M1.(a) (i) *(a =(v-u) / t)*

= 27.8 (−0) / 4.6 = 6.04 ✓

= <u>6.0</u> (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) ✓

<u>driving / forward</u> force must be greater than resistive / drag force ✓

no mark for wind resistance

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

4max3

(c) <u>horizontal</u> force arrows on both wheels towards the <u>right</u> starting where tyre meets road or <u>on the axle</u> labelled driving force or equivalent ✓

ignore the actual lengths of any arrows

ignore any arrows simply labelled 'friction'

a <u>horizontal</u> arrow to the <u>left</u> starting <u>anywhere</u> 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]

M2.(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]

M3.C

[1]

M4.D

[1]

M5.(a) Max GPE of block = Mgh = 0.46 × 9.81 × 0.63 = 2.84 J ✓

The first mark is for working out the GPE of the block

1

Initial KE of block = ½ Mv^2 = 2.84 J

Initial speed of block v^2 = (2 × 2.84) / 0.46

v = 3.51 ms^{-1} ✓

The second mark is for working out the speed of the block initially

1

momentum lost by pellet = momentum gained by block

= Mv = 0.46 × 3.51 = 1.61 kg m s^{-1} ✓

The third mark is for working out the momentum of the block (and therefore pellet)

1

Speed of pellet = 1.58 / m = 1.58 / 8.8 × 10^{-3} = 180 ms^{-1} (183) ✓

The final mark is for the speed of the pellet

1

At each step the mark is for the method rather than the calculated answer

Allow one consequential error in the final answer

(b) As pellet rebounds, change in momentum of pellet greater and therefore the change in momentum of the block is greater ✓

Ignore any discussion of air resistance

1

Initial speed of block is greater ✓

1

(Mass stays the same)

Initial KE of block greater ✓

1

Therefore height reached by steel block is greater than with wooden block ✓

1

(c) Calculation of steel method will need to assume that collision is elastic so that change of momentum can be calculated ✓

1

This is unlikely due to deformation of bullet, production of sound etc. ✓

1

And therefore steel method unlikely to produce accurate results.

[10]

M6.C

[1]

M7.C

[1]

M8.(a) (i) use of $\left(s = \frac{1}{2}gt^2\right)$ OR $t^2 = 2s / g$ ✓

t = $\sqrt{\frac{2 \times 1.2}{9.81}}$ ✓

= 0.49 (0.4946 s) ✓ allow 0.5 do not allow 0.50

Some working required for full marks. Correct answer only gets 2

3

(ii) ($s = vt$)
= 8.5 × 0.4946 ✓ ecf ai
= 4.2 m ✓ (4.20) ecf from ai

2

(b) (i) $\left(s = \frac{1}{2}(u + v)\,t\right)$

$t = \frac{2s}{u(+v)}$ or correct sub into equation above ✓

$= \frac{2 \times 0.35}{8.5} = 8.2 \times 10^{-2}$ (s) ✓ (0.0824) allow 0.08 but not 0.080 or 0.1

Allow alternative correct approaches

2

(ii) $a = (v - u) / t$ OR correct substitution OR a = 103 ✓
(= −8.5) / 8.24×10^{-2} = 103.2)

($F = ma$ =) 75 × (103.2) ✓ ecf from bi for incorrect acceleration due to arithmetic error only, not a physics error (e.g. do not allow a = 8.5. Use of g gets zero for the question.

= 7700 N ✓ (7741) ecf (see above)

Or from loss of KE

Some working required for full marks. Correct answer only gets 2

3

[10]

M9.(a) (i) 1000(N) AND 6000(N) seen

Independent marks

OR

$F = \sqrt{(1000)^2 + (6000)^2}$ ✓ allow incorrect values seen
= **6083** (N) (= 6100) ✓ More than 2 sf seen

Allow full credit for appropriate scale drawing
Ignore rounding errors in 3rd sig fig.

2

(ii) tanΘ = 1000 / 6000 or correct use of sin or cos ✓
Θ = 9.5 (9.46°) ✓
Allow range 9.4 − 10.4

Use of cos yields 10.4

Allow use of 6100
Some working required for 2 marks.
Max 1 mark for correct calculation of vertical angle (range 79.6 − 80.6) some working must be seen

2

(iii) (*m* = *W/g* =) 6500 / 9.81 (= 662.6 kg) ✓
(*a* = *F* / *m* = 6083 / 662.6)
= 9.2 (ms^{-2}) ✓ (9.180)

Use of weight rather than mass gets zero
Correct answer on its own gets 2 marks
Penalise use of g=10 in this question part only (max 1)

2

(b) (i) = 6500 × 600 ✓ (662.6 × 9.81 × 600)
= 3 900 000 ✓ (J)

Look out for W x g x h which gives 39000000 (gets zero)
Correct answer on its own gets 2 marks
Do not allow use of 1/2 mv² (= 39 000)

2

(ii) (E= Pt =) 320 000 ×; 55 (= 17 600 k J)
OR P= 1(b)(i) / 55 (7.09×10^4) ✓
3.9 / 17.6 OR 70.9 / 320 OR = 0.22(16) ✓ ecf from first line

Some valid working required for 3 marks

conversion to a percentage (= 22 %) ✓

Look out for physics error: Power / time (320/55) then use of inverted efficiency equation yielding correct answer
Do not allow percentages >= 100% for third mark

3

[11]