Assessment Schedule – 2013

Science: Demonstrate understanding of aspects of mechanics (90940)

Evidence Statement

Question	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE (a)	**Section A:** Accelerating at a constant rate of 1.25 m s^{-2}, from 0 m s^{-1} to 10 m s^{-1} in 8 seconds. **Section B:** Constant speed of 10 m s^{-1} for 7 seconds. **Section C:** Decelerating from 10 m s^{-1} to 0 m s^{-1} at a constant rate of 2 m s^{-2} (–2 m s^{-2} if discussing acceleration) for 5 seconds. **Section D:** Stationary (constant speed of 0 m s^{-1}) for 5 seconds.	• Correctly uses the terms acceleration / deceleration, constant speed for TWO **of sections A, B, and C**. • Correctly states the time period for THREE **of the four sections**.	• States **constant acceleration** for section A OR **constant** deceleration for section C. • States **acceleration** in section A as 1.25 m s^{-2}. OR **Deceleration** in section C as 2 m s^{-2}. • States constant speed of 10 m s^{-1} for section B OR **stationary** (constant speed of 0 m s^{-1}) for section D.	• Gives constant acceleration in section A as 1.25 m s^{-2} OR **Constant** deceleration in section C as 2 m s^{-2}.
(b)	**Section A:** Drawn and labelled F_{thrust} and $F_{friction}$ with thrust being larger than friction. **Section B:** Drawn and labelled F_{thrust} and $F_{friction}$ as equal and cancelling each other. **Section C:** Drawn and labelled F_{thrust} and $F_{friction}$ Both to the right while size of the arrows are irrelevant. OR $F_{friction}$ only to the right. OR small F_{thrust} to the left and large $F_{friction}$ to the right.	• Correctly points the forces in the right directions for **TWO of the three sections (sections A, B, and C)**. • Correctly labels F_{thrust} and $F_{friction}$ as being equal in section B.	• Correctly labels F_{thrust} as larger than $F_{friction}$ in section A. • Correctly labels F_{thrust} AND $F_{friction}$ in section C.	

(c)	A net force is the resultant force when multiple forces interact. If the forces are pointing in the same direction, the forces add, giving a larger net force. If the forces are in opposite direction, the forces subtract, giving a smaller net force (including a zero net force). Net forces determine whether the runner is accelerating, decelerating or maintaining constant speed. If the net force is pointing in the same direction as the direction of motion, the object accelerates. If the net force is pointing in the opposite direction to the direction of motion, the object decelerates. If there is no net force, the object maintains constant speed or is stationary. **Section A:** The runner is accelerating. This is because there is a net force pointing forwards. This occurs when the thrust force is greater than friction. **Section B:** The runner has constant speed. This is because there is no overall net force. This occurs when the thrust force is equal to friction. **Section C:** The runner is decelerating. This is because there is a net force pointing in the opposite direction to the motion.	• Correctly compares the size of the forces for TWO of the sections, **but** does not relate this to net forces. • States that net forces cause acceleration, **but** does not relate to the sections or force diagrams. • Makes a statement that shows what net forces are **but** does not relate to the sections or force diagrams.	• Gives correct explanation for sections **A** and **B**. Explanation demonstrates an understanding of net forces and relates this to the acceleration / constant speed.	• Gives correct explanation for section **C**. Explanation demonstrates an understanding of **net forces** and relates this to the fact that the net force and motion are in **opposite directions** so the runner **decelerates**.	
(d)	Distance travelled is found by calculating the area under the curve. **Section A:** Area = ½ $b \times h$ = ½ × 8 × 10 = 40 m **Section B:** Area = $b \times h$ = 7 × 10 = 70 m **Section C:** Area = ½ $b \times h$ = ½ × 5 × 10 = 25 m **Section D:** Area = 0 **Total Area:** Area A + Area B + Area C + Area D = 135 m	• Calculates the area / distance of section B as 70 m. • Identifies the area / distance of section D is 0 m. • Identifies that sections A and / or C are triangles and attempts to find the area using ½ $b \times h$ but makes an error in the calculation.	• Correctly calculates the area / distance of section A as 40 m OR Correctly calculates the area / distance of section C as 25 m. OR Finds the total area / distance by adding each section but either makes a mistake with the addition OR has made a mistake when calculating ONE section only.	• Correctly finds the total area / distance as 135 m.	

