M1.A

[1]

M2.(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]

M3.(a) 8300 × 9.81 OR = 81423 ✓
(8300 × 9.81 sin 25)
= 3.4 × 10^4 (N) ✓ (34 411 N) ecf from first line unless g not used

msin25 gets zero

Penalize use of g = 10 here only
(35 077 N)
Allow 9.8 in any question

Correct answer only, gets both marks for all two mark questions

2

(b) (i) ($E_k = ½mv^2$)
= ½ × 8300 × 56^2 ✓
= 1.3 × 10^7 (J) ✓ (13 014 400) allow use of 8300 only

In general: Penalise transcription errors and rounding errors in answers

2

(ii) *mgh* = KE (13 014 400) for *mgh* allow GPE or E_p
OR 13 014 400 / 81 423 ✓
h = 160 (m) ✓ (159.8) ecf 1bi

Allow use of suvat approach

2

(c) (i) (work done) by friction \ drag \ air resistance \ resistive forces ✓
(energy converted) to internal \ thermal energy ✓
Allow 'heat'

2

(ii) 0.87 x (8300 x 9.81 x 140 = 9 917 000) OR $v = \sqrt{\left[\frac{2 \times (9\,917\,000)}{8300}\right]}$ ✓
= 49 (= 48.88 ms^{-1}) ✓
87% of energy for 140m or 160m only for first mark.
Use of 160 (52.26) and / or incorrect or no % (52.4) gets max 1 provided working is shown
Do not credit suvat approaches here

2

[10]

M4.(a) $(s = \frac{1}{2}(u + v)t)$

Correct answer with no working gets 2 out of three.

$u = \frac{2s}{t} - v$ **OR** substitution in above equation **OR** $u = \frac{2 \times 1.5}{0.43} - 5.0$ ✓
= 6.9767 – 5.0 ✓ = 2.0 ✓ (1.98 m s^{-1})
Full credit for use of gsin25 = acceleration down slope. This yields answer 3.22 m s^{-1}
Allow 1sf answer (2).

3

(b) (i) (F = 75 × 9.81 ×) sin25 (°) ✓
= 310 (311, 310.94) (N) ✓
use of g = 10 not penalised here
'sin25' on its own
Use of g = 10 yields 317
Allow cos65

2

(ii) $W = Fs$
= 311 × 2.0 = 620 (622 J) ✓ ecf (2bi) × 2.0

1

(c) Idea that GPE is ultimately transferred to: internal (energy) / 'heat'/ 'thermal' (energy in the surroundings) ✓

Allow transfer of GPE to KE and then to 'thermal' etc
Do not allow reference to 'sound' on its own

Correct reference to a named resistive force: friction / drag / air resistance ✓

Don't accept implication that a resistive force is a form of energy

All GPE becomes 'heat', etc **OR** no (overall) increase in KE **OR** reference to work done against or by a resistive force ✓

Do not allow references to loss of body heat.
Allow: '(GPE) not converted to KE'

3

[9]

M5. (a) *GPE* to *KE* to *GPE* ✓

no energy lost (from system) / no work done against resistive forces ✓

initial *GPE* = final (*GPE*) / initial (*GPE*) = final *GPE*

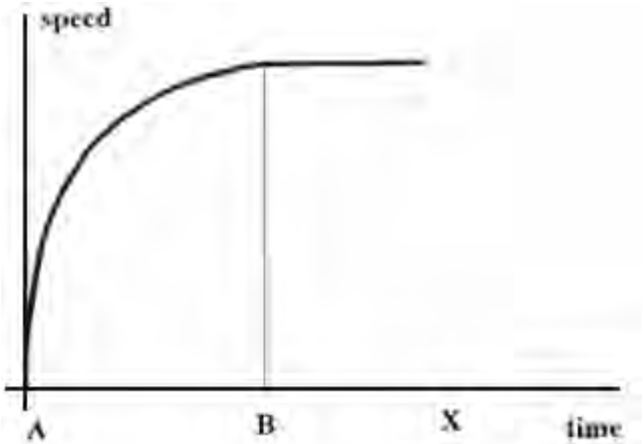
OR $h = GPE/mg$ and these are all constant so h is the same ✓

3

(b) Initial curve with decreasing gradient and reaching constant maximum speed before X and maintaining constant speed up to X ✓

B labelled in correct place ✓

B labelled in correct place **AND** constant speed maintained for remainder of candidates graph and line is straight ✓



3

(c) (first law) ball travels in a straight line at a constant speed / constant velocity / (maintains) uniform / no change in motion / zero acceleration ✓

there is no (external) **unbalanced / resultant** force acting on it ✓

2

[8]

M6.(a) (i) $(s = ½(u + v)\ t)\ t = 2s/v$ ✓ (correct rearrangement, either symbols or values)

(= 100/6.7) = 15 ✓ (s) (14.925)

or alternative correct approach

2

(ii) ($KE = 1/2mv^2 = ½ \times 83 \times 6.7^2$) = 1900 ✓ (1862.9 J)

2 sf ✓

2

(iii) GPE = 83 × 9.81 × 3.0 ✓ penalise use of 10, allow 9.8

= 2400 (2443 J) ✓ do not allow 2500 (2490) for use of g = 10

2

(b) (i) 5300 + 3700 (or 9000 seen)

or – 2443 – 1863 (or (–) 4306 seen) ✓

= 4700 (J) ✓ (4694) ecf from parts aii & aiii

2

(ii) mention of friction and appropriate location given ✓

mention of **air** resistance (or drag) ✓

do not allow energy losses or friction within the motor

do not allow energy losses from the cyclist

must give a **cause** not just eg ‘heat loss in tyres’

2

[10]