Prepared by Leong Yee Pak

3 Kinematics

3.1 Linear Motion
Section A

****1 June 02 P1 Q6** D Body attains terminal velocity due to air resistance
***2 June 02 P1 Q7** A Uniformly increasing speed = constant acceleration
****3 June 02 P1 Q8** D S is the distance of stone on the way up to the top. R is the distance from the top to the sea level.
****4 Nov 02 P1 Q9** D Form equation for motion of ball from time zero to time t_1. Form equation for motion of ball from time zero to time t_2. Solve the 2 equations.
****5 Nov 02 P1 Q10** D Same as **June 02 P1 Q6**
****6 June 03 June Q8** C
****7 Nov 06 Q9** D Distance = area under the graph v-t
****8 Nov 03 P1 Q7** B Speed = gradient of graph s-t
***9 Nov 03 P1 Q8** A Air resistance increases until it is equal to the weight of body. Hence net force decreases until it is zero, and acceleration decreases until it is zero.
****10 June 04 P1 Q7** B Apply $v^2 = u^2 + 2as$. $20^2 = 10^2 + 2\ a\ 100$
***11 June 04 P1Q8** D Same as **Nov 03 P1 Q8**
****12 Nov 04 P1 Q8** C
****13 Nov 04 P2 Q9** D Use $s = ut + ½ at^2$ to find time. Then use $v = u + at$ to find v
***14 June 05 P1 Q6** D Acceleration = gradient of graph v-t
****15 June 05 P1 Q7** B Force of gravity is the same on the way up, at the top and on the way down. Its direction is always vertically downwards. Hence acceleration of free fall is always downwards, and its magnitude is constant. Take upward direction as positive, Hence acceleration of free fall is negative.
****16 June 05 P1 Q8** D Distance = area under the graph v-t
***17 Nov 05 P1 Q6** C Same as **Nov 03 P1 Q8**
****18 Nov 05 P1 Q7** D same as **Nov 02 P1 Q9**
****19 June 06 P1 Q7** A Apply $s = ut + ½ at^2$. Since $u = 0$, $h = 0 + ½ gt^2$
****20 June 06 P1 Q8** C Same as **June 05 P1 Q8**
*****21 June 06 P1 Q9** D At the lowest point, the mass stops momentarily.
***22 Nov 06 P1 Q7** 21 C For constant acceleration, the increase of velocity with time is constant. Hence the graph of v against t is a straight line with positive gradient
****23 Nov 06 P1 Q8** D Distance travelled by X = area of triangle = ½ x 5 x 5 = 12.5 m. Distance travelled by Y = area of trapezium = ½ (2 + 3) x 5 = 12.5 m
***24 June 07 P1 Q6** D
*****25 June 07 P1 Q8** A Find the time for the stone to travel a distance of 30 m. Find the time for the stone to travel a distance of 40 m. Find the difference in time.
****26 Nov 07 P1 Q7** C
***27 Nov 07 P1 Q8** D
*****28 Nov 07 P1 Q9** B Area of the graph between 0 and 3 second = distance of stone moving upwards to the top. Area of the graph between 3 and 5 seconds = distance travelled by stone in moving from the top down. Find the difference.
****29 Nov 07 P1Q12** A At terminal velocity, velocity remains constant. Hence momentum remains constant.

****30 June 08 P1 Q6** C
****31 June 08 P1 Q7** C

***32 Jun 08 P1 Q8** C
***33 June 08 P1 Q9** A
****34 June 08 P1 Q10** D Assume both masses move to the right after collision. Total momentum is conserved $50 - 30 = V_x + V_y$. Relative speed of approach = relative speed of separation.. $50 + 30 = V_y - V_x$
****35 June 08 P1 Q11** A Apply F = ma. $20 \times 10^3 - F_R = 750 \times 2.0$
****36 June 08 P1 Q12** A At terminal speed, Weight = viscous drag + upthrust
****37 Nov 08 P1 Q6** D Distance = area of trapezium
****38 Nov 08 P1 Q8** A uniform increase in speed per unit time = constant acceleration
***39 June 09 P1 Q5** D
*****40 June 09 P1 Q6** C

3.1 Linear Motion
Section B

1 June 02 P2 Q4 **(a)** Conservation of energy: loss in g.p.e. = gain in k.e. $mgh - 0 = ½ mv^2 - 0$
OR apply $v^2 = u^2 + 2as$. $v^2 = 0 + 2 \times 9.81 \times 1.6$. v = 5.60 ms-1
(b) (i) Gain in g.p.e. = loss in k.e. = 0.9 of initial g.p.e.
Hence mgh = 0.9 mg 1.6. h = 0.9 x 1.6 = 1.44
(ii) loss in k.e. = gain in g.p.e. Hence $½ mv^2 - 0 = mgh$.
$½ v^2 = 9.81 \times 1.44$. v = 5.32 ms^{-1}
(c) momentum change = mv – mu = $73 \times 10^{-3} \times [5.32 - (-5.60)]$
(d) There is a change of momentum. Momentum is not conserved because an external force acts on the body by the steel plate during impact.

