

- 1 (a) (i) $s = \text{area under graph, stated or clearly used}$ C1
 $= (\frac{1}{2} \times 18 \times 10) + (120 \times 18) + (\frac{1}{2} \times 18 \times 20)$ Award if at least one term correct C1
 $= 90 + 2160 + 180$ C1
 $= 2430 \text{ m} / 2.43 \text{ km}$ at least 2 significant figures. *Unit penalty applies A1
- (ii) $v = u + at$ in any form OR $(a=)$ gradient OR 18/10 C1
 $= 1.8 \text{ m/s}^2$ *Unit penalty applies A1
- (b) $(F=) ma$ OR $1.1 \times 10^5 \times 1.8$ ecf from (a)(ii) C1
 $= 1.98 \times 10^5 \text{ N}$ at least 2 significant figures. *Unit penalty applies A1
- (c) driving force = friction/air resistance/drag B1 [9]
Apply unit penalty once only
- 2 (a) (i) a time from 12.5 – 14.9 s **or** 15.1 – 16.0 s *Unit penalty applies B1
- (ii) a time from 0 – 2.5 s **or** 14.9 – 15.1 s *Unit penalty applies B1
- (iii) a time from 2.5 – 12.5 s *Unit penalty applies B1
- (b) (initially) weight/force of gravity **and** air friction/resistance act B1
it speeds up/accelerates **and** (air) friction/resistance increases B1
reaches terminal/constant velocity B1
(air) friction/resistance = weight **or** no resultant (force) **or** forces in equilibrium B1
- (c) upwards B1 [8]
- *Apply unit penalty once onl

- 3 (a) all points correctly plotted $\pm 1/2$ small square
straight line of best fit for candidate's points B1
B1
- (b) candidate's correct value with unit (± 0.2), (expect 1.2 N)
- (ii) remains stationary / nothing happens / no acceleration NOT constant speed B1
- (c) Correct data from candidates graph for ΔF and Δm , used in $\Delta F/\Delta m$ B
- (d) $F = ma$ in any form, letters, words B1
- (ii) gradient = F/a OR gradient = m ignore $m=F/a$ C1
candidate's (c) with correct unit A1
- (e) straight line of positive gradient B1 [9]
- 4 (a) (i) downward curve B1
initially horizontal at top and not vertical at bottom B1
- (ii) force shown vertically down (accept leaning back a small amount) B1
- (b) any two from:
same (times) / air resistance negligible / same acceleration B2
OR
times different B1
one has (more) air resistance B1
- (c) (time =) 800/320 C1
2.5(s) C1
($v =$) at OR $10 \times$ candidate's t value C1
25 m/s A1 [9]

- 5 (a) decreases / braking / decelerating)
 constant / steady / nothing) all 3 B1
 increases / accelerate)
- (b) speed x time in any form, symbols, numbers or words C1
 OR any area under graph used or stated C1
 13 (m/s) OR 24 (s) seen or used in correct context A1
 312 m
- (c) rate of change of speed OR gradient of graph OR 18/12 C1
 18 (m/s) OR 12 (s) seen or used in correct context C1
 1.5 m/s² A1
- (d) same gradient / slope OR equal speed changes in equal times OR B1 [8]
 allow graph symmetrical