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SUPERVISOR'S USE ONLY

91171

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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 2 Physics, 2014

91171 Demonstrate understanding of mechanics

2.00 pm Tuesday 18 November 2014
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 2–11 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.

Not Achieved

TOTAL 08

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QUESTION ONE: BASKETBALL

Rachel is on her way to basketball practice. Her ball has a mass of 0.60 kg.

(a) Rachel drops the ball from a balcony. It takes the ball 1.2 seconds to reach the ground.

Calculate the size of the **impulse** on the ball during the time it takes to fall.

$\Delta p = F \Delta t$ $F = 0.60 \times 9.81 = 5.9$

$\Delta p = 5.9 \times 1.2 = 7.1 \text{ N} \ (1.dp)$

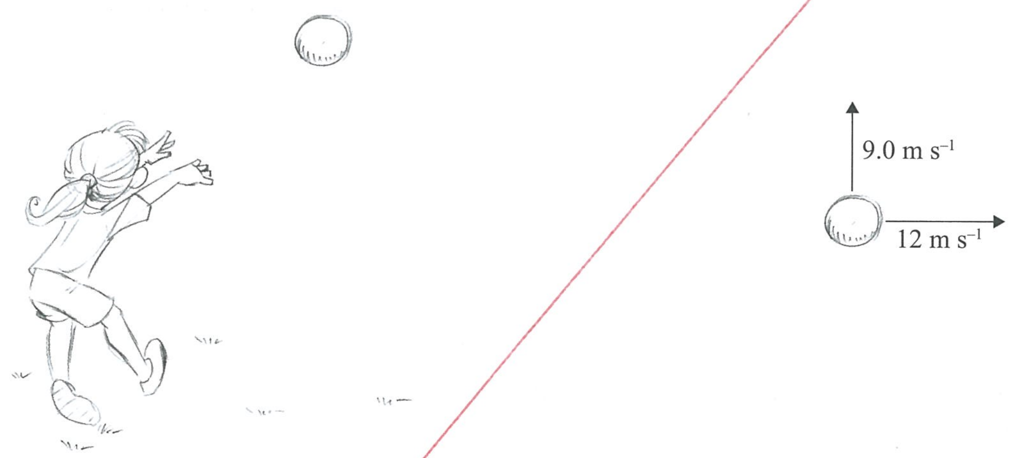
a

(b) Is the **momentum** of the **ball** conserved as it falls?

Explain your answer with reference to the conditions required for momentum conservation.

na

(c) Rachel throws the ball so it has a **vertical** component of velocity of 9.0 m s^{-1} and a **horizontal** component of velocity of 12 m s^{-1}, as shown in the diagram below.



State the size of the **vertical** component of velocity AND the **horizontal** component of velocity when the ball reaches the highest point.

Explain your answer.

You may ignore air resistance.

Vertical component = 0 ms^{-1}

Explanation: As the ball reaches its highest point, velocity slows as kinetic energy converts to grav. potential energy at its highest point because for avery brief moment the ball stops so the velocity will be 0 ms^{-1}.

Horizontal component = 12 ms^{-1}

Explanation: horizontal component isn't affected at the highest point, velocity will remain 12 ms^{-1}.

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a

(d) When the ball is compressed, it **acts** like a spring with a spring constant of 1200 N m^{-1}.

When Rachel throws the ball at the wall, the ball compresses a distance of 9.0 mm.

The ball has a mass of 0.60 kg.

- Calculate the elastic potential energy stored in the ball when it is momentarily stationary against the wall.
- Calculate the maximum possible speed at which the ball rebounds.
- State any assumptions you make.

Elastic potential energy stored: $E_p = \frac{1}{2}kx^2 = \frac{1}{2}(1200) \times (0.60)^2 = 216$ J

Maximum possible rebound speed: $\boxed{216 \times 0.09 = 19.44 \text{ ms}^{-1}}$

Assumptions made:

na

N2

QUESTION TWO: AT THE GYM

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Jamie is doing a workout. He is using a barbell with weights on it. The total mass of the bar with the weights on it is 120 kg.

For copyright reasons, this image cannot be reproduced here.

http://www.makeoverfitness.com/images/stories/standing-barbell-tricep-extension.jpg

(a) Calculate the work done on the bar if Jamie lifts it 0.55 m vertically at constant speed.

