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90183

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Level 1 Physics, 2006

90183 Demonstrate understanding of mechanics in one dimension

Credits: Five
9.30 am Monday 20 November 2006

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 2–10 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.

For Assessor's use only **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 (all criteria within a column are met)		

You are advised to spend 50 minutes answering the questions in this booklet.

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You may find the following formulae useful.

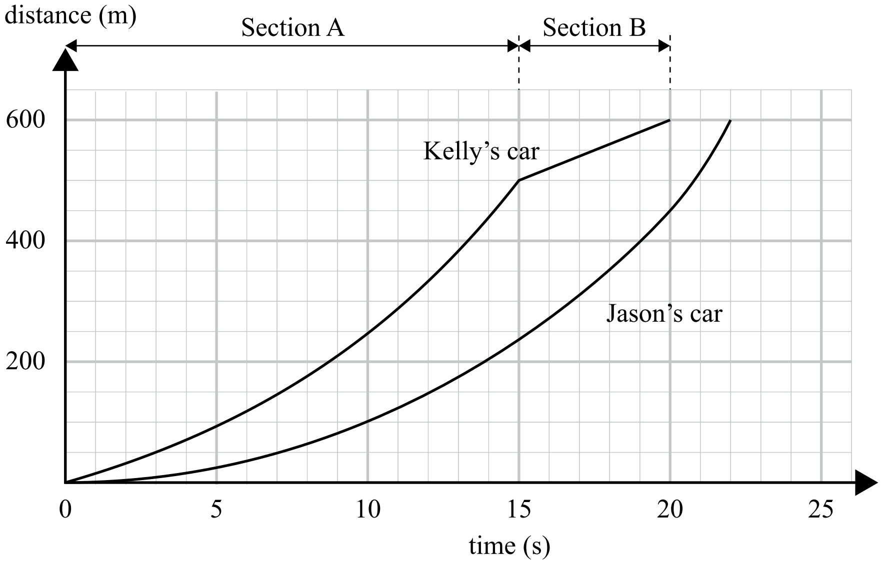
$$v = \frac{\Delta d}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t} \qquad F_{net} = ma \qquad P = \frac{F}{A}$$

$$\Delta E_P = mg\Delta h \qquad E_K = \frac{1}{2}mv^2 \qquad W = Fd \qquad P = \frac{W}{t}$$

The value of g is given as 10 m s^{-2}

QUESTION ONE: DUMMY RUN

Jason and Kelly are members of a stunt crew working on a movie set. They race their cars towards a river. The river is **600 m** away from the starting point. The distance-time graph for each car is shown below.



Use the above graph to answer the following questions.

(a) State how long the winner took to complete the race.

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(b) State how far ahead the winning car is, **in metres**, when it reaches the river.

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(c) Describe the motion of Kelly's ride.

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(d) Calculate the **average** speed of Jason's car.

Average speed = ________________

(e) Show that the **speed** of Kelly's car during **section B** of her race is 20 m s^{-1}.

(f) The combined mass of Kelly and her car is **1 350 kg**.

Calculate the **kinetic energy** of Kelly and her car during **section B** of her race. Write your answer in **kilojoules**.

Kinetic energy = ________________

(g) State the **size** of the **unbalanced force** acting on Kelly and her car during **section B** of her race. Explain your answer. (No calculation is required.)

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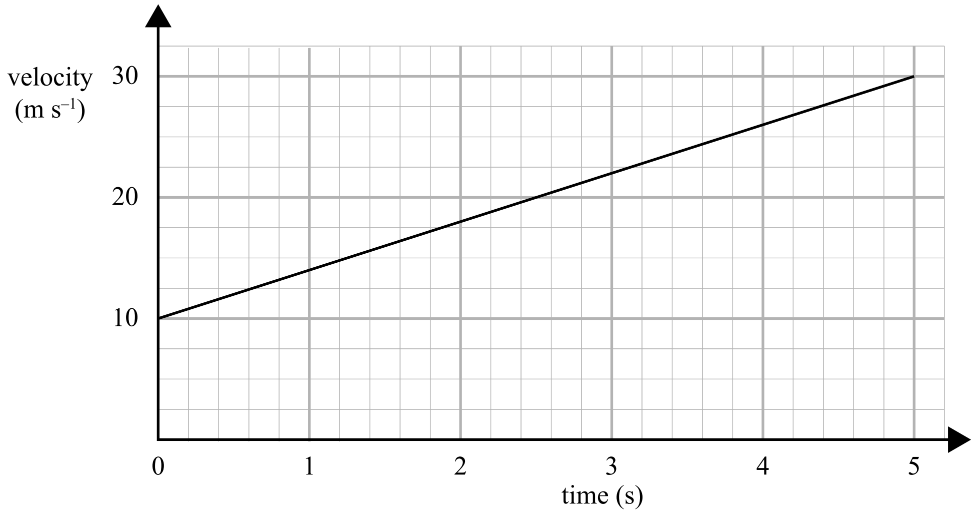
QUESTION TWO: SCENE ONE, TAKE ONE

In a stunt act, Kelly drives her car towards a cliff. The velocity-time graph below shows the motion of Kelly and her car.



