Assessment Schedule – 2006

Physics: Demonstrate understanding of mechanics (90255)

Evidence Statement

Note: Minor computational errors will not be penalised. A wrong answer will be accepted as correct provided there is sufficient evidence that the mistake is not due to a lack of understanding. Such evidence includes:

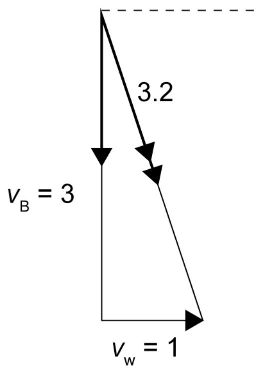
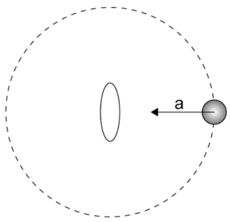
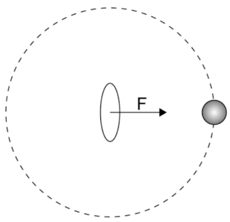
- the last written step before the answer is given has no unexpanded brackets or terms and does not require rearranging
- the power of any number that is multiplied by a power of 10 is correct.

Correct units and significant figures are required only in the questions that specifically ask for them.

Working must be shown for Excellence and Merit

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
1(a)	$a = \frac{\Delta v}{\Delta t}$ $a = 0.90\ \text{m s}^{-2}$	[2] Correct answer.		
	2 sf (regardless of answer to 1a)	[1] Correct significant figures.		
1(b)	$d = \frac{(v_i + v_f)t}{2}$ $d = \frac{(4.5 + 0) \times 5.00}{2}$ $d = 11.25\ \text{m}$ **OR** $v_f^2 = v_i^2 + 2ad$ $d = \frac{v_f^2 - v_i^2}{2a}$ $d = \frac{4.5^2 - 0^2}{2 \times 0.9} = 11.25\ \text{m}$ $d = 11.25\ \text{m}$ **OR** $d = \frac{1}{2}at^2$ $d = \frac{1}{2} \times 0.90 \times 5^2$ $d = 11.25\ (11)\ \text{m}$ $d = \frac{v_f + v_i}{2}$ $d = \frac{(4.5 + 0) \times 5.00}{2}$ $d = 11.25\ \text{m}$ **OR** $v_f^2 = v_i^2 + 2ad$	[2] Correct answer.		

1(c)	$P=\frac{W}{t}=\frac{F\times d}{t}=\frac{mad}{t}=\frac{120\times0.9\times11.25}{5}$ $P=\frac{1215}{5}$ $P=243\ \text{W}$ **OR** $P=\frac{W}{t}=\frac{F\times d}{t}=mav_{\text{ave}}$ $v_{\text{ave}}=\frac{4.5}{2}=2.25\ \text{ms}^{-1}$ $P=m\times a\times v_{\text{ave}}=120\times0.9\times2.25$ $P=243\ \text{W}$ **OR** $P=\frac{W}{t}=\frac{E_K}{t}=\frac{\frac{1}{2}mv^2}{t}=\frac{0.5\times120\times4.5^2}{5}$ $P=\frac{1215}{5}$ $P=243\ \text{W}$	2 Calculates the force only. (F = 108 N) **OR** Calculate average velocity only. ($v_{\text{ave}}=2.25\ \text{ms}^{-1}$) **OR** Shows awareness that Power can be calculated by considering the E_K gained. Combines power and E_k formula, but unable to solve.	2 Correctly calculates the work done (W = 1215 J) **OR** Calculates the force AND the average velocity, but is unable to combine to calculate Power. **OR** Correctly calculates the kinetic energy (E_K = 1215J)	2 Correct working and answer.
	W OR watts OR Js^{-1} OR Nms^{-1} (regardless of answer to 1c)	1 Correct unit.		
1(d)	Friction (and drag) opposes the motion. Therefore Steve must do extra work to overcome the work done by friction. Hence as Power is the rate at which work is done the Power that he produces must be greater than calculated in part c. **OR** Friction causes some energy to be wasted as heat. Hence not all the energy Steve puts in is transformed into kinetic energy. Therefore as Power is the rate at which energy is changed the Power he produces will be greater than the Power output calculated in part c.	1 Recognises the effect of fiction on Steve's motion / Friction does work against the boat. **OR** Some energy wasted as heat (and sound).	1 **Achieved plus** Links applied forces to work done by Steve. **OR** **Achieved plus** Links $E_{IN}=E_K+E_{HEAT}$	1 **Merit plus …** Links the rate of work done to power. **OR** **Merit plus …** Links the rate of change of energy to power.
1(e)	Net force = zero	1 Correct answer.		

