Motion Graphs

Mark Scheme 3

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Kinematics
Sub Topic	Motion Graphs
Paper Type	Theory
Booklet	Mark Scheme 3

Time Allowed: **78 minutes**

Score: **/65**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1	**(a**	evidence of use of area below the line	B1	
		distance = 39 m (*allow ±0.5 m*)	A	[3]
		(*if > ±0.5 m but ≤ 1.0 m, then allow 1 mark*)		
	(b)	**(i)** **1** $E_K = ½mv^2$	C1	
		$\Delta E_K = ½ \times 92 \times (6^2 - 3^2)$		
		= 1240 J	A1	[2]
		2 $E_P = mgh$	C1	
		$\Delta E_P = 92 \times 9.8 \times 1.3$		
		= 1170 J	A1	[2]
		(ii) $E = Pt$	C1	
		$E = 75 \times 8$		
		= 600 J	A	[2]
	(c)	**(i)** energy = (1240 + 600) – 1170	M1	
		= 670 J	A	[1]
		(ii) force = 670/39 = 17 N	A	[1]
	(d)	frictional forces include air resistance	B1	
		air resistance decreases with decrease of speed	B1	[2]

2 **(a)** 2.4 s …….. A1 [1]

(b) in **(b)** and **(c)**, allow answers as (+) or (–)
recognises distance travelled as area under graph line …….. C1
height = (½ × 2.4 × 9.0) – (½ × 1.6 × 6.0) …….. C1
= 6.0 m (*allow 6 m*) …… A1 [3]
(*answer 15.6 scores 2 marks*
answer 10.8 or 4.8 scores 1 mark)

alternative solution: $s = ut - \frac{1}{2}at^2$
$= (9 \times 4) - \frac{1}{2} \times (9 / 2.4) \times 4^2$
= 6.0 m
(*answer 66 scores 2 marks*
answer 36 or 30 scores 1 mark)

(c) **(i)** change in momentum = 0.78 (9.0 + 4.2) (*allow 4.2 ± 0.2*) …… C1
= 10.3 N s (allow 10 N s) …… A1 [2]

(ii) force = $\Delta p / \Delta t$ or $m\Delta v / \Delta t$ …… C1
= 10.3 / 3.5 / 0.08
= 2.9 N …… A1 [2]

(d) **(** 2.9 N …….. A1 [1]

(ii) g = weight / mass …… C1
= 2.9 / 0.78
= 3.7 m s^{-2} …….. A1 [2]

3 **(a)** uses a tangent (anywhere), not a single point C1
draws tangent at correct position B1
acceleration = 1.7 ± 0.1 A2 [4]
(*outside 1.6 → 1.8 but within 1.5 → 1.9, allow 1 mark*)

(b) **(i)** because slope (of tangent of graph) is decreasing M1
acceleration is decreasing A1 [2]
(ii) e.g. air resistance increases (with speed)
(angle of) slope of ramp decreases B1 [1]

(c) **(i)** scatter of points about line B1 [1]
(ii) intercept / line does not go through origin B1 [1]

4	(a)	(i)	use of tangent at time $t = 0$	B1	
			acceleration= 42 ± 4 cm s2	A1	**[2]**
		(ii)	use of area of loop	B1	
			distance = 0.031 ± 0.001 m	B2	**[3]**
			allow 1 mark if 0.031 ± 0.002 m)		
	(b)	(i)	$F=ma$	C1	
			= 0.93 x 0.42 {allow e.c.f. from (a)(i)}		
			= 0.39 N	A1	**[2]**
		(ii)	force reduces to zero in first 0.3 s	B1	
			then increases again in next 0.3 s	M1	
			in the opposite direction	A1	**[3]**

5 **(a)** constant gradient/straight line **B1 [1]**

(b) (1.2 s **A1**

(ii) 4.4 s **A1 [2]**

(c) *either* use of area under line *or h* = average speed x time **C1**

h = ½ x (4.4 – 1.2) x 32 **C1**

= 51.2 m **A1 [3]**

(allow 2/3 marks for determination of *h* = 44 m or *h* =58.4 m
allow 1/3 marks for answer 7.2 m)

(d) $\Delta p = m\Delta v$ OR $p = mv$ **C1**

= 0.25 x (28 + 12) **C1**

= 10 N s **A1 [3]**

(answer 4 N s scores 2/3 marks)

(e) (i) total/sum momentum before = total/sum momentum after **B1**

in any closed system **B1 [2]**

(ii) *either* the system is the ball and Earth **B1**

momentum of Earth changes by same amount **B1**

but in the opposite direction **B1**

or Ball is not an isolated system/there is a force on the ball (B1)

<u>Gravitational</u> force acts on the ball (B1)

causes change in momentum/law does not apply here (B1) **[3]**

(if explains in terms of air resistance, allow first mark only)

6 (a) $v^2 = u^2 + 2as$ OR use of triangle etc C1
$4.0^2 = 2 \times 9.8 \times s$ OR $s = ½ \times 4.0 \times 0.4$
s = 0.82 m OR 0.80 m ..... A1 [2]

(b) $¥ = m(v - u)$ OR $p = mv$ C1
speeds are 4.2 m s^{-1} and 3.6 m s^{-1} C1
$¥$ = 0.045 (4.2 + 3.6) (2/4 only if speeds not added) C1
= 0.35 N s ..... A1 [4]
(1 mark only if only one speed used)

(c) any time between 0.14 s and 0.17 s C1
force = $\Delta p / \Delta t$ = 0.35 / 0.14 (allow e.c.f.)
= 2.5 N ..... A1 [2]