	Not achieved			Achievement		Achievement with Merit		Achievement with Excellence	
Q1	**NØ** = no response or no relevant evidence	**N1** = 1 point	**N2** = 2 points from Achievement	**A3** = 3 points	**A4** = 4 points	**M5** = 3 points	**M6** = 4 points	**E7** = 1 point	**E8** = 2 points

Question	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
TWO (a)	Halfway: $E_p = 0.1$ J $E_k = 0.1$ J At the bottom: $E_p = 0$ J $E_k = 0.2$ J	• Correct answer(s) for at the bottom. • $2 E_p$ OR $2 E_k$	• Correct answer(s) for halfway.	
(b)	Option 3. At halfway $E_k = 0.1$ J $= \frac{1}{2}mv^2 = \frac{1}{2} \times 0.1 \times v^2$ $v^2 = 2$ $v = 1.41$ m s^{-1} OR if $v = 1$ m s^{-1} $E_k = \frac{1}{2}mv^2 = 0.05$J while halfway $E_k = 0.1$ J > 0.05J so $v > 1$ m s^{-1}	• Attempts to find the speed by using the **halfway** E_k (E_k does not need to be correct). $E_k = \frac{1}{2}mv^2$ does not need to be used correctly but **must** appear in answer. • Correctly gives 100 g = 0.1 kg	• Stated incorrect option consistently with wrong v calculated. Eg: Solves the equation using the correct method, **but** does not convert mass to kilograms. OR States Option 3. AND Solves the equation using the correct method but mathematical error in calculation.	• States Option 3 AND Solves the equation correctly. OR Calculates E_k with speed of 1 m s^{-1} then compare with half way E_k
	In reality there are losses for energy due to friction / air resistance. This means that some of the initial gravitational potential energy is converted into heat and sound as well as kinetic energy. As a consequence the kinetic energy is less than for an ideal case, and the ball falls slower. Air resistance / friction occurs as the ball falls, because the ball is pushing past air particles. As the air particles rub against the ball heat and sound are generated.	• Identifies that air resistance / friction. • Identifies that energy is lost in the form of heat OR sound. • States energy cannot be created or destroyed; they can only convert to different forms. Do not have to relate to this case.	• States that **air resistance / friction** causes losses and the energy is converted into heat / sound. OR States that **air resistance / friction** causes losses and this is caused by rubbing between the ball and air particles.	• **Explains** that air resistance / friction cause losses of energy and the energy is converted into heat and / or sound. This heat and sound are caused by friction between the ball and air.

	Not achieved			Achievement		Achievement with Merit		Achievement with Excellence	
Q2	N∅ = no response or no relevant evidence	N1 = 1 point from Achievement	N2 = 2 points from Achievement	A3 = 3 points	A4 = 4 points	M5 = 2 points	M6 = 3 points	E7 = 2 points but missing friction / heat explanation in (c) or minor error in (b)	E8 = 2 points

