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91171

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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.

Excellence

TOTAL 21

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QUESTION ONE: MOTION

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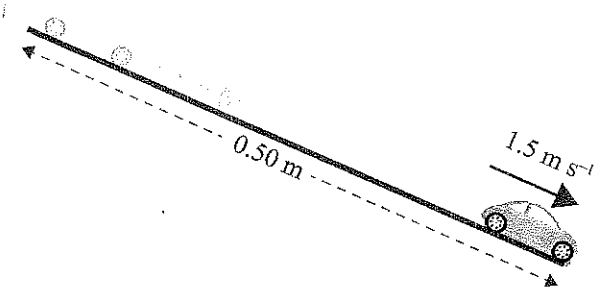


Sarah releases a red car, from rest, down a slope of length 0.50 m.

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.

$V_f = 1.5$ $\quad V_f^2 = V_i^2 + 2ad$

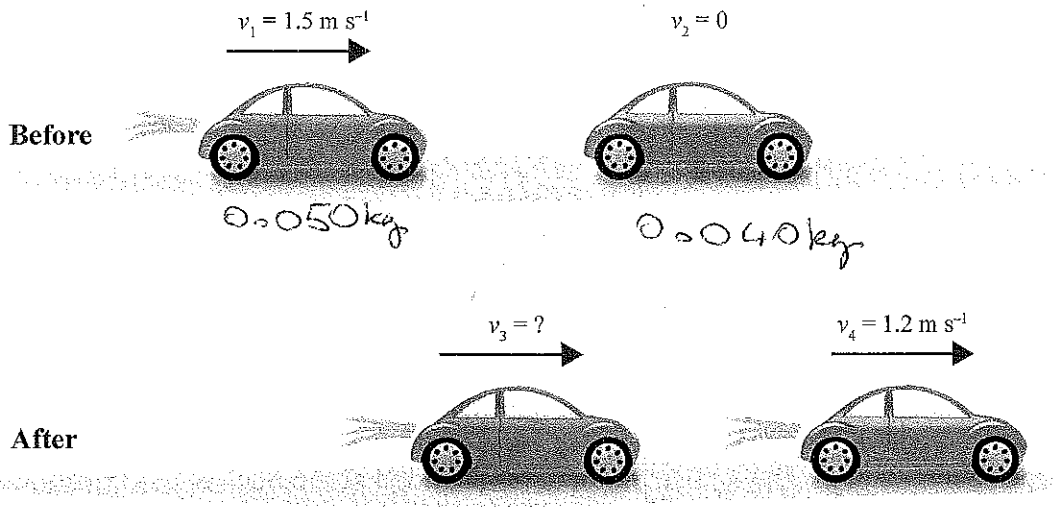
$d = 0.5$ $\quad 1.5^2 = 0^2 + 2 \times 0.5 \times a$

$V_i = 0$ $\quad 2.25 = 1a$

$a = ?$ $\quad a = 2.25 ms^{-2}$ ✓

a

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.

$p = mv$ $\quad 0.075 = (0.04 \times 1.2) + (0.05v)$

$0.050 \times 1.5 = 0.075$ $\quad 0.075 = 0.048 + 0.05v$

$0.027 = 0.05v$

$\frac{0.027}{0.05}$

$v = 0.54 ms^{-1}$ ✓

M

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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.

$\Delta t = 0.08$

~~$\Delta p = 0.075 - (0.54 + 0.05)$~~

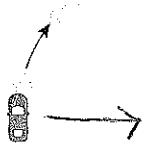
$\Delta p = 0.048$

$\Delta p = F\Delta t$

$\frac{0.048}{0.08} = \frac{0.08F}{0.08}$

$F = 0.6\,N$ m

(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.

Centripetal force

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

~~The velocity of~~ The direction of the velocity of the red car is constantly changing due to the centripetal force that is acting ~~as a force~~ towards the center of the circle. Because the car experiences a force it must also be accelerating ($F = ma$). This causes the size of the velocity to change aswell. m

