

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) $KE = \frac{1}{2} \times m \times v^2 = \frac{1}{2} \times 85 \times 12^2$;
 $= 6120$;
 J; 3
 (ii) $\text{time} = \frac{\text{energy}}{\text{power}} = \frac{6120\text{J}}{200\text{W}}$;[Allow ecf]
 $= 34 \text{ s}$; 2

- (d) (i) 20 (J) as heat/waste energy/to atmosphere/surroundings; 1
- (ii) $\text{efficiency} = \frac{\text{useful energy out}}{\text{energy in}};$
 $= \frac{180\text{J}}{200\text{J}};$
 $= 0.90 / 90%;$ 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/s²; [Accept –9.7 m/s²]
- 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/s²); [Allow ecf from b(iii)]
 3. = 630 – 633 (N);
- [Accept either 65 × 10 m/s² = 650 N for 2 marks
or 65 × 9.81 m/s² = 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; 2
- 100 m; 2
- (c) it is a straight line; 1
- (d) Y; 2
- 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;** 2
- curve of similar shape to graph; 2
- [Second mark conditional on first]
- (d) A description to include: 2
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 / 1
- weight is extra retarding force /
- gravitational potential energy increases / gravitational pull / OWTTE; 1
- [7]**
11. (a) 0 – 2 (seconds); 1
- (b) upwards; 2
- 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) 3
- distance = speed × time;
- $1 \times 1.8 + 6 \times 1.8 + 1 \times 1.8;$
- 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/s²); 2

[6]

13. (a) (i) area below graph / average velocity (speed) × time;
 [Reject velocity × time] 1
- (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 = $\frac{\text{change in velocity}}{\text{time}}$;

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

2. = $\frac{2}{10} = 0.2$ (m/s²);

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. $mg = \text{constant}$;

[OWTTE in right context]

3

[8]