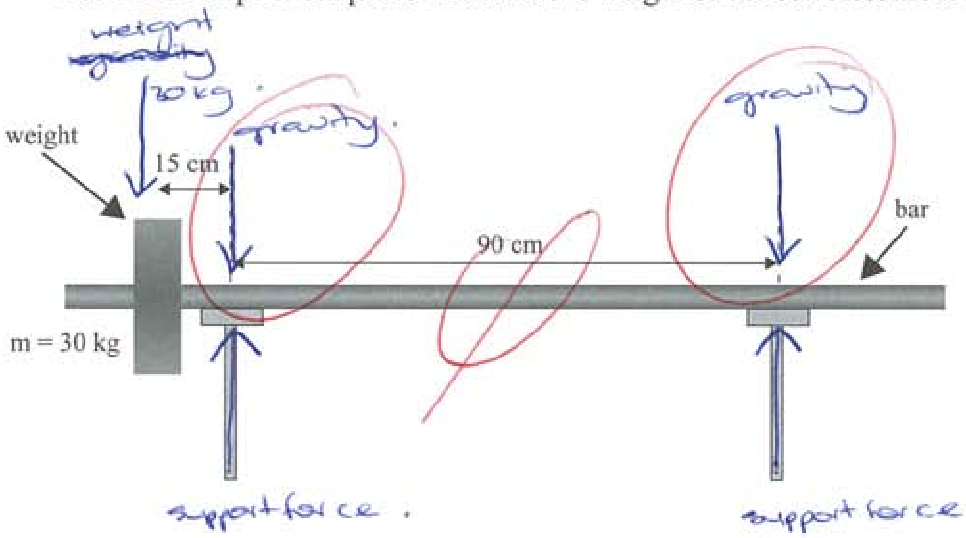
$W = Fd \quad F = mg = 120 \times 9.81 = 1176$

$W = 1176 \times 0.55 = 646.8$ J (1dp)

a

(b) Jamie puts the barbell on two supports and changes the weights on the bar. With no weights on one end and a 30 kg weight on the other end, the support force provided by the right-hand support is zero.

- Draw labelled arrows on the diagram showing the forces on the bar.
- Use the concept of torque to calculate the weight of the bar. Assume it is a uniform bar.



If you need to redraw your labels, use the spare diagram on page 9.

$\tau = Fd$

$F = 30 \times 9.8 = 294$ ~~÷ 0.15~~ $\tau = 294 \times 0.15 = 44.1$

$\tau = 294 \times (0.15 + 0.90) = 308.7$ Nm ~~44.1 ÷ 0.90 = 49.~~ 49 ~ 44.1

$= 308.7 \div 9.8$

$= 31.5$ kg

na

(c) After doing some weights, Jamie goes across to the punch-bag, which is a large bag hanging from a chain. The bag has a mass of 35 kg. Jamie pulls the bag horizontally, using the rope tied to a ring at the top of the bag, until the chain is at an angle of 30° to the vertical, as shown in the diagram opposite.

(i) Draw the three forces acting on the ring at the top of the bag.

(ii) By drawing a vector addition diagram of the three forces acting on the ring at the top of the bag, determine the size of the tension force on the chain.

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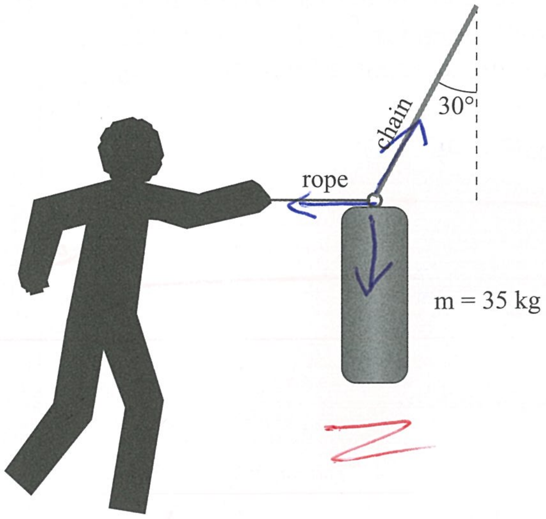
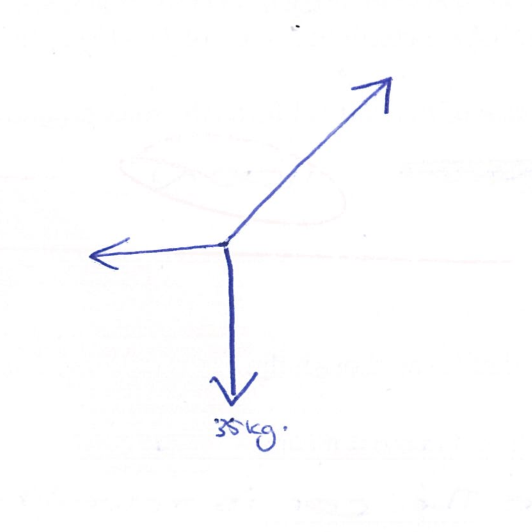


Vector diagram



If you need to redraw your diagram, use the spare diagram on page 9.

a

(d) Jamie punches the bag horizontally. He then puts on a glove with thick padding and punches the bag again with the same velocity.