M6

QUESTION TWO: PROJECTILE MOTION

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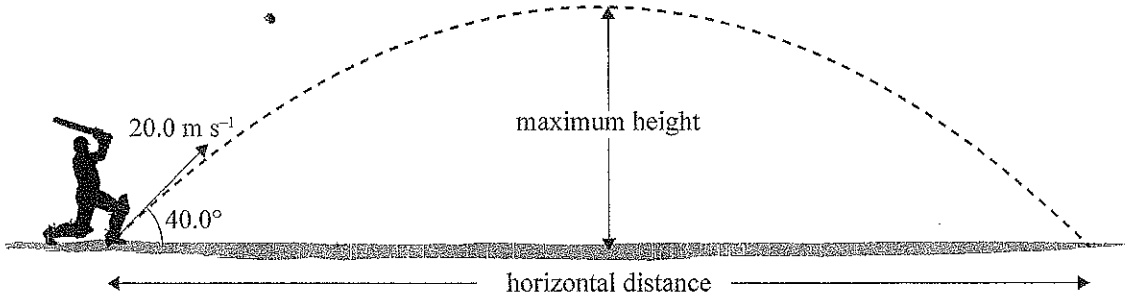
During a cricket game a batsman hits the ball at an angle of 40.0° with the ground at a velocity of 20.0 m s^{-1}, as shown below.

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}.

20 m/s, 40°

SOH sin40 × 20 = 12.85

= 12.9ms⁻¹

a

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

V KD

$V_i = 12.9$ $V_f = V_i + at$

$V_f = 0$ $0 = 12.9 + -9.8t$

$a = -9.8$ $\frac{-12.9}{-9.8} = \frac{-9.8t}{-9.8}$

$t =$ $t = 1.315$

$t = 1.3s$

M

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

H

$V_h = \cos 40 \times 20$ $V = \frac{d}{t}$

$= 15.32 ms^{-1}$ $15.32 = \frac{d}{2.6}$

$t = 1.3 \times 2$ $15.32 \times 2.6 = 39.832$

$= 2.6$

$d = ?$

40 meters

M

(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.

Vertical: Initially the ball is moving upwards. The force due to gravity causes the ball to decelerate ($F=ma$). The ball then decelerate's to $0ms^{-1}$ at the top of it's flight. The ball then accelerates downwards due to the force of gravity. Eventually the speed increases due to the force of gravity.

Horizontal: The ball moves at a constant speed through out it's flight. This is because there are no unbalanced forces acting on the ball so there is no acceleration ($F=ma$). Therefore the ball remains at a constant speed. ✓

e

E8

QUESTION THREE: TORQUES AND ENERGY

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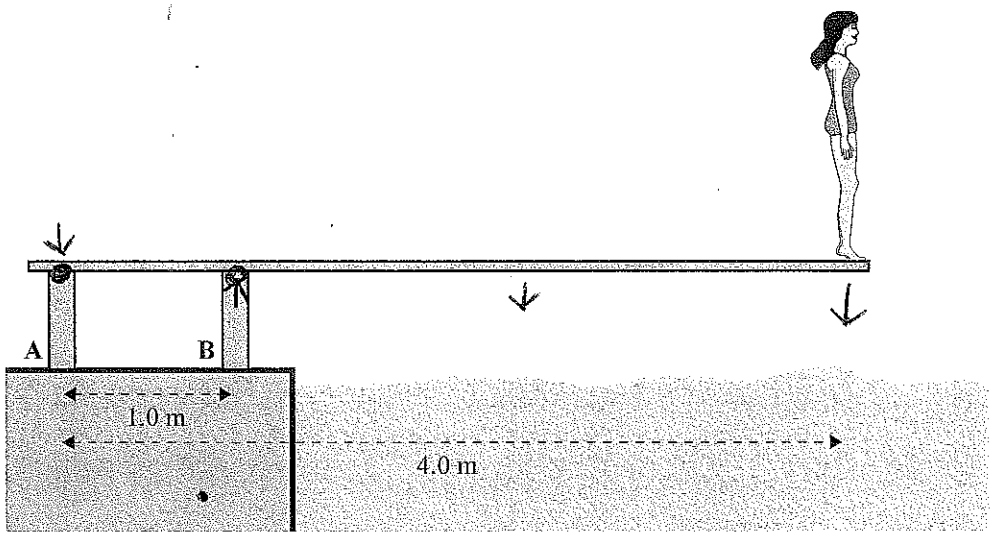

Sarah stands at the end of a diving board of total length 4.0 m. The diving board is fixed to two supports, **A** and **B**, which are 1.0 m apart. The mass of the board is 10 kg and Sarah's mass is 50 kg. Assume the mass of the board is evenly distributed.

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

Give units with the answer.

~~50×9.8~~ 490 Nm⁻¹ 10×9.8 98

Tc	=	Ta
T = Fd		2000Nm⁻¹
T = (4×490)+(98×2)	Sarah exerts	~~196Nm⁻¹~~ of torque about support B.
= 2156	~~2156 Nm⁻¹~~ 210	
	support B exerts	~~2156 Nm⁻¹~~ 2000

WA

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

Explain your answer.

