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90255

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 2 Physics, 2005

90255 Demonstrate understanding of mechanics

Credits: Six
2.00 pm Tuesday 29 November 2005

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 answer ALL the questions in this booklet.

For all numerical answers, full working must be shown. The answer should be given with an SI unit.

For all 'describe' or 'explain' questions, the answer should be in complete sentences.

Formulae you may find useful are given on page 2.

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 2–15 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.

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Achievement Criteria		
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Identify or describe aspects of phenomena, concepts or principles.	Give descriptions or explanations in terms of phenomena, concepts, principles and/or relationships.	Give concise explanations, that show clear understanding, in terms of phenomena, concepts, principles and/or relationships.
Solve straightforward problems.	Solve problems.	Solve complex problems.

Overall Level of Performance

You may find the following formulae useful.

$$v = \frac{\Delta d}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t} \qquad v_f = v_i + at$$

$$d = v_i t + \frac{1}{2}at^2 \qquad d = \frac{v_i + v_f}{2}t \qquad v_f^2 = v_i^2 + 2ad$$

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

$$F = ma \qquad \tau = Fd \qquad F = -kx$$

$$F_c = \frac{mv^2}{r} \qquad p = mv \qquad \Delta p = F\Delta t$$

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

$$W = Fd \qquad P = \frac{W}{t}$$

Where needed, use $g = 10 \text{ m s}^{-2}$

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You are advised to spend 60 minutes answering the questions in this booklet.

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QUESTION ONE: TRAVELLING BY CAR

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www.stvincent.ac.uk/Resources/Physics/Speed/road/images

(a) A car starts from rest at traffic lights and accelerates in a straight line to a speed of 50.0 km h^{-1} in 10 seconds.

Using the approximation that 50.0 km h^{-1} = 13.9 m s^{-1}, **show** that the car's **acceleration** is 1.4 m s^{-2}.

(b) The mass of the car and its occupants is 1357 kg. Calculate the **net force** acting on the car when it is accelerating.

(c) State whether the force that you calculated in your answer to (b) is **equal to**, **less than** or **greater than** the total driving force provided by the car's engine.

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(d) Explain clearly the **reason** for your answer to part (c).

(e) Calculate the car's **power output** during the first 10 seconds of its motion. Give the correct **unit** for your answer.

(unit)

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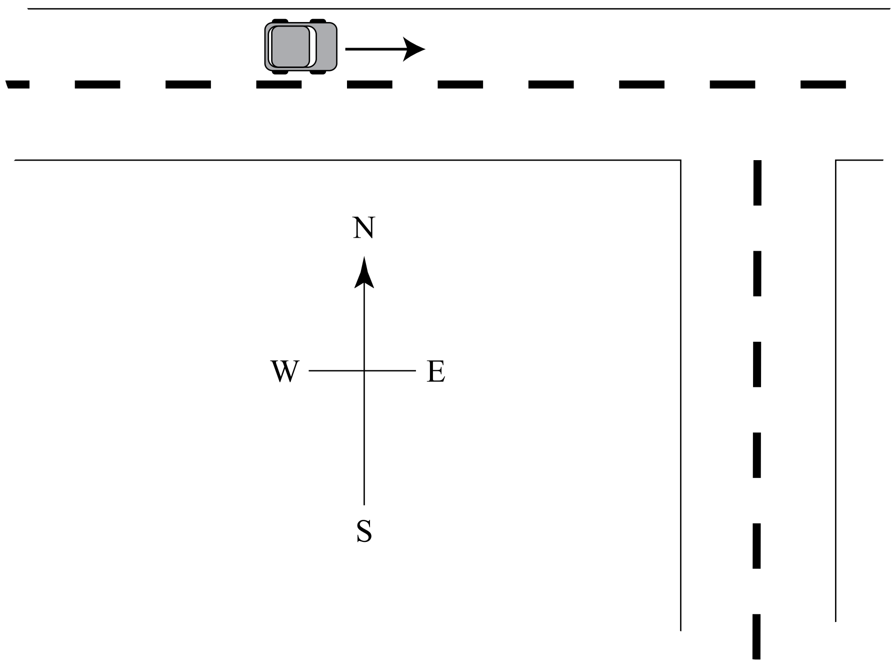
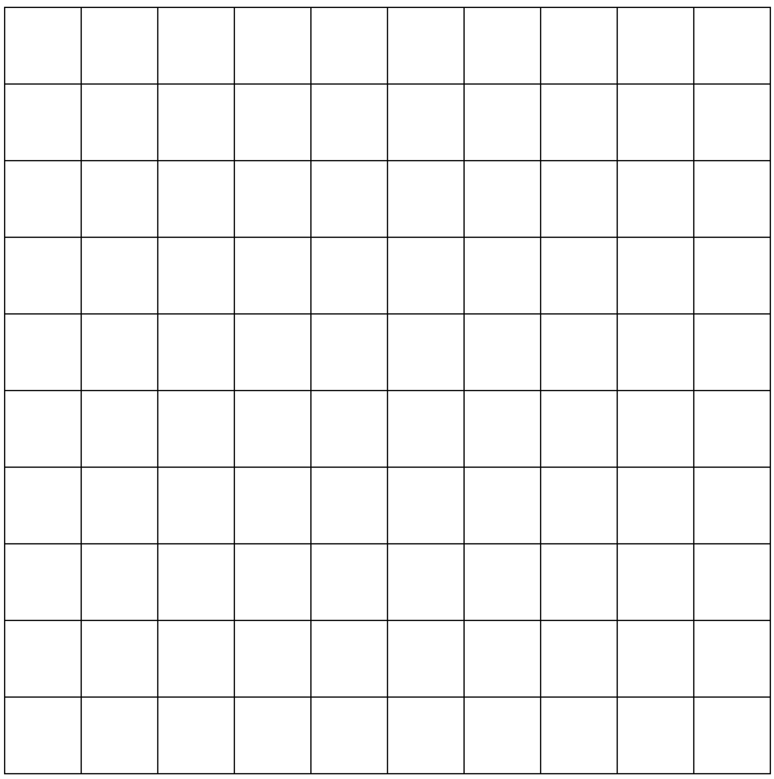
(f) Some time later the car is travelling in an easterly direction with an initial velocity of 12 m s^{-1}. It makes a right hand turn, and then travels south with a final velocity of 16 m s^{-1}.



