LINEAR MOTION

1. (a) (i) arrow pointing to the left; 1

(ii) A; 1

(b) (i) both points plotted correctly;
line completed on graph; 2

(ii) 20 and 30;
[Accept any two values between 20 and 30] 1

(iii) 0 and 20;
[Accept any two values between 0 and 20]
line is steepest/calculation/reference to travelling greater distance in same or less time; 2

[7]

2. (a) An explanation to include:

1. van plus reference to change in speed;
2. in same time/ 5 s / 10 s; 2

(b) An explanation to include:

1. same mass/weight/eq;
2. bigger acceleration;

[Accept also $F = ma$ argument) 2

[4]

3. (a) An explanation to include three from:

1. initially driving force greater than resistive force;
2. resistive force increases;
3. resultant or unbalanced force decreases/acceleration decreases (in correct context);
4. forces equal in size at constant speed/resultant force is zero; 3

(b) greater acceleration/less driving force;
since less mass *(F=ma);* 2

(c) (i) $KE = ½ \times m \times v^2 = ½ \times 85 \times 12^2$;
$= 6120$;
J; 3

(ii) $\text{time} = \frac{\text{energy}}{\text{power}} = \frac{6120\,\text{J}}{200\,\text{W}}$;[Allow ecf]
= 34 s; 2

(d) (i) 20 (J) as heat/waste energy/to atmosphere/surroundings; 1

(ii) efficiency = $\frac{\text{useful energy out}}{\text{energy in}}$;

$= \frac{180\text{J}}{200\text{J}}$;

= 0.90 / 90%; 3

(iii) all the energy goes to atmosphere/surroundings/work done against/overcoming friction; 1
[Reject energy lost as heat/friction unqualified]

[15]

4. (a) drag/resistance/force/push/thrust/upthrust;
air/atmosphere;
[Reject wind/friction] 2

(b) 56; 1

(c) (i) pull of Earth/weight/gravitational pull/downward (pull) greater than upward (push)/there is resultant force downwards;
[Allow gravity] 1

(ii) both forces the same/balanced/equal/resultant force is zero/OWTTE; 1

(d) (i) speed decreases;
new lower terminal velocity/horizontal region shown;
(Independent marking points) 2

(ii) An explanation to include three from:
- air resistance increases;
- at start upward force greater than downward force;
- eventually forces balance;
- larger surface area;
- air resistance decreases as parachutist slows down; 3

[10]

5. (a) An explanation to include:

1. it increases;
2. cyclist moves further in same time interval/each time; 2

(b) 12 m; 1

(c) X marked anywhere between 21 and 27 m;
[Reject 28 m] 1

[4]

6. (a) (i) friction (between book and table top); 1

(ii) (transferred to) heat;
[Ignore sound]
[Reject other answers] 1

(b) forward push of **ground**/force due to **ground**/forward push on **shoe**/friction;
[Ignore reaction with ground] 1

[3]

7. (a) A description to include:

1. upward push/reaction/thrust;
2. of the **ground** on the athlete; 2

(b) (i) 0.39 (s);
[Accept 0.4 (s)] 1

(ii) A calculation to include:
= area below graph / average velocity × time;
$= \frac{1}{2} \times 3.8 \times 0.39$;[Allow ecf from (b)(i) – 0.76(m)]
= 0.74 (m);
[If 4.0 used for velocity then the first and the third marks can be credited] 3

(iii) A calculation to include:

1. acceleration = $\frac{(v - u)}{t}$;
2. substitution of correct data, eg $\frac{3.8}{0.39}$; [Allow $\frac{7.6}{0.78}$]
3. = 9.7 m/s^2; [Accept –9.7 m/s^2] 3

(iv) downwards;
negative gradient/backwards slope/athlete slowing down/retardation/deceleration; 2

(v) A calculation to include:

1. F = ma;
2. = 65 kg × 9.7 (m/s^2);[Allow ecf from b(iii)]
3. = 630 – 633 (N);

[Accept either 65 × 10 m/s^2 = 650 N for 2 marks
or 65 × 9.81 m/s^2 = 638 N for 2 marks] 3