No calculations are required.

Downwards ~~Downwards~~ ~~upwards~~. Both A & B are pivots and forces up = forces down. If we were to make B a pivot point A would provide a anticlockwise torque*. Otherwise there would only be clockwise torque and the diving board would no longer be in static equilibrium.

M

* because in static equilibrium torque clockwise = torque anticlockwise.

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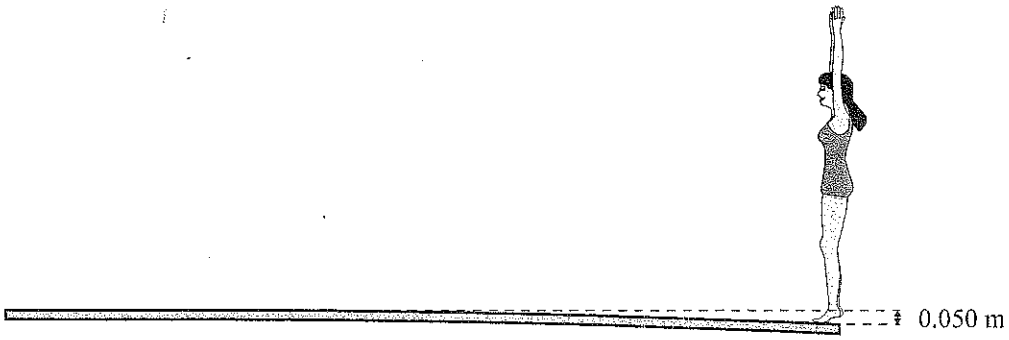
(c) The diving board sags 0.050 m when Sarah stands still on the end of the board.



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

$x = 0.05$

$F = 50 \times 9.8 = 490$

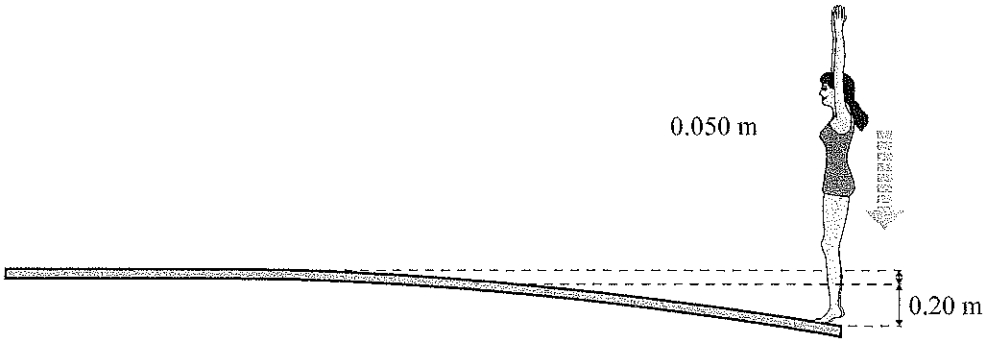
$F = -kx$

$490 = -k\,0.05$

$\frac{490}{0.05} = -9800$

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.

$E_p = \frac{1}{2}kx^2$

~~-9800×0.25~~

$x = 0.25$

$k = -9800$

$E_p = 0.5 \times -9800 \times 0.25^2$

$E_p = -306.25\,J$

$E_p = E_k$

$E_k = \frac{1}{2}mv^2$

$-306.25 = 0.5 \times 50v^2$

$-306.25 = 25v^2$

$\sqrt{12.25} = \sqrt{v^2}$

$v = 3.5\,ms^{-1}$ ✓

e

E7

Annotated Exemplars 2016

Excellence exemplar 2016

Subject:	PHYSICS	Standard:	91171	Total score:	21

Q	Grade score	Annotation
1	M6	This response is at the Merit level. The candidate's solutions for the numerical problems in parts (a), (b) and (c) are set out in a competent manner, showing that they clearly understand the concepts and the processes. However, in part (d), the candidate fails to explain the reason why the centripetal/friction force has no effect on the size of the velocity of the car
2	E8	This response demonstrates strong evidence for Excellence. The solutions to the numerical problems in parts (a), (b) and (c) are set out concisely, demonstrating a comprehensive understanding of the concepts. The discussion in part (d) provides an accurate and succinct explanation of the two components of projectile motion
3	E7	Sufficient evidence is provided for Excellence in this response. The answers to the numerical questions (c) and (d) are very clearly set out, including all steps but with no extraneous material. The candidate's explanation in part (b) demonstrates clear understanding of the concept of equilibrium in an unusual situation. However, the question in part (a) has been misunderstood