M1. (i) weight greater than air resistance
[or (initially only) weight/gravity acting] **(1)**
hence resultant force downwards or <u>therefore</u> acceleration (2nd law) **(1)**
air resistance or upward force increases with speed **(1)**
until air resistance equals weight or resultant force is zero **(1)**
leaf moves at constant velocity (1st law)
[or 1st law applied correctly] **(1)**

(ii) air resistance depends on shape
[or other correct statement about air resistance] **(1)**
air resistance less significant **(1)**
air resistance less, therefore greater velocity
[or average velocity greater or accelerates for longer] **(1)**

max 5
QWC 2

[5]

M2. (a) (i) (use of $a = \frac{\Delta v}{\Delta t}$ gives) $a = \frac{4.5}{3600}$ **(1)**

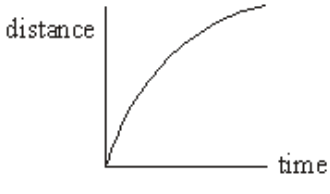
$=1.25 \times 10^{-3}\,\text{ms}^{-2}$ **(1)**

(ii) (use of $v^2 = u^2 + 2as$ gives) $0 = 4.5^2 - 2 \times 1.25 \times 10^{-3} \times s$ **(1)**

$s\left(= \frac{20.25}{2.5 \times 10^{-3}}\right) = 8.1 \times 10^3\,\text{m}$ **(1)**

4

(b) increasing curve **(1)**
correct curve **(1)**



1

(c) gradient (slope) of graph represents speed **(1)**
hence graph has decreasing gradient **(1)**

2

[8]

M3. (a) (i) $\left(a = \frac{F}{m}\right) = \frac{(-)30(000)}{15100}$ **(1)** = (–)2.0 (= 1.99 m s^{-2}) **(1)**

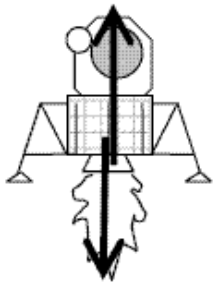
2

(ii) ($v = u + at$) $t = \frac{v-u}{a}$ or substitution **(1)**

$= \left(\frac{150 - 20401}{-1.99}\right)$ = 950 (s) **(1)** ecf from (i)

2

(b) (i)



opposing vertical arrows of roughly equal length **or** labelled weight/mg/gravity/W **and** thrust/reaction/R/F/TF/engine force/rocket force/motor force/motive force/driving force **(1)**

correctly labelled
+ arrows vertical
+ not more than 2 mm apart
+ roughly central
+ weight arrow originates within rectangular section and thrust originates within rectangular section or on jet outlet **(1)**

2

(ii) new mass = 15100 × 0.47 = 7097 (kg) **(1)**

(F = *mg* = 7097 × 16(1)) = 11000 (= 11426 N) **(1)**

2

(c) ($v^2 = u^2 + 2as$ $v = \sqrt{0.80^2 + 2 \times 1.61 \times 1.2)}$ correct *u*, *a* and *s* clearly identified **(1)**

= 2.1 (= 2.122 m s^{-1}) **(1)**

2

[10]

M4. (a) scales **(1)**

six points correctly plotted **(1)**

trendline **(1)**

3

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

= 1.0(4) ms^{-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]

M5. (a) any **two** from

freefall is too quick (any indication of slower motion) **(1)**

(Galileo had) no (accurate) method to **time** freefall (or valid comment regarding timing of freefall or inclined plane) **(1)**

correct reference to **air** resistance or **drag** (not 'wind') **(1)**

max 2

(b) (i) 0.20 × 9.81 = 1.962 (N) **(1)**

(1.962 sin 1.8 =) 0.0616 or 0.062 seen **(1)** (allow 0.061)
(0.0628 for use of g = 10 gets 1 mark)

2

(ii) 0.06(16)/0.20

or use of $a = F/m$ with a clearly identified force but not the weight

or g sinθ = g sin 1.8° **(1)**

0.31 (m s^{-2}) **(1)** (0.308)
accept 0.3 or 0.30 correct answer only for second mark

or ($a = 2s/t^2$)

= 2 × 0.29/1.4^2 **(1)** = 0.31 **(1)** or use of other values from table

2

(c) accelerating **(1)** (accept increasing speed, etc but not increasing acceleration/quicker motion, etc)

greater distance for each additional swing ('per unit time' must be implied) or gradient/ steepness/ slope increasing **(1)** (accept curves upwards)

2

(d) **tangent used:**

tangent drawn at 3.0 m ± 0.3 on graph **(1)**

their time from graph × 1.4 **(1)**

= 1.28 to 1.44 (m s^{-1}) **(1)**

or suvat used:

use of $v = \frac{2s}{t}$ or $v = (u) + at$ with a from (b) (ii) **(1)**

(t =) 4.4 to 4.5 (s) **(1)**

(speed =) 1.3 to 1.4 (m s^{-1}) **(1)**

3

[11]

M6. (a) scales **(1)(1)** (one mark for each scale)

six points correctly plotted **(1)(1)**
(ignore 0,0 and lose one mark for each error)

trend line **(1)** (if misses more than two points then lose mark)

5

(b) average acceleration = 26/25 **(1)**

= 1.0(4) m s^{-2} **(1)** e.c.f. from correct values used

2

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

2

(d) curve decreasing **(1)**

to zero at end of graph **(1)** and starting from vertical axis within 1mm **(1)**

3

(e) (since) gradient of a velocity-time graph gives acceleration **(1)**

(first graph shows) acceleration is decreasing **(1)**

or resistive force increases (with speed) **(1)**

so resultant force (or acceleration) decreases **(1)**

2

[14]