Assessment Schedule – 2018

Science: Demonstrate understanding of aspects of mechanics (90940)

Evidence Statement

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	Runner A has the greater acceleration during the first 3 seconds. The gradient / slope of a speed-time graph equals the acceleration of the object. The steeper the slope, the greater the acceleration. Runner A has a steeper slope than Runner B in the first 3 seconds.	• Correct statement. E.g. Runner A has greater acceleration. OR Slope of speed-time graph = acceleration.	• Explains why Runner A has greater acceleration in terms of slope (gradient, angle of the path on the graph, or change in speed). E.g. Runner A has greater acceleration as the graph has a steeper slope. OR E.g. Runner A's speed changed from 0 to 9 m s^{-1} while Runner B's went from 0 to 7.7 m s^{-1} (in 3 s). *(NOT distance.)*	
(b)	$a = \frac{\Delta v}{\Delta t} = \frac{9.0 - 0.0}{3.0 - 0.0} = 3.0 \text{ m s}^{-2}$	• Calculates acceleration.		

<table>
<tr>
<td>(c)(i)</td>
<td>Runner A accelerates at 3 m s^{-2} for 3 seconds, reaching a speed of 9 m s^{-1}. Stays at constant speed of 9 m s^{-1} for next 7 seconds.

Runner B accelerates at 2.5 m s^{-2} for 4 seconds, reaching a constant speed of 10 m s^{-1}. Stays at constant speed of 10 m s^{-1} for next 6 seconds.

Comparison: Runner A has a greater acceleration during first 3 seconds, but does not accelerate for as long as Runner B. Between 4 and 10 seconds, neither accelerated, they both had a constant speed. Runner B had a higher constant speed during this time.</td>
<td>• Correct statement / calculation for both runners

i.e.

Correct statement about speed.

OR

Correct working and answer for average speed.

OR

Correct statement about acceleration.

OR

Correct working and answer for average acceleration.</td>
<td>• Correct comparison about speed with justification from graph.

AND

Correct comparison about acceleration with justification from graph.

OR

Two cells either horizontally or vertically. (is this needed)
<table>
<tr><td></td><td>Speed</td><td>Acceleration</td></tr>
<tr><td>A</td><td>First 3 s:
v= 4.5 m s^{-1}

The rest:
v = 9 m s^{-1}</td><td>First 3 s:
a = 3.0 m s^{-2}

The rest:
a = 0 m s^{-2}</td></tr>
<tr><td>B</td><td>First 4 s:
v = 5 m s^{-1}

The rest:
v = 10 m s^{-1}</td><td>First 4 s:
a = 2.5 m s^{-2}

The rest:
a = 0 m s^{-2}</td></tr>
</table>
OR the bold 4 for merit.</td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>Distance = area under graph.

$d\text{ (Runner A)} = \left(\frac{1}{2}\times 9\times 3\right) + (9\times 9) + \left(\frac{1}{2}\times 2\times 2\right)$
$= 13.5 + 63 + 18 + 2$
$= 96.5\text{ m}$

$d\text{ (Runner B)} = \left(\frac{1}{2}\times 10\times 4\right) + (8\times 10) + \left(\frac{1}{2}\times 2\times 2\right)$
$= 20 + 80 + 2$
$= 102\text{ m}$

Therefore, only Runner B has finished the race.</td>
<td>• Calculates a correct distance under the graph for any part of either Runner A or Runner B’s journey.</td>
<td>• Correct calculation of distance for one of the two runners for 12 s.</td>
<td>Area for runner A correct

AND

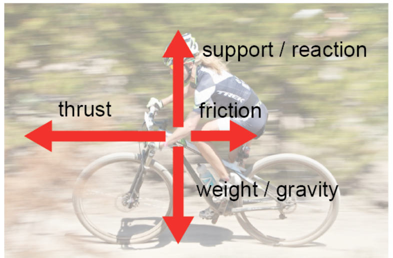
Area for runner B correct

AND

States runner B finished first</td>
</tr>
</table>

(d)	Surface area of both feet = $2 \times 0.0200 = 0.0400\ m^2$ $F = P \times A = 13000 \times 0.0400 = 520$ N (2 sf) (Correct significant figures not required.)	• Attempts to calculate weight force of Runner A using correct concepts / formula, but with mathematical error(s).	• Calculates weight force of Runner A using one foot, ie: $F = P \times A = 13000 \times 0.0200$ = 260 N (2 sf) OR using area in cm^2. (5200000 N) (Sig. figs and unit not required.)	Calculates weight of the Runner A (2 feet) with the correct unit. (Wrong unit for OMI.)

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; or no relevant evidence.	ONE Achievement point.	TWO Achievement points.	THREE Achievement points.	FOUR Achievement points.	THREE Merit points.	FOUR Merit points.	TWO Excellence points; minor omission.	TWO Excellence points.

