \quad \frac{1}{2} m v^2$

$196 = \frac{1}{2} \times 490 \, v^2$

$v^2 =$ //

a

A3

Achieved exemplar 2016

Subject:	PHYSICS	Standard:	91171	Total score:	10

Q	Grade score	Annotation
1	N1	This response does not demonstrate adequate evidence for Achieved. The candidate cannot do the algebraic manipulation necessary for solving the numerical problem in part (a). A start is made to part (b), showing good physics understanding but inadequate algebraic skill. The response to part (c) is confused while the discussion in part (d) does not answer the question as asked
2	M6	Here the candidate shows an ability to answer a question on projectiles at the Merit level, with only one error in the numerical parts of their response. The discussion of the effects of forces on the flight of the ball lacks the required detail regarding the force of gravity
3	A3	This response is clearly at the Achieved level. The candidate omits the required units in part (a) and uses incorrect terminology when describing the direction of a force in part (b). The concept tested in part (c) is clearly understood. The candidate applies the correct ideas in part (d) but uses an incorrect item of data and then fails to complete the calculation