Discuss the difference between the two punches in terms of:

- the stopping time of his fist
- the force on the bag.

State any assumptions you make.

~~with out the glove on, the hand covers less surface area of the bag and absorbs most of the the hit is harder to the hand. When wearing gloves the thick padding gives more surface area, the stopping time of his fist is slower as the padding allows the hand to go further into the bag without the solid bag stopping it and the force on the bag is much larger~~

a

A3

QUESTION THREE: SHAMILLA DRIVES TO THE GYM

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Shamilla and her car have a combined mass of 1100 kg. She is driving at **constant velocity**.

(a) Calculate the size of the vertical force the road produces on the car.

~~1100~~ 1100N

na

(b) Shamilla says that 'even though the car is moving, it is in equilibrium'.

Explain what this statement means.

because the car is travelling at a constant speed, there is not net force acting on the car meaning it is also at equillibrium (all forces acting on the car are equal.)

a

(c) A short time later, Shamilla's car accelerates from a speed of 2.0 m s^{-1} to a speed of 22.0 m s^{-1}, covering a distance of 72 m.

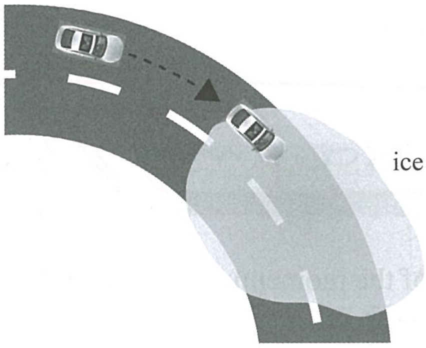
Calculate the size of the average net force on the car while it accelerates.

~~$a = \frac{\Delta v}{\Delta t} = 20.0$~~ $\Delta t = \frac{\Delta d}{v} = \frac{72}{22.0} = 3.3s$ (1dp)

$a = \frac{\Delta v}{\Delta t} = \frac{20.0}{3.3} = 6$

na

(d) Shamilla drives her car at constant speed around a corner, and then drives over some ice, as shown in the diagram below. You can assume there is no friction between the ice and the tyres.



- Describe the net force on the car (if any) before and after she reaches the ice.
- Explain how the net force (if any) affects the motion of the car before and after she reaches the ice.

before she reaches the ice, the net force on the car is zero as she is travelling at a constant speed. Because the net force was zero before she reached the ice, the net force will still remain at zero as there is no friction for the car to be able to slow down or accelerate because of the 0 friction between the ice and the tyres. After the ice the car will slow down or accelerate depending on the drivers actions after the ice, changing the net force from zero.

na

N1

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QUESTION FOUR: SHAMILLA DRIVES HOME

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Shamilla and her car have a combined mass of 1100 kg.

(a) Calculate the total momentum of the car and Shamilla when the car has a velocity of 18 m s^{-1}.

Include the correct unit with your answer.

$p = mv$

$p = 1100 \times 18 = 19800$ Nm ?

na

(b) Calculate the size and the direction of the momentum change of the car as it slows from a velocity of 18 m s^{-1} to a velocity of 11 m s^{-1}.

$p = mv$ $\quad p = 19800$

$p = 1100 \times 11 = 12100 = 19800 - 12100$

$= 7700$ Nm

a

(c) Shamilla puts her foot on the brake, and the car slows down.

Explain the principle of energy conservation in this situation, and identify the transfer of energy caused by braking.

Energy is not made, it is conserved, This is possible as energy transfers from potential energy to kinetic energy. By breaking, energy transfers from kinetic from the car moving to ~~gravitational~~ Heat potential energy from the tyres pushing down on the road

na

(d) Calculate the average rate at which the brakes transfer energy as the car slows from a velocity of 18 m s^{-1} to a velocity of 11 m s^{-1} in a time of 6.0 s.