Q	Evidence	Achievement	Merit	Excellence
TWO (a)	$F_{net} = ma = 82 \times 0.80 = 65.6$ N (66 N)	Calculates accelerating force.		
(b)(i)		• States / draws 4 forces with correct labels • A correct force pair of relevant size. • Horizontal forces are unbalanced / net force $\neq 0$ when accelerating.	• **Vertical** forces are balanced as, they are **equal** and opposite / or shown in the diagram AND **horizontal** forces are **unbalanced**, as thrust is greater than friction (or from diagram). • Explains that unbalanced forces with reference to cyclist lead to a change in speed.	• All labelled forces drawn correctly with relevant sizes AND Explains that unbalanced forces lead to a change of speed AND This change of motion is in the direction of the unbalanced force
(ii)	Weight and support are equal and opposite. Thrust and friction are not equal and opposite. The bike is accelerating, meaning that the horizontal net force is not zero, as thrust is greater than friction. The bike will accelerate (to the left / speed up).			
(c)(i)	As the height above the ground is the same for both ramps, **the same amount of work / energy** is done.	• Same amount of work done (energy gained), regardless of length. OR Less force is needed to ride up Ramp A OR more force to ride up Ramp B. OR Less power is needed to ride up Ramp A (**not** less energy).	• Work done is the same as the height / vertical distance is the same. • Less power needed to ride up Ramp A, as it takes longer. OR Ramp A is easier, as the **work** is spread over a longer **distance.** OR More **power** needed to ride to top, as energy is used up faster. (**links to time)**	• Ramp A requires less **force**, as the work done is the same and is linked to greater **distance** (or converse for Ramp B). • Ramp A requires less **power**, as the work is the same and is linked to greater **time** (or converse for Ramp B).
(ii)	As the work done is the same and $P = \frac{W}{t}$, the **time** taken to go up Ramp A is greater and so **the power used is less** going up Ramp A. As the work is the same, but the **distance** is greater for Ramp A, and $W = F \times d$, **the force needed is less** on Ramp A.			

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; or no relevant evidence.	ONE Achievement point.	TWO Achievement points.	THREE Achievement points.	FOUR Achievement points.	TWO Merit points.	THREE Merit points.	TWO Excellence points	THREE Excellence points.

Q	Evidence	Achievement	Merit	Excellence
THREE (a)	$F_w = m \times g$ $= 62 \times 10$ $= 620$ N $W = F \times d$ $= 620 \times 46.2$ $= 28\,644$ J	• Correct calculation of weight force OR correct calculation of work from incorrect weight value	• Correct calculation of work. (Unit not required.) OR calculate power using wrong work value.	• Correct calculation of power, including unit.
(b)	$P = \frac{W}{t} = \frac{28\,644}{525} = 54.6$ W (Sig. figs not required.)			
(c)(i) (ii)	Jake had gravitational potential energy at the top of the jump, and this was converted into kinetic energy. If energy is conserved, we assume that all gravitational potential energy will equal the kinetic energy. $E_P = E_K$ $3200 = \frac{1}{2} \times 75 \times v^2$ $v = \sqrt{\frac{3200}{0.5 \times 75}}$ $= 9.24$ m s^{-1} There are some losses of 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 that calculated (theoretical value), and Jake hits the snow at a slower speed. Air resistance / friction occurs as Jake falls, because he is pushing past air particles. As the air particles rub against Jake, heat and sound are generated.	• Uses the correct formula to calculate kinetic energy. • Correctly names the two energies for given locations. • Identifies that air resistance / drag / friction is the reason for the slower speed.	• Writes relationship between E_P and E_K, and a substitution using numbers or symbols eg $E_p = E_k$ then $3200 = ½ \times 75 \times v^2$ OR $mgh = ½mv^2$ (or $v = \sqrt{\frac{2E_k}{m}}$) OR 9.24 m s^{-1} without working. • Explains that air resistance / friction causes energy losses / transfers to heat / sound.	• Calculates the speed correctly, with unit AND An explanation of energy loss due to **friction/ air resistance** causing **heat / sound** and then links to a **loss in speed**.

(d)	Sinking into the snow depends on pressure – the greater the pressure, the further the skis sink in to the snow. $P = \frac{F}{A}$ The weight force does not change, but the surface area does. If the surface area is increased, then the pressure exerted on the snow is decreased. A larger surface area with the same weight will have less pressure than a smaller surface area with the same weight.	• States that sinking depth depends on pressure. • States that wide skis have a larger surface area.	• Explains that the wide skis have more **surface area**, therefore **less pressure**. OR Any Two Excellence points	• Explains that the wide **skis have more surface area**, therefore **less pressure** and since the **weight/force does not change**, the skis will not sink as far into the snow.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; or no relevant evidence.	ONE Achievement point.	TWO Achievement points.	THREE Achievement points.	FOUR Achievement points.	TWO Merit points.	THREE Merit points.	THREE Excellence points (OMI)	THREE Excellence points

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8 – 13	14 – 18	19 – 24