

- 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

[8]

M2. (a) 4

allow 1 mark for extracting correct information 12

2

m/s²

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

[8]

- 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/s² 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 0.8×15 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 6×8
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 0.8×15 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]