Question	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
THREE (a)	Weight is the downward force due to gravity that an object experiences, while mass is a measure of the amount of matter that an object has.	• Defines mass or weight.	• Explains the difference between mass and weight.	
(b)	$F_{weight/gravity} = mg = 2\,500 \times 10 = 25\,000$ N	• Correctly calculates weight force as 25 000N.		
(c)	$F = 25\,000$ N $W = Fd = 25\,000 \times 4 = 100\,000$ J $P = W / t = 100\,000 / 5 = 20\,000$ W	• Calculates the work but uses mass (2 500 kg) instead of weight.	• Correctly calculates the work as 100 000 J OR 100 kJ. OR Calculates the power using the incorrect work value.	• Correctly calculates the power as 20 000 W OR 20 kW.
(d)	$v = d / t = 4 / 5 = 0.8$ m s^{-1}	• Correctly calculates the speed at 0.8 (m s^{-1})		
(e)	The power needed will increase. This is because if the speed is doubled, the time to lift the load is halved. Since the work done does not change and power is a measure of the amount of work done per second, if the time is halved the power is doubled.	• States power increases. • Mentions more speed means less time to lift box, **but does not** relate to power.	• **Explains** relationship between time and power. • **Explains** relationship between speed and time.	• Links increased speed to decreased time to lift the box. Then clearly shows the link between time and power when explaining why power has increased. (This could be done either stating the equation $P = W / t$ or describing that relationship through words).

	Not Achieved			**Achievement**		**Achievement with Merit**		**Achievement with Excellence**	
Q3	**NØ** = no response or no relevant evidence	**N1** = 1 point	**N2** = 2 correct points from Achievement	**A3** = 3 points	**A4** = 4 points	**M5** = 2 points	**M6** = 3 points	**E7** = 2 points with minor error, eg does not explain speed doubled and therefore time halved (ie just says speed increased, so time decreased) OR makes mathematical error in (c).	**E8** = 2 points

Question	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
FOUR (a)	$F_{weight/gravity} = mg = 80 \times 10 = 800$ N Area $= b \times h = 0.25 \times 1.6 = 0.4$ m^2 $P = F / A = 800 / 0.4 = 2\ 000$ Pa	• Calculates the weight force correctly as 800 N. • Calculates the area correctly as 0.4 m^2. • Gives the correct unit for pressure (Pa OR N m^{-2}). • Calculates pressure but does not use the correct values for force / area.	• Calculates the pressure correctly as 2 000 Pa.	
(b)	Sinking depends on pressure – the greater the pressure, the further the person sinks. $P = F/A$ A 'lighter' person will have less weight force than a 'heavier' person. However, if the 'lighter' person's force is spread over a smaller area, it can produce a higher pressure than the 'heavier' person. In this example, the skis have much less area than the skateboard, so the daughter sinks further than her father, even though she is 'lighter'. $P_{dad} = 800/0.4 = 2\ 000$ Pa $F_{daughter} = 58 \times 10 = 580$ N $A_{daughter} = 2 \times 0.08 \times 1.75 = 0.28$ m^2 $P_{daughter} = F / A = 580 / 0.28 = 2071$ Pa $P_{daughter} > P_{dad}$ so daughter sinks further into the snow.	• States that sinking depth depends on pressure. • States that the lighter person / daughter has less weight force **but** does not link to pressure (or vice versa for heavier person / father). • States that the light person / daughter is on a smaller area, **but** does not link directly to pressure (or vice versa for heavier person).	• Explains how a 'lighter' person / daughter (less force), **can** produce a larger pressure (or vice versa for heavier person / father) **but** does not compare the areas for dad and daughter. OR Explains pressure difference with comparison of the areas between the ski and skateboard. • Calculates the pressure for the daughter, **but** does not factor in both skis. OR Calculates the pressure for the daughter and correctly uses both skis **but** uses mass instead of weight force.	• Compares the areas of the dad's snowboard and the daughter's skis to explain how the daughter who has less weight force can in fact have a greater pressure and therefore sink further in the snow. • Correctly calculates the daughter's pressure and makes a comparison in the answer.

	Not achieved			Achievement		Achievement with Merit		Achievement with Excellence	
Q4	**NØ** = no response or no relevant evidence	**N1** = 1 point	**N2** = 2 points from Achievement	**A3** = 3 points	**A4** = 4 points	**M5** = 2 points	**M6** = 3 points	**E7** = 2 points but calculation has minor error	**E8** = 2 points

Judgement Statement

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 9	10 – 18	19 – 25	26 – 32