2

SUPERVISOR'S USE ONLY

91171

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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.

Merit

TOTAL 18

ASSESSOR'S USE ONLY

QUESTION ONE: PROJECTILES

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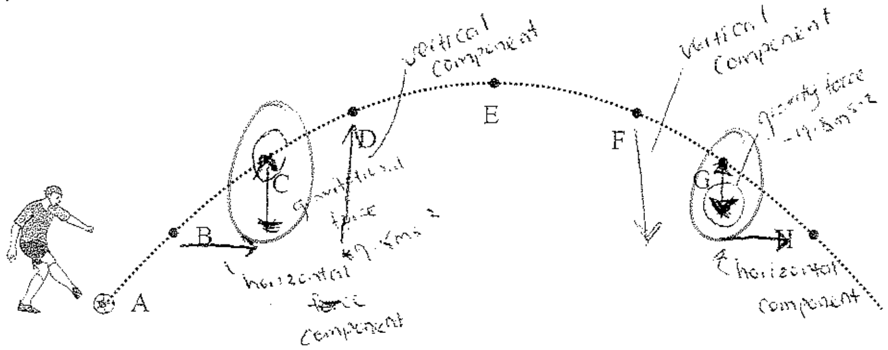
Roy kicks a ball. The diagram below shows the trajectory of the ball. You may assume air resistance to be negligible.



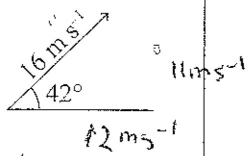
If you need to redraw your labelled arrows, use the spare diagram on page 10.

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.

Vertical = Sin42 × 16 = 10.7 or 11ms⁻¹ (2SF)

Horizontal = Cos42 × 16 = 11.8 or 12ms⁻¹ (2SF)

a

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

Explain your answers.

vertical component will be at 0ms⁻¹ at point E, as it has reached the highest point and momentarily stops before continuing to accelerate downwards at 9.8ms⁻².

Horizontal component will not change and remain 12ms⁻¹ as, their is not ~~force~~ acceleration horizontaly, therefore it is 12ms⁻¹

a

"E" "I"

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

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vf = vi + at

~~0 = 11 t~~ 0 = 11 − 9.8t

t = 1.12 ~~s~~

~~t = 2.24 or 2.3 (2SF)~~

D = V × t

12 × ~~2.3~~ 1.12 = ~~27.6m~~ 13.44m or ~~28m~~ 14m (2SF)

M

Horizontal

V = 12 ms⁻¹

D = ?

T = 2.3

Vertical

vi = 11 ms⁻¹

vf = 0

t = ~~2.3~~ 1.12

A = −9.8

D =

M5

65 × 0

5 × m

QUESTION TWO: ICE SKATING

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.

p = mv

(ii) Calculate Janet's mass.

$p_b = p_a$

$m_J \times 5 = (65 + m) \times 2.2$

$\frac{5.5}{2.2} = 2.27 m_J = 143$

m = 62.9 → 63 kg

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

As there are no external forces we may assume p before = p after therefore momentum is conserved (except when their are external forces).

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.

Jannet must Somehow increase the time of impact from the floor and her feet. As the equation $\Delta P = F\Delta t$ states, if velocity is constant and momentum is changing: ~~and So is the and then is a change in the~~ if, the amount of time taken for the force to be delt to Janet, was to Spread over a longer time, She would recieve less overall force and therefore, won't not hurt herself. As the time of Impact has increased, the force acts over a longer period of time therefore no immediate ~~sta~~ pain as sudden.

a

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

Explain.

No, because of the external force of gravity, therefore due to the acceleration of gravity momentum is not conserved. as an external force is acting, therefor momentum will Change.

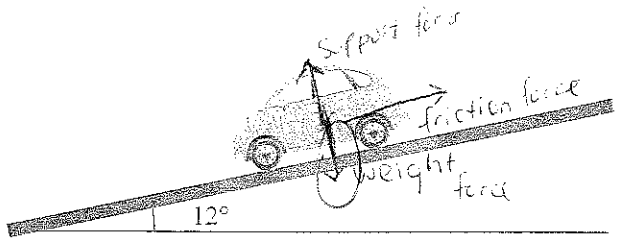
a

A4

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.

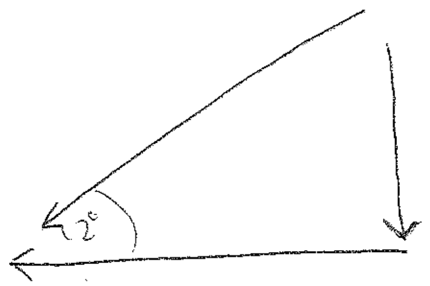


If you need to redraw your labelled arrows, use the spare diagram on page 10.

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.



Friction force is the Strongest influence, as the car is unable to overcome it, rendering it Stationary. As the horizontal Component current exceeds the vertical Components of weight / Support forces. This is because the ramp is at a low angle of 12°, making the car less elevated, So horizontal Component is greater than vertical and friction ~~overcomes~~ becomes the Strongest influence.

na

(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.

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Weight force = $F = mg$

$1500 \times 9.8 = 14700N$

~~Since it is in equilibrium with the bridge support force weight force.~~

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.)