(a) Describe the motion of Kelly and her car.

___

(b) The combined mass of Kelly and her car is **1 350 kg.**

Calculate the **size** of the **unbalanced force** acting on Kelly and her car.

___

Force = ___

(c) Calculate the total **distance** travelled by the car during **5.0** seconds.

___

Distance = ___

(d) When the car is travelling at **30 m s^{-1}** Kelly applies the brake. The car decelerates uniformly at **8.0 m s^{-2}** before coming to a stop. Calculate the **time** it takes for the car to come to a stop.

___

Time = ___

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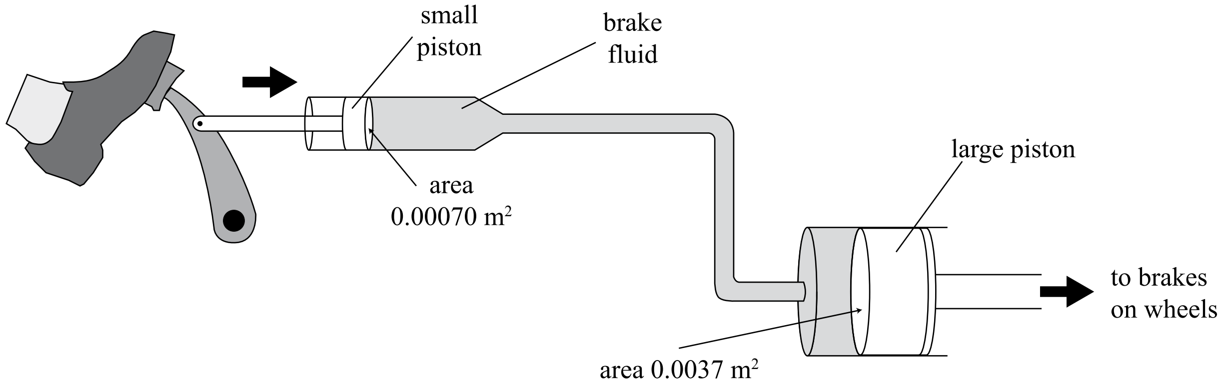
(e) The net braking force used in question (d) to stop the car when it is travelling at **30 m s⁻¹** is **10 800 N**. The combined mass of Kelly and her car is **1 350 kg**. Using the idea of conservation of energy or otherwise, calculate the **distance** travelled by the car during braking.

Distance =

Cars use a hydraulic braking system. The diagram below shows a simple design of a hydraulic brake. When the driver pushes the brake pedal down it applies a force on the small piston. This force exerts pressure on the brake fluid in the small cylinder. This pressure is transmitted to the large piston. The large piston squeezes the brake discs of the wheel to slow the car down. The pressure is the **same** at both pistons.



The force on the small piston is **110 N** and its cross sectional area is **0.00070 m².** The cross-sectional area of the large piston is **0.0037 m²**.

(f) Calculate the **force** exerted by the brake fluid on the **large** piston.

Force =

(g) Hydraulic brakes are designed to magnify the applied force on the brake pedal. In terms of the sizes of the pistons, explain how a hydraulic brake **magnifies** the applied force.

QUESTION THREE: DARE-DEVIL ESCAPE

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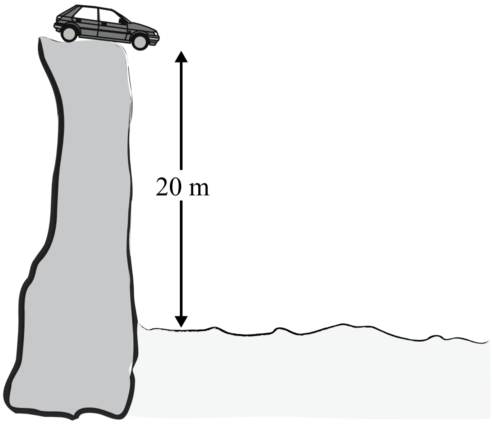
When Kelly stops the car on top of the cliff, it just balances on the cliff edge, as shown in the diagram on the right. The car is **20 m** above the water level.



(a) The combined mass of Kelly and her car is **1 350 kg.**

Calculate the **gravitational potential** energy of Kelly and her car when they are on the cliff edge. (Assume that gravitational potential energy is zero at water level and $g = 10 \text{ N kg}^{-1}$).