(i) On the grid below, using a scale of 1 cm = 2 m s^{-1}, draw **labelled** vectors to represent the initial and final velocities of the car.



(ii) On the grid below, using a scale of 1 cm = 2 m s^{-1}, draw a labelled vector diagram showing the **change** in velocity of the car.

An extra copy of the grid is reproduced at the end of the examination paper in case you need to redraw your diagram. Ensure that you cross out work that is not to be marked.

(iii) Calculate the size of the **change** in velocity of the car.

(iv) Calculate the **direction** of the **change** in velocity of the car.

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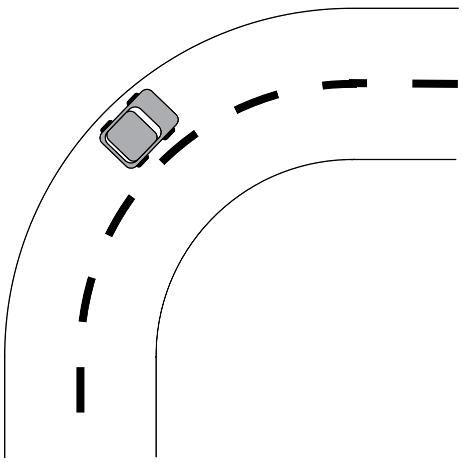
(g) The car is now travelling on the open road at a constant speed of 25 m s^{-1}. Part of the road forms the arc of a circle of radius 40 m. The mass of the car and its occupants is still 1357 kg.



(i) On the diagram above, use a labelled arrow to show the **direction** of the resultant force acting on the car as it travels around the corner at constant speed.

(ii) Calculate the **value** of this force. Give your answer to the correct number of **significant figures**.

(iii) Explain clearly, with reasons, what would happen to the car if the road was icy and could not provide any of the force calculated in (ii).

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(h) One of the reasons why cars have suspension systems is to help provide a smooth ride. Part of the suspension system consists of **four** springs, one at each corner of the car.

(i) The spring constant of each of the car's springs is 2.26×10^4 N m^{-1}. Assuming that the weight of the occupants is evenly shared between the four springs, calculate how much the car **sinks down** when the driver and passengers (total mass 357 kg) all get into the car.

(ii) Calculate how much energy is stored in ONE front spring if it is compressed by 0.12 m.

