

- M1.** (a) distance is a scalar and displacement is a vector  
**or**  
distance has magnitude only, displacement has magnitude and direction 1
- (b) 37.5 km  
*accept any value between 37.0 and 38.0 inclusive* 1
- 062° or N62°E  
*accept 62° to the right of the vertical* 1
- accept an angle in the range 60° – 64°*  
*accept the angle correctly measured and marked on the diagram*
- (c) train changes direction so velocity changes 1
- acceleration is the rate of change of velocity 1
- (d) number of squares below line = 17  
*accept any number between 16 and 18 inclusive* 1
- each square represents 500 m 1
- distance = number of squares × value of each square correctly calculated – 8500 m 1

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**M2.** (a) 4

*allow 1 mark for extracting correct information 12*

2

m/s<sup>2</sup>

*ignore negative sign*

1

(b) 9 (s)

1

**[4]**

- M3.** (a) (i) velocity includes direction  
*accept velocity is a vector* 1
- (ii) 64  
*allow 1 mark for obtaining values of 16 and 4 from the graph  
or marking correct area or correct attempt to calculate an area* 2
- (iii) any **two** from:  
  - velocity zero from 0 to 4 seconds
  - increasing in 0.2 s (or very rapidly) to 8 m/s
  - decreasing to zero over the next 8 seconds 2
- (iv) momentum before does not equal momentum after  
*ignore reference to energy*  
**or** total momentum changes  
**or** an external force was applied 1
- (b) to reduce the momentum of the driver 1
- a smaller (constant) force would be needed  
*do not accept reduces the impact / impulse on the driver* 1

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- M4.** (a) (i) a single force that has the same effect as all the forces combined  
*accept all the forces added / the sum of the forces / overall force* 1
- (ii) constant speed (in a straight line)  
*do not accept stationary*  
or constant velocity 1
- (b) 3  
*allow 1 mark for correct substitution into transformed equation*  
*accept answer 0.003 gains 1 mark*  
*answer = 0.75 gains 1 mark* 2
- m/s<sup>2</sup> 1
- (c) as speed increases air resistance increases  
*accept drag / friction for air resistance* 1
- reducing the resultant force 1

[7]

**M5. (a)** (i) longer reaction time  
*accept slower reactions*  
*do **not** accept slower reaction time unless qualified*  
**or**  
 greater thinking distance  
*accept greater thinking time*  
**or**  
 greater stopping distance  
*accept greater stopping time*  
*greater braking distance negates answer*

1

(ii) lines / slopes have the same gradient  
*accept slopes are the same*  
**or**  
 velocity decreases to zero in same time / in 2.6 seconds  
*accept any time between 2.3 and 2.8*  
*accept braking distances are the same*

1

(iii) 12  
*accept extracting both reaction times correctly for 1 mark*  
*(0.6 and 1.4 ) **or** time = 0.8(s) for 1 mark*  
*accept  $0.8 \times 15$  for 2 marks*  
*accept calculating the distance*  
*travelled by car **A** as 28.5 m **or** the distance travelled by car*  
***B** as 40.5 m for 2 marks*

3

(b) **Z**

1

different force values give a unique / different resistance  
*only scores if **Z** chosen*  
*do **not** accept force and resistance are (directly) proportional*  
*accept answers in terms of why*  
*either **X** **or** **Y** would not be the best eg*  
***X** – same resistance value is obtained for 2 different force*  
*values*  
***Y** – all force values give the same resistance*

1

[7]

**M6.** (a) 48

*allow for 1 mark correct method shown, ie  $6 \times 8$   
or correct area indicated on the graph*

2

(b) diagonal line from (0,0) to (6,48) / (6, their (a))

*if answer to (a) is greater than 50, scale must be changed to  
gain this mark*

1

horizontal line at 48m between 6 and 10 seconds

*accept horizontal line drawn at their (a) between 6 and 10  
seconds*

1

**[4]**

**M7.** (a) any **two** from:

- (acceleration occurs when) the direction (of each capsule) changes
- velocity has direction
- acceleration is (rate of) change of velocity

2

(b) to(wards) the centre (of the wheel)

1

(c) the greater the radius / diameter / circumference (of the wheel) the smaller the (resultant) force (required)

*accept 'the size' for radius both parts required for the mark*

1

**[4]**

**M8.** (a) more streamlined  
*accept decrease surface area* 1

air resistance is smaller (for same speed)  
*accept drag for air resistance*  
*friction is insufficient* 1

so reaches a higher speed (before resultant force is 0)  
*ignore reference to mass* 1

(b) (i) 1.7  
*allow 1 mark for correct method, ie  $\frac{5}{3}$*   
*or allow 1 mark for an answer with more than 2 sig figs that rounds to 1.7*  
*or allow 1 mark for an answer of 17* 2

(ii) 7.5  
*allow 1 mark for correct use of graph, eg  $\frac{1}{2} \times 5 \times 3$*  2

(iii) air (resistance)  
*accept wind (resistance)*  
*drag is insufficient*  
*friction is insufficient* 1

[8]



**M9.** (a) (i) longer reaction time  
*accept slower reactions*  
*do **not** accept slower reaction time unless qualified*

**or** greater thinking distance  
*accept greater thinking time*

**or** greater stopping distance  
*accept greater stopping time*  
*greater braking distance negates answer*

1

(ii) lines / slopes have the same gradient  
*accept slopes are the same*

**or** velocity decreases to zero in same time / in 2.6 seconds  
*accept any time between 2.4 and 2.8*  
*accept braking distances are the same*

1

(iii) 12  
*accept extracting both reaction times correctly for 1 mark (0.6 and 1.4)*  
**or**  
*time = 0.8 (s) for 1 mark*  
*accept  $0.8 \times 15$  for 2 marks*  
*accept calculating the distance travelled by car **A** as 28.5 m*  
**or**  
*the distance travelled by car **B** as 40.5 m for 2 marks*

3

(b) **Z**

1

different force values give a unique / different resistance  
*only scores if **Z** chosen*  
*do **not** accept force and resistance are (directly) proportional*  
*accept answers in terms of why either **X** or **Y** would not be best eg*  
***X** – same resistance value is obtained for 2 different force values*

**Y** – all force values give the same resistance

1

[7]