$E_k = \frac{1}{2}\, 1100 \times 18^2$ $\quad E_k = \frac{1}{2}\, 1100 \times 11^2$

$= 600 \times 18^2$ $\quad = 600 \times 11^2$

$= 194400$ J $\quad = 72600$ J

a

c

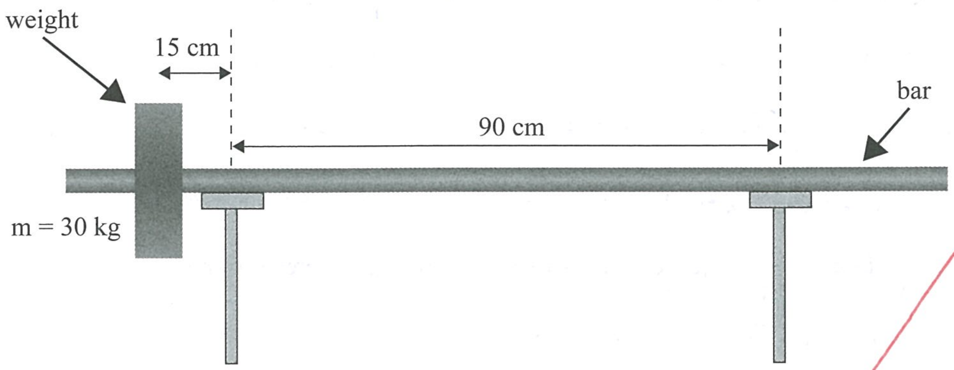
$194400 - 72600 = 121800$ J $\div 600$

$= \sqrt{203} = 14.4$ m s^{-1} (1dp)

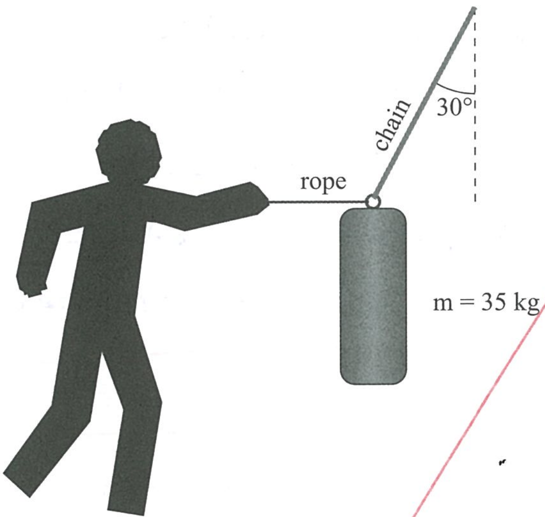
N2

If you need to redraw your diagrams from Question Two, draw them below. Make sure it is clear which diagram you want marked.

(b)



(c)



Vector diagram

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

QUESTION NUMBER

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2d. Without the glove on, the hand covers less surface area and has no protection from the contact between his fist and the solid punching bag. This results in a much faster stoping time of his fist as it hits the punching bag, therefore less force is excerted onto the bag.

Whereas when a glove is worn, the thick padding allows protection to the hand, more surface area allowing a more efficient punch. The padding also slows down the time the hand stops, it allows the hand to go through further with the punch as the thick padding absorbs the shock, therefore there is a larger force on the bag.

Seen

4c cont.

The tyres on the road creates friction that create the heat energy that stops the car.

Seen

Not Achieved exemplar for 91171 2014			Total score	08
Q	**Grade score**	**Annotation**		
1	N2	This response does not meet the requirements for Achievement. Although the candidate can carry out a simple calculation correctly and can recall features of projectile motion, explanations of situations described in the question are either not attempted or show a lack of understanding.		
2	A3	The candidate shows some evidence of Achievement in this response, solving a simple problem correctly, drawing a free body force diagram and demonstrating a slight understanding of the effects of not using/using a glove on a punch bag. However, there is no understanding of torques, nor of vector addition, nor of the further ramifications of the effects of not using/using a glove on a punch bag.		
3	N1	There is no evidence in this response that the candidate meets the requirements for Achievement. Calculations are either incorrect or not attempted. There is one valid point in the explanation of equilibrium, but the response to the question about driving a car around an icy corner shows no understanding of forces and their relation to motion.		
4	N2	The candidate shows insufficient evidence for Achievement. Although a fair attempt is made with some numerical parts of the question, an obvious lack of understanding is demonstrated in the incompleteness of the solutions and in the attempt to explain the principle of conservation of energy.		