M1. (a) distance is a scalar and displacement is a vector

or

distance has magnitude only, displacement has magnitude and direction

(b) 37.5 km

accept any value between 37.0 and 38.0 inclusive

062° or N62°E

accept 62° to the right of the vertical

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

acceleration is the rate of change of velocity

(d) number of squares below line = 17

accept any number between 16 and 18 inclusive

each square represents 500 m

distance = number of squares × value of each square correctly calculated – 8500 m
M2. (a) (i) gravity/weight

(ii) 2193750000000 or 2.19 \times 10^{12}

\textbf{not} 2.19^{12}

allow 1 mark for the correct conversion to 7500 (m/s)
allow one mark for answer 2193750(J)

transferred to heat

\textit{ignore extras of sound and light}

\textit{accept changed to heat}

\textit{accept lost due to friction}

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

\textit{accept word speed instead of velocity}

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

\textbf{or correct rearrangement}

\textit{do not accept}

\[ a = \frac{v - u}{t} \]

\textit{even if subsequent calculation correct}

\textbf{can gain credit if subsequent calculation correct}
(ii) 2

ignore + or – signs

m/s^2 1
accept m/s/s or ms^{-2}

(c) (i) force = mass × acceleration

accept correct rearrangement
accept F = m × a
do not accept

unless subsequent calculation correct

(ii) 156 000

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

(b) 6
Else a = 30/5
gets 2 marks
Else a = v/t
gets 1 mark

(c) 9000
Else F = 6 × 1500
gets 2 marks
Else F = ma
gets 1 mark

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

(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

[17]
M4. (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

(b) Z

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
M5. (a) any **two** from:

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

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

(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*