1. (a) AB: (uniform) acceleration **(1)**
BC: constant velocity/speed or zero acceleration **(1)**
CD: negative acceleration or deceleration or decreasing speed/velocity **(1)**
DE: stationary or zero velocity **(1)**
EF ; (uniform) acceleration in <u>opposite</u> direction **(1)** 5

(b) area under the graph **(1)** 1

(c) distance is a scalar and thus is the total area under the graph
[or the idea that the train travels in the opposite direction] **(1)**
displacement is a vector and therefore the areas cancel **(1)** 2

[8]

2. (a) scalars have *magnitude* (or size) **(1)**
vectors have *magnitude* and *direction* **(1)** 2

(b) (i) $s = \upsilon t$ **(1)**

$s = 100 \times \frac{3}{60} = 5$ km **(1)**

(ii) 1.59 **(1)** km (or other correct unit) **(1)** 4

[6]

3. (a) (i) car A: travels at constant speed **(1)**

(ii) car B: accelerates for first 5 secs (or up to 18 m s^{-1}) **(1)**
then travels at constant speed **(1)** 3

(b) (i) car A: distance = 5.0 × 16 **(1)**
= 80 m **(1)**

(ii) car B: (distance = area under graph)
distance = [5.0 × ½ (18 + 14)] **(1)**
= 80 m **(1)** 4

(c) car B is initially slower than car A (for first 2.5 s) **(1)**
distance apart therefore increases **(1)**
cars have same speed at 2.5 s**(1)**
after 2.5 s, car B travels faster than car A (or separation decreases) **(1)** max 3

[10]

4. (a) (i) rate of change of velocity

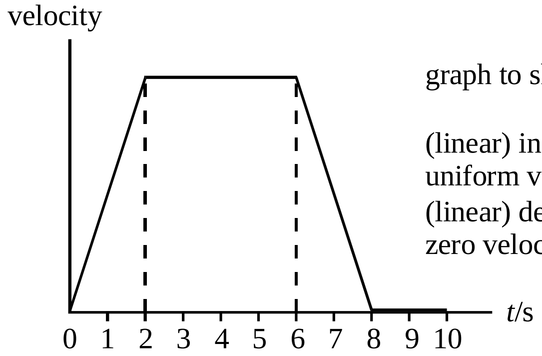
[or $a = \frac{\Delta v}{t}$] **(1)**

(ii) (acceleration) has (magnitude and) direction **(1)** 2

(b) (i) (acceleration) is the gradient (or slope) of the graph **(1)**

(ii) (displacement) is the area (under the graph) 2

(c)



graph to show:

(linear) increase to t = 2.0 ± 0.2 s ✓
uniform velocity between 2.0 s and 6.0 s ✓
(linear) decrease from 6.0 ± 0.2 s to 8.0 s ✓
zero velocity after t = 8.0 s ✓

4

[8]

5. (a) (i) **region A**: <u>uniform</u> acceleration

(or (free-fall) acceleration = g(= 9.8(i) m s^{-2}))

force acting on parachutist is entirely his weight

(or other forces are very small) **(1)**

(ii) **region B**: speed is still increasing

acceleration is decreasing **(2)** (any two)

because frictional (drag) forces become significant
(at higher speeds)

(iii) **region C**: uniform speed (50 m s^{-1})

because resultant force on parachutist is zero **(2)** (any two)

weight balanced exactly by resistive force upwards 6

QWC

(b) deceleration is gradient of the graph (at t = 13s) **(1)**

(e.g. 20/1 or 40/2) = 20 m s^{-2} **(1)** 2

(c) distance = area under graph **(1)**
suitable method used to determine area (e.g. counting squares) **(1)**
with a suitable scaling factor (e.g. area of each square = 5 m^2) **(1)**
distance=335m (±15m) **(1)** 4

(d) (i) speed = $\sqrt{(5.0^2 + 3.0^2)}$ = 5.8 m s^{-1} **(1)**

(ii) $\tan \theta = \frac{3}{5}$ gives θ = 31°**(1)** 2

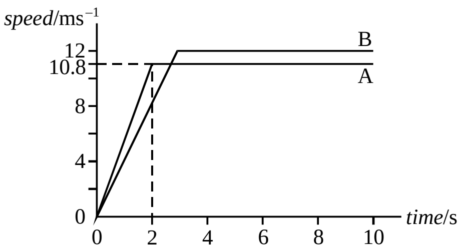
[14]

6. (a) (i) ($v = \frac{s}{t}$ gives) $v = \frac{100}{10.2}$ = 9.8 m s^{-1} **(1)**

(ii) ($v = at$ gives) v = 5.4 × 2 = 11 m s^{-1} (10.8 m s^{-1})

(iii) ($s = ut + ½ at^2$ gives) s = ½ × 5.4 × 2^2 **(1)**
= 11 m **(1)** (10.8 m) 4

(b)



positive slope and then horizontal **(1)**
initial slope correct **(1)**
horizontal line with correct
value from (a)(ii) **(1)**

3
QWC

(c) (i) t = 2.8 s **(1)**

(ii) (area under graph gives)
athlete B : 15 m **(1)**
athlete A : 11 **(1)** + 8.6(4) = 20 m **(1)** (10.8 + 8.64 = 19.4 m)

(iii) 20 – 15 = 5.0 m **(1)** (19 – 15 = 4.0 m)
(allow e.c.f. from(c)(ii)) max 4

[11]

7. (a) (i) acceleration **(1)**

(ii) both represent acceleration of free fall
[or same acceleration] **(1)**

(iii) height/distance ball is dropped from above the ground
[or displacement] **(1)**

(iv) moving in the opposite direction **(1)**

(v) kinetic energy is lost in the collision
[or inelastic collision] **(1)** 5

(b) (i) $v^2 = 2 \times 9.81 \times 1.2$ **(1)**
$v = 4.9$ m s^{-1} **(1)** (4.85 m s^{-1})

(ii) $u^2 = 2 \times 9.81 \times 0.75$ **(1)**
$u = 3.8$ m s^{-1} **(1)** (3.84 m s^{-1})

(iii) change in momentum = $0.15 \times 3.84 - 0.15 \times 4.85$ **(1)**
= $^{-1}$.3 kg m s^{-1} **(1)** (1.25 kg m s^{-1})

(allow C.E. from (b) (i) and (b)(ii))

(iv) $F = \dfrac{1.3}{0.10}$ **(1)**

= 13 N **(1)**

(allow C.E. from (b)(iii)) 8

[13]

8. (a) scales **(1)**

six points correctly plotted **(1)**
trendline **(1)** 3

(b) average acceleration = $\dfrac{26}{25}$ **(1)**

= 1.0(4) m s^{-2} **(1)**

(allow C.E. for incorrect values used in acceleration calculation) 2

(c) area under graph **(1)**
= 510 ± 30 m **(1)** 2

(d) (graph to show force starting from *y*-axis)
decreasing (not a straight line) **(1)**
to zero (at end of graph) **(1)** 2

(e) (since) gradient of a velocity-time graph gives acceleration **(1)**
first graph shows acceleration is decreasing **(1)** 2

[11]