

M1. (a) increases 1

increases 1

(b) 23 (m) 2  
*accept 43 circled for 1 mark*  
*accept 9 + 14 for 1 mark*

(c) (i) all points correctly plotted 2  
*all to  $\pm \frac{1}{2}$  small square*  
*one error = 1 mark*  
*two or more errors = 0 marks*

line of best fit 1

(ii) correct value from their graph ( $\pm \frac{1}{2}$  small square) 1

(d) (i) 70 3  
 *$\frac{1}{2} \times 35 \times 4$  gains 2 marks*  
*attempt to estimate area under the graph for 1 mark*

(ii) line from (0.6,35) 1

sloping downwards with a less steep line than the first line

1

cutting time axis at time  $> 4.6$  s  
*accept cutting x-axis at 6*

1

(e) (i) 42 000  
*1200  $\times$  35 gains 1 mark*

2

kgm / s  
Ns

1

(ii) 10 500 (N)  
*42 000 / 4 gains 1 mark*  
*alternatively:*  
 *$a = 35 / 4 = 8.75 \text{ m / s}^2$*   
 *$F = 1200 \times 8.75$*

2

[19]

- M2. (a) (i)** zero  
*accept nothing* 1
- speed is zero  
*accept not moving* 1
- (ii)** A 1
- largest mass **or** weight  
*accept heaviest luggage*  
*do **not** accept largest luggage* 1
- (iii)** momentum does change  
*accept yes* 1
- direction is changing  
*accept velocity is changing*  
*do **not** accept answers in terms of speed changing* 1
- (iv)** kg m/s 1

[7]

- M3. (a) (i) 4.5**  
*allow 1 mark for correct substitution i.e.  $9 \div 2$*   
 2
- (ii)  $\text{m/s}^2$   
*accept answer given in (a)(i) if not contradicted here*  
 1
- (iii) speed  
 1
- (iv) straight line from the origin passing through (2s, 9m/s)  
*allow 1 mark for straight line from the origin passing through to  $t = 2$  seconds*  
*allow 1 mark for an attempt to draw a straight line from the origin passing through (2,9)*  
*allow 1 mark for a minimum of 3 points plotted with no line provided if joined up would give correct answer. Points must include (0,0) and (2,9)*  
 2
- (b) (i) **B**  
*if A or C given scores 0 marks in total*  
 1
- smallest (impact) force  
 1
- on all/ every/ any surfaces  
*these marks are awarded for comparative answers*  
 1
- (ii) (conditions) can be repeated  
**or**  
 difficult to measure forces with human athletes  
*accept answers in terms of variations in human athletes e.g. athletes may have different weights area / size of feet may be different difficult to measure forces athletes run at different speeds*  
*accept any answer that states or implies that with humans the conditions needed to repeat tests may not be constant*

e.g.  
*athletes unable to maintain constant speed during tests (or  
during repeat tests)*  
do **not** accept the robots are more accurate  
*removes human error is insufficient*  
*fair test is insufficient*

1

[10]

- M4.** (a) (i) 10800  
*allow 1 mark for correct substitution i.e.  $900 \times 12$*  2
- (ii) arrow pointing towards the left  
*allow anywhere on the diagram or at bottom of the page* 1
- (b) zero  
*accept 0 / none / nothing* 1
- velocity is zero  
*accept speed for velocity*  
*accept stopped / not moving*  
*accept a calculation i.e.  $900 \times 0 = 0$*  1

**[5]**

- M5. (a)** (i) 16 000  
*allow 1 mark for correct substitution ie  $3200 \times 5$*  2
- (ii) 16 000 or their (a)(i) 1
- (iii) less than 1
- (b) increases 1
- decreases  
*correct order only* 1

**[6]**

M6. (a) (i) lorry  
*reason only scores if lorry chosen* 1

greatest mass  
*accept weight for mass*  
*accept heaviest*  
*accept correct calculations for all 3 vehicles*  
*the biggest is insufficient* 1

(ii) 2450  
*allow 1 mark for correct substitution*  
*ie  $175 \times 14$*  2

(b) (i) increases  
*accept any clear indication of the correct answer* 1

(ii) speed increases  
*accept velocity for speed*  
*accept gets faster*  
*do **not** accept it accelerates on its own*  
*moves more is insufficient* 1

(iii) straight line going to 6, 20  
*allow 1 mark for a curve going to 6,20*  
*or a straight line diagonally upwards but missing 6,20* 2

horizontal line from 6,20 to 8,20  
*allow a horizontal line from where their **diagonal** meets*  
*20m/s to 8,20* 1

[9]