(vi) downward pull of the Earth/gravitational pull;
[Reject gravity] 1

[15]

8. (a) $F = m \times a$ / $W = m \times g$;
= 70 × 10;
= 700 N; 3

(b) speed constant;
upward force = downward force/
forces balanced/from F = ma if a = 0; 2

(c) A description and an explanation to include:

- opens parachute at C;
- drag force increased/upward force increased;
- lower terminal velocity;

plus 1 communication mark for using a suitable structure and style of writing; 4

(d)(s)(h)

ows lower terminal velocity at D;
shows longer time to land; 2

[11]

9. (a) 600 m; 1

(b) 200 – 100;

100 m; 2

(c) it is a straight line; 1

(d) Y;
greater slope/steeper line; 2

[6]

10. (a) distance increases as speed increases / it increases / OWTTE; 1

(b) 138 – 140 m; 1

(c) **below the first line**;
curve of similar shape to graph; 2
[Second mark conditional on first]

(d) A description to include:
1. **kinetic / movement energy**;
2. (to) thermal (heat) /sound energy; 2

[List after kinetic energy scores 0 marks for the second marking point]

(e) some kinetic energy transferred to gravitational potential energy /
weight is extra retarding force /
gravitational potential energy increases / gravitational pull / OWTTE; 1

[7]

11. (a) 0 – 2 (seconds); 1

(b) upwards;
lift is slowing (even though it is falling); 2
[Direction must be mentioned to score second marking point]

(c) area below graph is height (distance travelled)
distance = speed × time;
$1 \times 1.8 + 6 \times 1.8 + 1 \times 1.8$; 3

14.4 (m); [Allow ecf]
[Accept $8 \times 1.8 \rightarrow 14.4$ m for 3 marks]

[6]

12. (a) points plotted correctly;; [Deduct 1 mark for each error] 2
[Line not necessary]

(b) 3 (m/s); 1

(c) (i) acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$; 1

[Accept $a = \frac{v}{t}$ or $\frac{\text{velocity}}{\text{time}}$ or $\frac{\text{speed}}{\text{time}}$]

(ii) acceleration = $\frac{3}{15}$; [Allow ecf from part (b)]
= 0.2 (m/s^2); 2

[6]

13. (a) (i) area below graph / average velocity (speed) × time; 1
[Reject velocity × time]

(ii) A calculation to include:
1. Distance = ½ × 15 × 3;
2. = 22.5 (m) ; 2
[Allow 45 m for 1 mark]

(b) A calculation to include:
1. acceleration = $\frac{\text{change in velocity}}{\text{time}}$;

[Accept $a = \frac{v}{t}$ or $\frac{\text{velocity}}{\text{time}}$ or $\frac{\text{speed}}{\text{time}}$]

2. = $\frac{2}{10}$ = 0.2 (m/s^2);
3. force = mass × acceleration;
4. = 1.2 × 10^5 × 0.2 = 2.4 × 10^4 N ;

[Allow ecf if acceleration calculated and evidence of this is shown]

[7]

14. (a) plots;;
[Deduct 1 mark for each error] 2

(b) straight line / goes up equally / uses data table; 1

(c) A calculation to include:
1. speed = gradient / slope / distance/time;
2. = $\frac{750}{25}$ / spot value from graph or table;
3. = 30 m/s; 3

(d) An explanation to include:
1. friction / drag / air resistance present;
2. no unbalanced force / equals driving force; 2

[8]

15. (a) (i) 90; 1

(ii) (39-40); 1

(iii) An explanation to include:
1. (15-16) s;
2. slows down / less (lower) speed / reference to graph /

decelerate;
[Reject change in speed] 2

(iv) 20; 1

(b) A description to include three from:

1. F = mg;
2. F increases;
3. F > mg
   F decreasing;
4. F = mg;
5. mg = constant;

[OWTTE in right context] 3

[8]