1(f)	$\tau_1 = 450 \times 0.50$ $\tau_1 = 225$ Nm $\tau_2 = 225$ Nm $F_2 \times 3.5 = 225$ $F_2 = 64$ N *OR* $F_1 d_1 = F_2 d_2$ $450 \times 0.50 = F \times 3.5$ $F = 64$ N	[2] Calculates torque due to Steve ($\tau = 225$ Nm).	[2] Correct working and answer.	
1(g)	$\tan\theta = \frac{3}{1}$ $\boldsymbol{\theta = 72°}$ $v = \sqrt{3.0^2 + 1.0^2}$ $\boldsymbol{v = 3.2\ \mathrm{m\,s^{-1}}}$  *Both can be found by calculation or scale drawing.*	[2] Correct diagram must have arrows and labels. **OR** Speed correctly determined. **OR** Angle correctly determined	[2] Correct diagram must have arrows and labels. **AND** Speed **AND** Angle.	
2(a)		[1] Correct direction and label.		
2(b)		[1] Correct direction and label.		
2(c)	The ball has a constant speed but is changing direction and so its velocity is changing. This means it is accelerating. This acceleration requires a centripetal force. As the force is at 90˚ to the direction of motion the ball will travel at a constant speed.	[1] A force is needed to change the direction of the ball. OR Without a force the ball would travel in a straight line (tangent to the circle).	[1] **Achieved plus** Reference to centripetal force /centre acting force /force perpendicular to direction of motion.	[1] **Merit plus** The direction of the force is perpendicular to the direction of motion resulting in constant speed**.**

2(d)	$C = 2\pi r = 2 \times \pi \times 2.0 = 12.57$ m $v = \frac{d}{t} = \frac{12.57}{1.5} = 8.38\ \text{ms}^{-1}$ $F = \frac{mv^2}{r} = \frac{10 \times 8.38^2}{2.0} = \mathbf{350.9\ N}$ **OR** $F = \frac{mv^2}{r}$ $v = \frac{2\pi r}{T}$ $F = \frac{4\pi^2 mr}{T^2} = \frac{4\pi^2 \times 10 \times 2}{1.5 \times 1.5} = 350\ \text{N}$	2 Correct calculation of circumference.	2 Correct calculation of velocity. **OR** Correct use of centripetal force equation but calculates velocity using radius instead of circumference.	**2** Correct working and answer.
2(e)	Shorter period means greater speed. Therefore greater centripetal force acting on iron ball**.** Therefore the reaction force acting on Jan will be greater (Newton's 3rd law).	1 **Greater force**.	1 **Achieved plus** Links greater speed to greater force on ball**.**	1 **Merit plus** Clear understanding of reaction force.
3(a)	$V_H =$ **6.4 cos 20**	2 Correct working.		
3(b)	$V_V =$ **6.4 sin 20**	2 Correct working.		
3(c)	$v_f = v_i + at$ $0 = 2.2 - 9.8 \times t$ $t = 0.22$ s total time = 0.44 s $d_h = v_h \times t = 6.0 \times 0.44$ $\mathbf{d_h = 2.69\ m}$ Accept calculation using g =10ms^{-2} so $d_h = 2.64$ m	2 Calculates time to highest point.	2 Calculates total time OR Correctly uses $d = vt$ but with time to max height.	**2** Correct working and answer.
3(d)	**9.8 ms^{-2}, downwards** (accept 10 down). Do not accept – 9.8 down.	1 Correct answer.		
3(e)	As friction is negligible there are no other forces acting horizontally. A zero net force means Marama will not experience any acceleration.	**1** Horizontal net force is zero. **OR** The only force acting on Marama is in the vertical plane **OR** Just quotes Newton's 1st or 2nd law but doesn't apply.	1 Clearly applies Newton's 1st or 2nd law to the idea of a zero net force horizontally on Marama.	
4(a)	Momentum	1 Correct answer.		