Energy = ____________

(b) Kelly now gets out of the car. A few moments later, the car falls freely into the water.

Explain how the **gravity** force acting on the car affects its **vertical velocity**. (**Ignore air friction**.)

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(c) The mass of the car is **1 270 kg** and it falls through a distance of **20 m**.

Calculate the **vertical speed** of the car when it hits the water. Ignore air resistance.

Speed = ____________

(d) Explain, in terms of its **energy**, how the **velocity** of the car changes as it enters the water. Give reasons.

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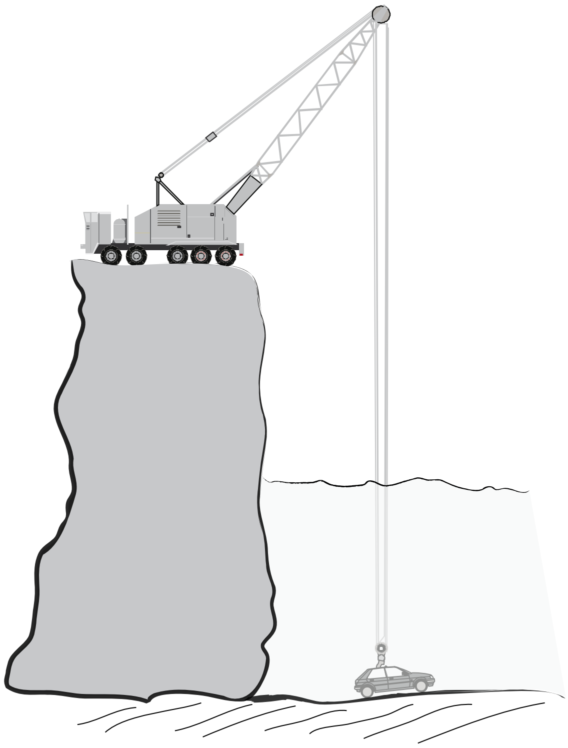
QUESTION FOUR: CAR RECOVERY

The diagram on the right shows a crane pulling the car from the bottom of the river. The cable of the crane pulls the car with a force of **14 000 N** for **25 s** but is **unable** to move it.



(a) Explain why **no work** has been done on the car by the cable even though the cable pulls the car with a force of 14 000 N for 25 s.

The car is raised to the surface and some water is drained from the car. A force of **16 000 N** is then used to pull the car upwards. The car travels up at a constant speed of **0.30 m s^{-1}**. It takes **80 s** to raise the car to a certain height.

(b) Calculate the **power** used by the crane to pull the car to this height. Give the correct unit with your answer.

Power = ____________ unit ____________

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(c) While the car is moving up, it gently swings back and forth in a **horizontal direction**.

Explain why the side-ways swing has no effect on the work being done by the crane on the car.

___

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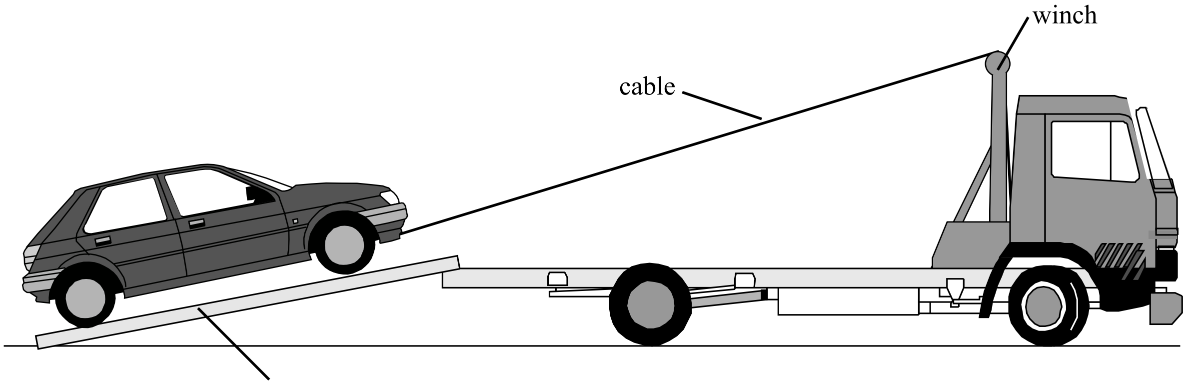
The crane lowers the car onto the ground. A tow truck operator winches the car up a ramp onto the back of the tow truck, as shown in the diagram.



(d) On the diagram above, **draw** arrows to show the directions of the forces acting on the car.

(e) On the same diagram **label** the forces acting on the car.

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

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Question number