M1.(a) Velocity and speed correct ✓
Distance and displacement correct ✓

	velocity	speed	distance	displacement
vector	✓			✓
scalar		✓	✓	

2

(b) (i) $v^2 = u^2 + 2as$

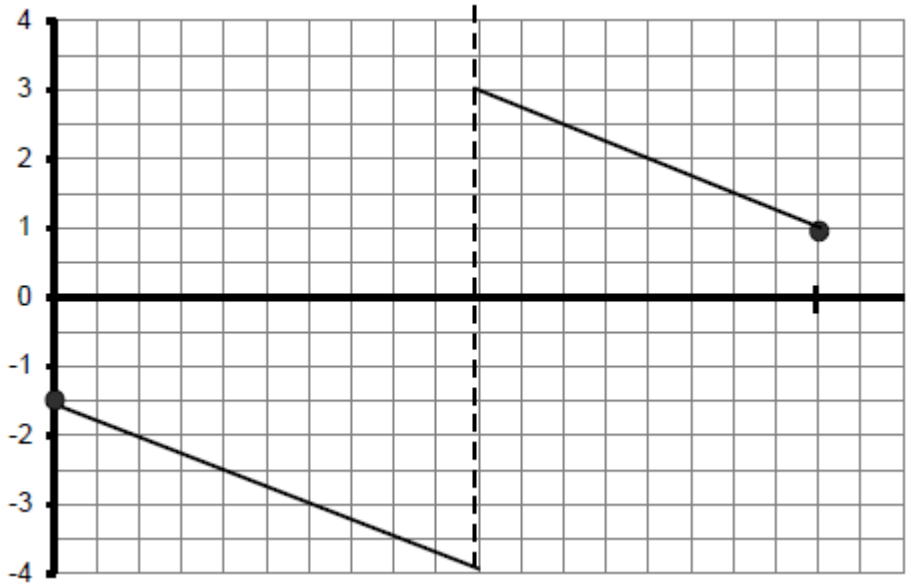
$v = \sqrt{u^2 + 2as}$ ✓ $v = \sqrt{1.5^2 + 2 \times 9.81 \times 0.65}$ ✓

= (−)3.9 (m s^{-1}) ✓two or more sig fig needed (− 3.87337 m s^{-1})

1st mark for equation rearranged to make v the subject (note sq' root may be implied by a later calculation) penalise the use of g = 10 m s^2 only on this question
2nd mark for substituting numbers into any valid equation
3rd mark for answer
Alt' approach is gainKE = lossPE
missing out u gives zero marks
answer only gains one mark [Note it is possible to achieve the correct answer by a wrong calculation]

3

(ii) **velocity / ms^{-1}**



first line descends from X to the dotted line at t_A or up to one division sooner ✓
(allow line to curve)

first line is straight and descends from X to $v = -4$ (m s^{-1}) ✓(allow tolerance one division)
second line has same gradient as the first, straight and descends to v = 1(m s^{-1}) ✓(tolerance ½ division)
a steep line may join the two straight lines but its width must be less than 2 divisions

3

(c) $s = ut + 1/2at^2$

t = $\sqrt{\frac{2s}{a}}$ OR correct substitution seen into either equation t = $\sqrt{\frac{2\times1.2}{9.81}}$ ✓

= 0.49 (s) ✓ (0.4946 s)

working must be shown for the first mark but not the subsequent marks

$v = s / t$
= 5.0 / 0.49 = 10 (m s^{-1}) ✓ (10.2 m s^{-1}) (allow CE from their time)

[note it is possible to achieve the correct answer by a wrong calculation]

3

[11]

M2.(a) (i) *(a =(v-u) / t)*
= 27.8 (−0) / 4.6 = 6.04 ✓
= 6.0 (ms^{-1}) ✓

no need to see working for the mark
2 sig fig mark stands alone

2

(ii) (*F = ma*)
= (360 + 82) × 6.0(4) ✓ (allow CE from (i))
= 2700 (N) ✓ (2670 N or 2652 N)

F = 442 × (i)
1 mark may be gained if mass of rider is ignored giving answer 2200N from 2175N

2

(b) (forward force would have to) increase ✓
air resistance / drag increases (with speed) ✓
driving / forward force must be greater than resistive / drag force ✓
no mark for wind resistance

(so that) resultant / net force stayed the same / otherwise the resultant / net force would decrease ✓

4max3

(c) horizontal force arrows on both wheels towards the right starting where tyre meets road or on the axle labelled driving force or equivalent ✓
ignore the actual lengths of any arrows
ignore any arrows simply labelled 'friction'

a horizontal arrow to the left starting anywhere on the vehicle labelled drag / air resistance
no mark for wind resistance, resistance or friction force
the base of an arrow is where the force is applied

2

(d) ($F = P / v$)
= 22 000 / 55 ✓ Condone 22 / 55 for this mark
= 400 ✓ (N)

2

[11]

M3.(a) (i) 11 (m)

B1

1

(ii) Use of $F = k\Delta L$ or $W = mg$
Allow use of ΔL =12 m

C1

3400 (N)

A1

2

(b) Sets $mg = k\Delta L$

C1

1.9 (m)

A1

2

(c) Correct use of $W = ½k\Delta L^2$ or $½F\Delta L$
$\Delta L = 5\ m$

C1

Correct use of $\Delta GPE = mg\Delta h$
$\Delta h = 25\ m$

C1

States or uses $(mg\Delta h) – (½\ k\Delta L^2) = ½mv^2$

C1

19 (m s^{-1}) cnao

A1

4

(d) Same kinetic energy when rope begins to stretch

B1

More work done per unit extension / stops in shorter distance
"Shorter time" gets no credit

B1

Increases force on jumper (increasing the risk of injury)

B1

3

[12]

M4.(a) (i) Use of $KE = \frac{1}{2} m v^2$

C1

21.7 (J)

A1

2

(ii) Use of $W = Fs$

Allow 1 mark for use of suvat or F=ma

C1

0.70 (m)

A1

2

(b) Use of $\Delta E_p = mg\Delta h$

C1

Correct sub for h (1.7 sin 18°)

C1

77.3 (W)
OR
Use of $P=Fv$
Correct sub for F (mg sin 18°) or v (1.7 sin 18°)
77.3 (W)

A1

3

[7]