4(b)	$\Delta v = v_f - v_i = 2 - 8 = -6$ $\Delta p = m \times \Delta v$ $= 950 \times (-6)$ **= - 5700 kg m s⁻¹** $\mathbf{= -5700\ kg\ m\ s^{-1}}$ (or 5700 kg m s^{-1} to the left/backwards/west) **OR** $P_{before} = m_c v_{ci} = 950 \times 8 = 7600\ \text{kg m s}^{-1}$ $P_{after} = m_c v_{cf} = 950 \times 2 = 1900\ \text{kg m s}^{-1}$ $\Delta p = p_{cf} - p_{ci} = 1900 - 7600$ $\mathbf{\Delta p = -5700\ kg\ m\ s^{-1}}$ (or 5700 kg m s^{-1} to the left/backwards/west)	2 Calculates the momentum of the car before **OR** after the collision.	2 **Correct size** of the change is calculated only. **OR** Correct size is calculated BUT the direction is incorrect. (consistent with the sign)	2 Correct working (using change = final – initial) and final answer is a valid physics statement with respect to sign and direction.
4(c)	$\Delta p = m \times \Delta v = 5700 = 1700 \times v$ $\mathbf{v = 3.4\ m\ s^{-1}}$ **OR** $950 \times 8 + 0 = 950 \times 2 + 1700 \times v$ $\mathbf{v = 3.4\ m\ s^{-1}}$	2 Recognition that the SIZE of the change in momentum $\Delta p_{\text{van}} = \Delta p_{\text{car}}$ **OR** Total p_i = Total p_f	2 Correct working and answer.	
4(d)	$\Delta p = F.\ \Delta t$ $\Delta t = \frac{\Delta p}{F}$ $\Delta t = \frac{5700}{3800}$ $\Delta t =$ **1.5 s** **OR** $a = F/m = 3800/950 = 4\ \text{ms}^{-2}$ $v_f = v_i + at$ $2 = 8 - 4t$ $t = -6/-4 = \mathbf{1.5s}$	2 **Correct working** and answer.		
4(e)	By Newton's 1st Law a net force is required to cause a change in velocity and as the bag is not attached to the car it will not experience a decelerating force. Hence the bag will continue to move at a constant speed in a straight line, assuming that the friction between the bag and the front seat is negligible, until it experiences a force from the front of the car to change its motion.	1 The bag continues to move at a constant speed / bags momentum remains the same. **OR** No forces act on the bag to slow it down.	1 **Achieved plus** Links constant speed / constant momentum with absence of a force.	1 **Merit plus** States assumption that the force due to friction is negligible. **OR** Until a force is applied by collision with the dashboard to change its velocity /momentum.

4(f)	Crumple zones cause the collision time to increase. Change in momentum remains the same. So a longer collision time for the same momentum means a smaller force on the occupants as $F = \Delta p/t$. **OR** Crumple zone increases stopping distance, therefore the **time of the collision increases**. For the **same Δv**, if Δt increases then Δa decreases. As F=ma then **F must also decrease** resulting in less force on the occupants.	1 Increases stopping time. **OR** Reduces the force.	1 **Achieved plus** Links increasing the time with reducing the force.	1 **Merit PLUS** Recognises that Δp remains the same (if using momentum considerations to solve). **OR** Merit plus Recognises that Δv remains the same (if using Newton's 2nd law to solve).

Judgement Statement

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The grade awarded is the highest one that has been demonstrated in all achievement criteria up to and including that grade.

The following is a guide to the standard required for each grade in the two criteria.

	Achievement	Achievement with Merit	Achievement with Excellence
Criterion One	SIX opportunities at A1 or higher	SEVEN opportunities $4 \times$ A1 + $3 \times$ M1	EIGHT opportunities $4 \times$ A1 + $2 \times$ M1 + $2 \times$ E1
Criterion Two	SIX opportunities at A2 or higher	EIGHT opportunities $4 \times$ A2 + $4 \times$ M2	TEN opportunities $4 \times$ A2 + $4 \times$ M2 + $2 \times$ E2