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) 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) shows 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; [Second mark conditional on first]	2
	(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); [Direction must be mentioned to score second marking point]	2
	(c)	area below graph is height (distance travelled) distance = speed × time; 1 × 1.8 + 6 × 1.8 + 1 × 1.8; 14.4 (m); [Allow ecf] [Accept 8 × 1.8 → 14.4 m for 3 marks]	3

[6]

12.	(a)	points plotted correctly;; [Deduct 1 mark for each error] [Line not necessary]	2
	(b)	3 (m/s);	1
	(c)	(i) acceleration = $\frac{\text{changein velocity}}{\text{timetaken}}$;	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 $= \frac{1}{2} \times 15 \times 3$;
2. $= 22.5$ (m) ; 2

[Allow 45 m for 1 mark]

(b) A calculation to include:

1. acceleration = $\frac{\text{changein velocity}}{\text{time}}$;

[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. $= 1.2 \times 10^5 \times 0.2 = 2.4 \times 10^4$ 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]