$E_p = \frac{1}{2}kx^2$ $F = -kx$ $F = mg$

$65 \times 9.8 = 637N$ $637 = -k \times 0.075$

$k = 8493.3$

$\frac{1}{2} 8493.3 \times 0.075^2 = 23.8 \rightarrow 24J$ (2SF)

M

A4

QUESTION FOUR: CIRCULAR MOTION AND TORQUES

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(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

Because their is always a change in velocity (direction), so we know from the formula $a = \frac{\Delta v}{\Delta t}$ there has to be an acceleration. And also there is a force drawing it to the centre (centripital ~~motion~~ force) from the tension force of holding the string.

It is always to a tangent.

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.

$a_c = \frac{v^2}{r}$

$\frac{0.84^2}{0.75} = 0.94\ ms^{-2}$

Na

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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.

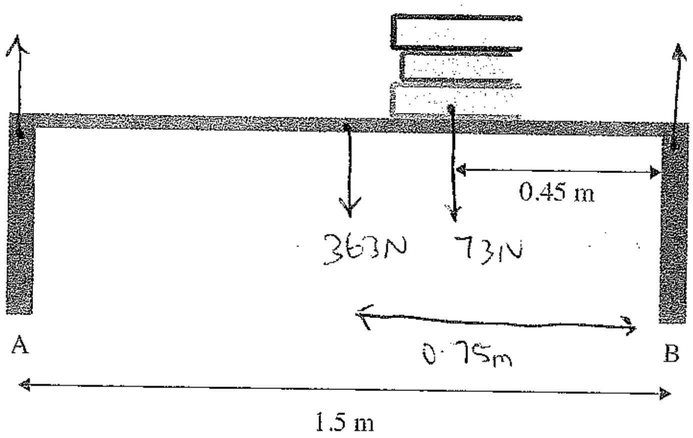
Centripital force. This is because, we know that the ball is always being drawn towards the centre, despite having its velocity (direction) constantly at a tangent changing, therefore we know that their is an acceleration due to $a = \frac{\Delta v}{\Delta t}$, so because of this we know a force must be acting on the ball drawing it in, as F = ma, their is both mass and acceleration in the circle, both acceleration & centripital force act inwards to the centre

m

(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.



Τanti = Tclock

F = mg   table = 37 × 9·8 = 362·6 or 363N

books = 7·4kg × 9·8 = 72·52 or 73N

τ = FD   363 × 0·75 = 272·25 → 272 Nm

73 × 0·45 = 32·85 → 33Nm

272 + 33 = 305Nm

~~305 = … × … DT~~

~~… F = … / 400·6~~

$\frac{305}{0·75}$ = F   F → 407 N

m

M5

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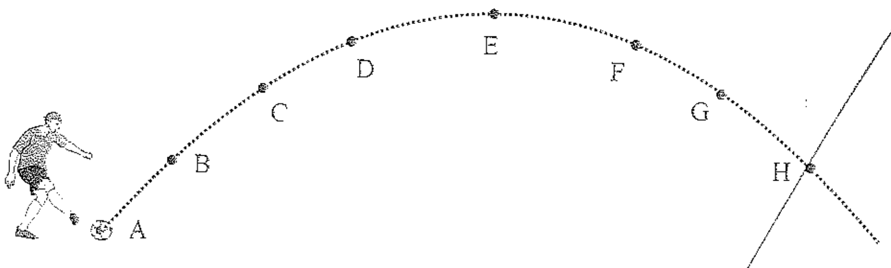
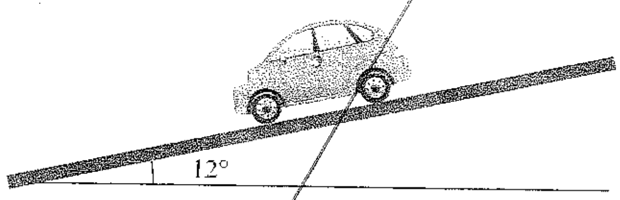
SPARE DIAGRAMS

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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Merit exemplar for 91171 2015			Total score	18
Q	**Grade score**	**Annotation**		
1	M5	The candidate provides sufficient evidence for M5 in this response as, apart from not realising that the time to the top of the flight needs to be doubled to find the range, the numerical solutions are competently done. The double-headed arrows on the vertical forces on the ball are ambiguous. The sizes of the vertical and horizontal components of projectile motion are correct but unexplained		
2	A4	This response does not reach the Merit level. Only the first step in the calculation is completed. The explanation of the assumptions fails to link the fact that the collision took place on an icy surface to the absence of an external force. The candidate demonstrates some understanding of the concept of impulse but fails to provide a logical discussion.		
3	A4	Overall, this response does not reach the Merit level. While the energy calculation is proficient, the candidate demonstrates little understanding of balanced forces. Weight force is not shown to be vertical and the associated vector diagram bears no resemblance to the free body force diagram. The discussion of equilibrium and the related calculation show no understanding of the physics relating to the context		
4	M5	This response provides adequate evidence for Merit. The explanation and discussion relating to centripetal force are well applied in the context of the question. The calculation based on the concept of torques is marred by a careless error at the end		