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) (i) gravity/weight

1

(ii) 2193750000000 or 2.19×10^{12}

not *2.19^{12}*

allow 1 mark for the correct conversion to 7500 (m/s)

allow one mark for answer 2193750(J)

2

transferred to heat

ignore extras of sound and light

accept changed to heat

accept lost due to friction

1

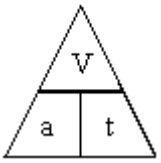
(b) (i) acceleration = $\frac{\text{change in velocity}}{\text{time (taken)}}$

accept word speed instead of velocity

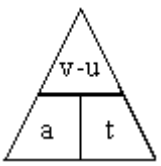
accept $a = \frac{v - u}{t}$

or *correct rearrangement*

do not accept



even if subsequent calculation correct



can gain credit if subsequent calculation correct

1

(ii) 2

ignore + or – signs

m/s^2 1

accept m/s/s or ms^{-2}

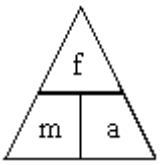
2

(c) (i) force = mass × acceleration

accept correct rearrangement

accept F = m × a

do not accept



unless subsequent calculation correct

1

(ii) 156 000

accept 78 000 × their (b)(ii)(only if (b)(i) correct)

1

[9]

M3. (a) Each scale optimum
Else both half size
Straight line joining 30,0 to 30,0.67 to 0, 5.67
any 5 for 1 mark each

5

(b) 6
Else a = 30/5
gets 2 marks

Else a = v/t
gets 1 mark

3

(c) 9000
Else F = 6 × 1500
gets 2 marks

Else F = ma
gets 1 mark

3

(d) (i) Driver has forward momentum
Which is conserved
Giving drive relative forward speed to car
for one mark each

3

(ii) Car stops in 75m
gets 1 mark

W = F.d or 9000 × 75
gets 1 mark

W = 675 000 J
OR ke = 1/2 mv^2
gets 1 mark

ke = 1/2.1500.302
ke = 675 000 J

3

[17]

M4. (a) (i) longer reaction time

accept slower reactions

*do **not** accept slower reaction time unless qualified*

orgreater thinking distance

accept greater thinking time

orgreater stopping distance

accept greater stopping time

greater braking distance negates answer

1

(ii) lines / slopes have the same gradient

accept slopes are the same

orvelocity 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]

M5. (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 radiusboth parts required for the mark

1

[4]