## Assessment Schedule – 2011

## Physics: Demonstrate understanding of mechanics (90255)

## Evidence Statement

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	$v_f = v_i + at \Rightarrow v_f = 0 + 1.2 \times 14 \Rightarrow v_f = 16.8 \text{ ms}^{-1}$	<sup>2</sup> Correct answer. ( <i>must show in some way that</i> $v_i = 0$ )		
(b)	** triangle must have arrows $\Delta v = \sqrt{16.8^2 + 16.8^2}$ $\Delta v = 23.76 \text{ m s}^{-1}$ $\theta = 45^{\circ}$	<sup>2</sup> Correct diagram. OR Correct answer to change in velocity without direction.	<ul> <li><sup>2</sup> Correct diagram. AND Correct answer to change in velocity without direction/wrong direction. OR incorrect diagram AND correct Δv with wrong direction (consequential to wrong diagram).</li> </ul>	<sup>2</sup> Correct diagram. AND Correct answer to change in velocity including direction.

(c)	$t = \frac{d}{v} = \frac{65}{6.8} = 9.6 \text{ s}$ $v_{\text{river}} = \frac{d}{t} = \frac{15}{9.6} = 1.56 \text{ ms}^{-1}$ $v_{\text{boat rel bank}} = \sqrt{6.8^2 + 1.56^2} = 7.0 \text{ ms}^{-1}$ $65 \qquad \theta = \tan^{-1} \frac{15}{65} = 13^{\circ}$ $6.8 \qquad v = \frac{6.8}{\cos 13}$ $v = 7.0 \text{ m s}^{-1}$ (either method acceptable)	<sup>2</sup> Correct labelled diagram. OR Correct time (9.6 s)	<sup>2</sup> Correct answer to direction (13° or 77°). OR Correct answer to speed of river = 1.56 ms <sup>-1</sup>	<sup>2</sup> Correct answer to relative speed.
(d)	Friction between the tyres and the road provides (centripetal) force. This acts towards the centre of the circle.	<ul> <li>States friction between tyres and road (not enough to say just friction). OR The direction of the force is towards the centre of the circle.</li> </ul>	<ul> <li><sup>1</sup> States friction between tyres and road (not enough to say just friction).</li> <li>AND The direction of the force is towards the centre of the circle.</li> </ul>	
TWO (a)	At equilibrium, $\Sigma$ clockwise torques = $\Sigma$ anticlockwise torques Taking A as pivot, $(5 \times 72 \times 9.8) + (12.5 \times 760 \times 9.8) = F_B \times 25$ $F_B = 96\ 628/25$ $\Rightarrow F_B = 3865.12 = 3900 \text{ N}$ $F_A = (705.6 + 7448 - 3865.12)$ $F_A = 4288 \text{ N}$ $F_A = 4300 \text{ N}$	<sup>2</sup> Correct answer to sum of downward torques = 96 628 Nm.(or 10721 Nm) (Must use weight force for calculation not just mass). *Accept 98 600 Nm if using $g = 10 \text{ms}^{-2}$	<sup>2</sup> Correct answer to support force at either A or B. Accept 3 944 N for $F_{\rm B}$ and 4376 N for $F_{\rm A}(g = 10 {\rm m s}^{-2})$ .	<sup>2</sup> Correct answer to support force at both A and B.