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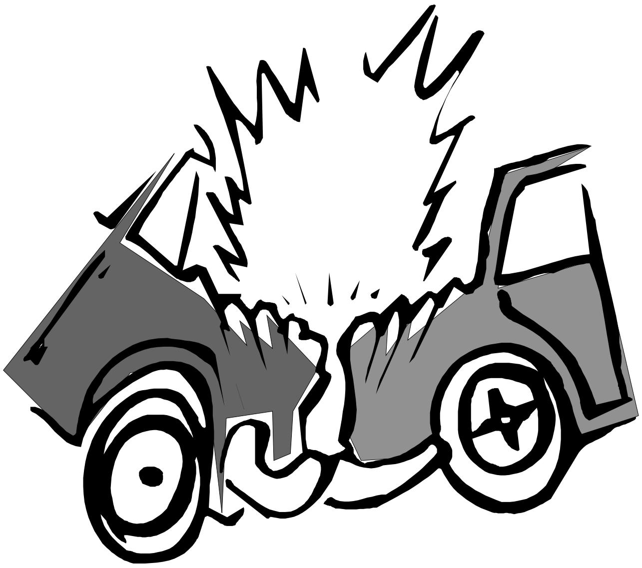
QUESTION TWO: A COLLISION



A car and its driver have a combined mass of 1200 kg. The car collided with a stationary van of mass 1500 kg. The car and van locked together after impact and from the marks on the road the police were able to deduce that the wreckage moved at 4.0 m s^{-1} immediately after the collision.

(a) Calculate the **speed** of the car **just before** it collided with the van.

(b) State what physical **quantity** is conserved in the collision.

(c) State the **condition** necessary for the quantity you have named in (b) to be conserved.

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(d) The impact lasted for 0.50 seconds. Calculate the average **force** that the car exerted on the van during the collision.

(e) **Explain** TWO features that a car has in order to reduce injury to the driver **during a collision**.

(f) Use **calculations** to explain whether the collision was elastic or inelastic.

QUESTION THREE: TRAVELLING IN A HOT AIR BALLOON

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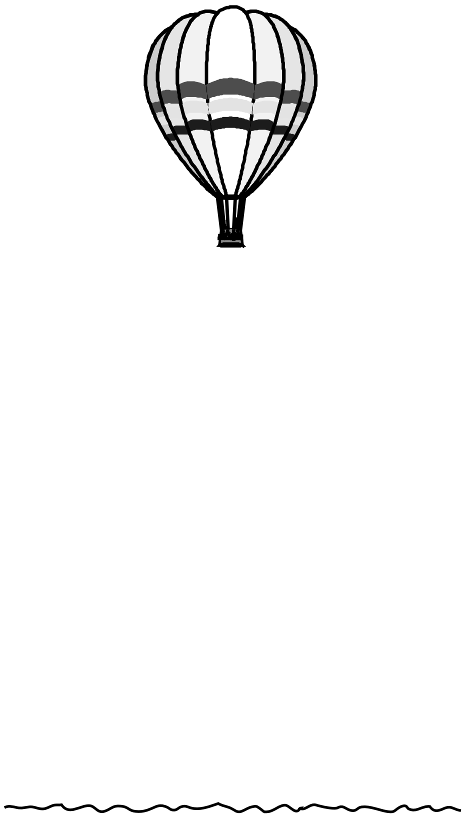
A hot air balloon is rising vertically at a **constant** speed of 2.5 m s^{-1}.



(a) Compare the **sizes** of the total upward force acting on the hot air balloon with the total downward force acting on it, giving your **reasons**.

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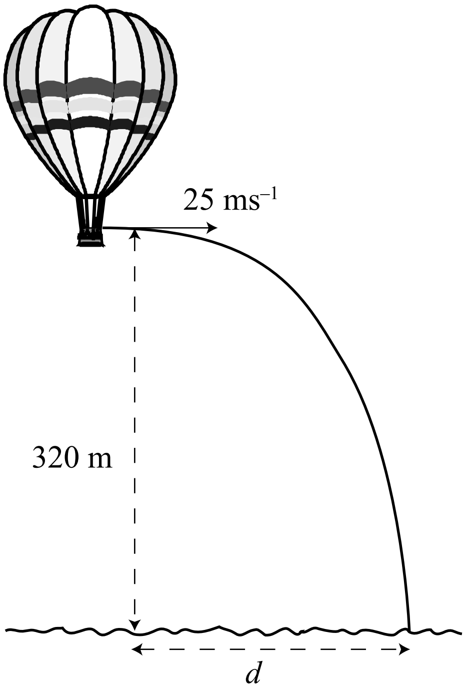
Some time later, the hot air balloon is hovering in a stationary position, 320 m above the sea. One of the passengers throws a tennis ball with a speed of 25 m s^{-1} in a horizontal direction as shown in the diagram below.



(b) Assuming that it was a calm day with no wind, calculate the **horizontal** distance *d* from the balloon to where the ball lands in the sea.

EXTRA COPY OF THE GRID FOR QUESTION 1(f)(ii)

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Extra paper for continuation of answers if required.
Clearly number the question.

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Question number