2 Nov 02 P2 Q3
Q3(a) Use distance = area under the graph v-t
(b) Change in momentum = final momentum – initial momentum
= 45×10^{-3} [-3.6 – (-4.2)]
(c) average force = momentum change / time taken. Time taken = 0.57 – 0.43

3 June 03 P2 Q1
Q1 (a)(i) displacement = distance moved in a specific direction from a fixed point
(ii) Car travelled and returned to the original position.
(b) (i) 1. apply $v^2 = u^2 + 2as$. $28^2 = 0 + 2 a 450$\
2. apply $s = \frac{u+v}{2}t$
3. gain in k.e. = $½ mv^2 - 0$
4. gain in g.p.e. = mgh – 0
(ii) Useful output = (gain in k.e. + gain in g.p.e.) / time
(iii) Work done against air resistance

4 Nov 03 P2 Q1

1 (a) (i) acceleration (allow a definition of acceleration) B1

(ii) the velocity is decreasing or force/acceleration is in negative direction – accept 'body is decelerating'/'slowing down' .... B1 [2]

(b) (i) e.g. separation of dots becomes constant/does not continue to increase (must make a reference to the diagram) B1

(ii)1 distance = 132 cm B1

(ii)2 at constant speed, distance travelled in 0.1 s = 25 cm (allow ± 1 cm) C1

distance = 132 + (4 x 25)

= 232 cm .... A1 [4]

(c) $s = ut + ½at^2$

1.6 = ½ x 9.8 x t^2 (allow g = 10 m s^{-2} C1

t = 0.57 s C1

hence 6 photographs ('bald' answer scores 2 marks only) .... A1 [3]

5 June 04 P2 Q3

3	(a)	(i)	scatter of points (about the line)	B1	
		(ii)	intercept (on t^2 axis)	B1	[2]
			(note that answers must relate to the graph)		
	(b)	(i)	gradient = $\Delta y / \Delta x$ = (100 – 0)/(10.0 – 0.6)	C1	
			gradient = 10.6 (cm s^{-2}) *(allow ±0.2)*	A1	[2]
			(Read points to within $\pm\frac{1}{2}$ square. Allow 1 mark for 11 cm s^{-2} *i.e. 2 sig fig, -1. Answer of 10 scores 0/2 marks)*		
		(ii)	$s = ut + \frac{1}{2}at^2$	B1	
			so acceleration = 2 x gradient	B1	
			acceleration = 0.212 m s^{-2}	B1	[3]
			Total		**[7]**

6 Nov 04 P2 Q3 (a) graph of v-t is a straight line. Hence its gradient is constant

(b) (i) At maximum height, v = 0. From graph t = 1.2 s

(ii) t = 4.4 s

(b) maximum height above base = height fallen from maximum height to the base = larger area of triangle below the time axis =

(c) Momentum change = final momentum – initial momentum (take note of direction: for opposite direction, momentum is negative)

(d) (i) Total momentum of a closed system remains constant if there is no external force acting on it.

(ii) refer to Q4 (d)

7 Nov 06 P2 Q2

2	(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]

8 Nov 07 P2 Q2

2	**(a)** 3.5 T	B1	[1]
	(b) **(i)** distance = average speed × time (however expressed)	C1	
	= 14 m	A1	[2]
	(ii) distance = 5.6 × (T – 5) (*or* 3.5T – 14)	A1	[1]
	(c) 3.5T = 14 + 5.6(T – 5)	C1	
	T = 6.7 s	A1	[2]
	(d) **(i)** acceleration = (5.6 / 5 =) 1.12 m s^{-2}	C1	
	force = *ma*	C1	
	= 75 N	A1	[3]
	(ii) power = (force × speed =) {75 + 23} × 4.5	C1	
	= 440 W	A1	[2]
	(*allow 1/2 for 234 W, 0/2 for 338 W or 104 W*)		

9 Nov 08 P2 Q2

2	**(a)** **(i)** $v^2 = 2as$		
	$v^2 = 2 \times 0.85 \times 9.8 \times 12.8$	C1	
	v = 14.6 m s^{-1}	A1	[2]
	(ii) time = 29.3 / 14.6	C1	
	= 2.0 s	A1	[2]
	(*any acceleration scores 0 marks; allow 1 s.f.*)		
	(b) *either* 60 km h^{-1} = 16.7 m s^{-1}		
	or 14.6 m s^{-1} = 53 km h^{-1}		
	or 22.1 m s^{-1} = 79.6 km h^{-1}	M1	
	so driving within speed limit	A1	
	but reaction time is too long / too slow	B1	[3]

3.2 Non-linear Motion
Section A

****1 Nov 02 P1 Q8** A No horizontal force acting. Hence no horizontal acceleration
****2 June 03 P1 Q7** C Horizontal direction: motion with constant velocity.
Vertical direction: apply v = u + at
*****3 June 04 P1 Q9** D Horizontal direction: 10 = vt.

ertical direction: $1.25 = 0 + ½ \times 9.81\ t^2$. Solve for t and v
***4 Nov 04 P1 Q7** D Only 1 force is acting. That is, the weight which acts vertically downwards. The same force acts at T as well as at Q. Hence acceleration is the same.
***5 June 05 P1 Q9** A Same as **Nov 02 P1 Q8**
****6 Nov 05 P1 Q11** A Same as **Nov 04 P1 Q7**
****7 Nov 06 Q9** C Same as **June 03 P1 Q7**
****8 June 08 P1 Q6** C
****9 Nov 08 P1 Q7** A

3.2 Non-linear Motion
Section B

1 Nov 05 P2 Q3

3	**(a)**	<u>change</u> in velocity/time (taken)			B1	**[1]**
	(b)	velocity is a vector/velocity has magnitude & direction			B1	
		direction changing so must be accelerating			B1	**[2]**
	(c)	*either* 6.1 × cos35 = 4.99 N	*or* scale shown	B1		
		so no resultant vertical force	triangle of correct shape	B1		
		6.1 sin35 = 3.5 N	resultant = 3.5 ± 0.2 N	B1		
		horizontally	horizontal ± 3°	B1		**[4]**
		allow answer based on centripetal force:				
		resultant is centripetal force (which is horizontal)			(B1)	
		resultant is horizontal component of tension			(B1)	
		6.1 sin35 = 3.5 N			(B1)	
		horizontally			(B1)	