(b)	2 s.f. for both FA and FB The lowest number of sf in the question is 5.0 which is 2 s.f. The final answer cannot be any more accurate than the least accurate piece of data in the question.	<sup>1</sup> Correct rounding to 2 sf. OR Reason.	<sup>1</sup> Correct rounding and reasoning.	
(c)	$(16.8 \times 72.0) - (8.0 \times 0.430) = (72x) + (5.0 \times 0.430)$ 1 209.6 - (3.44 + 2.15) = 72x 1 204.01 = 72x $x = 16.7 \text{ m s}^{-1}$ forward (same as original direction).	<sup>2</sup> Correct answer to 1206.2 kg m s <sup>-1</sup> .	<ul> <li><sup>2</sup> correct answer to 1 204.01 kg m s<sup>-1</sup> OR Correct velocity without direction.</li> </ul>	<sup>2</sup> Correct answer including direction.
(d)	<ul> <li>An elastic collision is one in which kinetic energy is conserved. An inelastic collision is one in which some kinetic energy is lost (in form of heat to the surroundings.)</li> <li>In order to find out whether a collision is elastic or inelastic, the total kinetic energy before collision and the total kinetic energy after collision are to be calculated.</li> <li>If they are the same, the collision is elastic, if kinetic energy after collision is less/different, then the collision is inelastic.</li> </ul>	<sup>1</sup> States one point correctly.	<sup>1</sup> States two points correctly.	<sup>1</sup> States all three points correctly.
(e)	<ul> <li>When the change in momentum is the same, the force can be reduced by a longer impact time.</li> <li>Force exerted by Jacquie and her bike on the ball is equal in size but opposite in direction to the force exerted by the ball on the bike and Jacquie.</li> <li>(Since the change in momentum of Jacquie and her bike is equal to the change in momentum of the ball, and they are in contact with each other for the same length of time.)</li> </ul>	<ul> <li><sup>1</sup> Less force when time of impact is longer. OR</li> <li>Each object exerts an equal force on the other. OR</li> <li>The direction of force is opposite.</li> </ul>	<ul> <li><sup>1</sup> Less force is exerted when time of impact is longer since change in momentum is the same. OR Each object exerts an equal but opposite force on the other.</li> </ul>	<ul> <li><sup>1</sup> Less force is exerted when time of impact increases since change in momentum is the same.</li> <li>AND</li> <li>Each object exerts an equal but opposite force on the other.</li> </ul>

THREE (a)	Since the force is at an angle and the lawn mower is moving horizontally, only the horizontal component of the force will act to move the lawn mower forward. The vertical component of the force will act into the ground, pushing the lawn mower down.	<sup>1</sup> One point made about either the vertical or horizontal components.	<sup>1</sup> Both points made and explained.	
(b)	$P = \frac{W}{t}$ $P = \frac{26\cos 34^{\circ} \times 4.0}{3}$ $P = 28.7 \text{ W}$	<sup>2</sup> Calculates power using $F = 26$ N (will get 34.6 W). OR Correct answer to work done using horizontal component of force.	<sup>2</sup> Correct working and answer.	
	Watts or J s <sup>-1</sup> or N m s <sup>-1</sup>	<sup>1</sup> Correct unit.		
(c)	Horizontal component = $24 \cos 36^\circ = 19.4 \text{ m s}^{-1}$ Vertical component = $24 \sin 36^\circ = 14.1 \text{ m s}^{-1}$ Time taken to travel $35 \text{ m} = 35/19.4 = 1.80 \text{ s}$ $d = (14.1 \times 1.80) - (1/2 \times 9.8 \times 1.80^2)$ d = 9.5  m The ball will go over Ernie's head.	<ul> <li><sup>1</sup> Calculates horizontal and vertical components. OR Calculates horizontal component of velocity and time to travel 35 m.</li> </ul>	<ul> <li><sup>2</sup> Calculates time taken to travel 35 m. AND Calculates initial vertical velocity correctly.</li> </ul>	<ul> <li><sup>2</sup> Calculates height of ball at 35 m range. AND</li> <li>States the ball goes over Ernie's head.</li> </ul>
(d)	The area under the graph is a measure of the work done or energy stored. This is a triangle and so, the formula is $\frac{1}{2} Fd$ . (Or, could calculate $k = F/x$ and substitute into $F = \frac{1}{2} kx^2$ .) The formula $W = Fd$ can be used only if the force is constant or if <i>F</i> is the average force. In the case of a spring / web as the extension increases, force increases and is therefore not constant.	<sup>1</sup> Recognition that the area under graph is energy stored or work done. OR States use $E_p = \frac{1}{2} kx^2$	<sup>1</sup> The idea that force is not constant but is proportional to extension. OR States bullet point 2.	<sup>1</sup> Correct answer covering bullet points 2 and 3.
(e)	$k = \frac{F}{x} = \frac{0.003 \times 9.8}{0.065} = 0.45 \text{ N m}^{-1}$ $E_{p} = \frac{1}{2}kx^{2} = \frac{1}{2} \times 0.45 \times 0.065^{2}$ $E_{p} = 9.5 \times 10^{-4} \text{ J}$	<sup>2</sup> Correct answer for <i>k</i> .	<sup>2</sup> Correct answer for elastic potential energy.	

## Judgement Statement

Achievement	Achievement with Merit	Achievement with Excellence
3 <b>A1</b> + 3 <b>A2</b> + 2 <b>A</b>	2 M1 + 2 M2 + 4 M + 4 A	1 E1 + 1 E2 + 2 E + 4 M + 4 A

Note: where the criterion is not specified, the required grade(s) can be from either.