

GCE Examinations
Advanced Subsidiary / Advanced Level

Mechanics
Module M1

Paper E

MARKING GUIDE

This guide is intended to be as helpful as possible to teachers by providing concise solutions and indicating how marks should be awarded. There are obviously alternative methods that would also gain full marks.

Method marks (M) are awarded for knowing and using a method.

Accuracy marks (A) can only be awarded when a correct method has been used.

(B) marks are independent of method marks.



Written by Shaun Armstrong & Chris Huffer

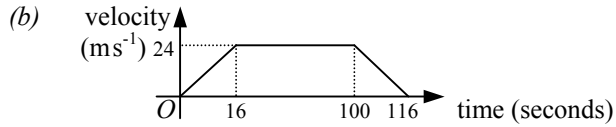
© *Solomon Press*

These sheets may be copied for use solely by the purchaser's institute.

M1 Paper E – Marking Guide

1. $-5 + 2q + 1 = 0 \Rightarrow q = 2$ M1 A1
 $4p + 3 + 1 = 0 \Rightarrow p = -1$ M1 A1 (4)

2. (a) $t = \frac{116-84}{2} = 16$ seconds M1 A1

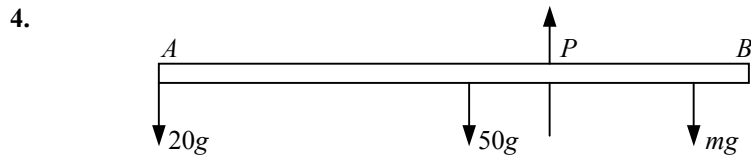


B2

- (c) dist. = area under graph = $\frac{1}{2}(116 + 84)(24) = 2400$ m M2 A1 (7)

3. (a) resolve \rightarrow : $6 + X\cos 45 - 18\sin 30 = 0$ M2
 $6 + X\frac{\sqrt{2}}{2} - 9 = 0$ so $X = 3\sqrt{2}$ N M1 A1

- (b) resolve \uparrow : $Y + X\cos 45 + 18\cos 30 - 20 = 0$ M2
 $Y + (3\sqrt{2})\frac{\sqrt{2}}{2} + 18\frac{\sqrt{3}}{2} - 20 = 0$ M1
 $Y = 20 - 9\sqrt{3} - 3 = 17 - 9\sqrt{3}$ A1 (8)



- (a) moments about P : $20g(3) + 50g(0.5) - mg(1.7) = 0$ M2
 $1.7m = 60 + 25 = 85 \Rightarrow m = 50$ kg M1 A1

- (b) moments about P : $(20 + x)g(3) + 50g(0.5) - 50g(2) = 0$ M1
 $100 - 25 - 3(20 + x) = 0 \Rightarrow x = 5$ kg M1 A1

- (c) weight acts at the middle of the plank B1 (8)

5. (a) particle B1

- (b) cons. of mom. (dirⁿ of bat +ve) $1.5(15\mathbf{i}) + 0.3(-30\mathbf{i}) = 1.5(5\mathbf{i}) + 0.3(v\mathbf{i})$ M1 A1
 $6\mathbf{i} = 0.3v\mathbf{i} \Rightarrow v = 20$ M1 A1

- (c) $Ft = \Delta\text{mom.}$ i.e. $F(0.2) = 0.3(20\mathbf{i} - 30\mathbf{i})$ M2
 $F = 75\mathbf{i}$ so F has magnitude 75 N A1 (8)

6.	(a) $u = 10.5, v = 0, a = -g$ use $v^2 = u^2 + 2as$ $0 = 110.25 - 19.6s \Rightarrow s = 5.625$ ball starts from 0.6 m, so it reaches 6.225 m above ground level	M1 M1 A1 A1	
	(b) $s = 2 - 0.6 = 1.4, u = 10.5, a = -g$, use $s = ut + \frac{1}{2}at^2$ $10.5t - 4.9t^2 > 1.4$ i.e. $7t^2 - 15t + 2 < 0$ $(7t - 1)(t - 2) < 0$ leading to $\frac{1}{7} < t < 2$ ball is above ground for $\frac{13}{7}$ (≈ 1.86) seconds	M1 M1 A1 M1 A1 A1	(10)
<hr/>			
7.	(a) let acc^n be $k(2\mathbf{i} + \mathbf{j})$ so magnitude is $k\sqrt{(2^2 + 1^2)} = k\sqrt{5}$ $\Rightarrow k = 3$, so $\mathbf{a} = 6\mathbf{i} + 3\mathbf{j}$ using $\mathbf{v} = \mathbf{u} + \mathbf{a}t$, $\mathbf{v} = (1 - 5\mathbf{j}) + t(6\mathbf{i} + 3\mathbf{j})$ so $\mathbf{v} = [(6t + 1)\mathbf{i} + (3t - 5)\mathbf{j}] \text{ ms}^{-1}$	M2 A1 M1 M1 A1	
	(b) $\text{speed}^2 = (6t + 1)^2 + (3t - 5)^2 = 45t^2 - 18t + 26$ by calculus or completing square, $t = \frac{1}{5}$	M1 A1 M2 A1	(11)
<hr/>			
8.	(a) for A, resolve \uparrow : $R - 5Mg = 0 \Rightarrow R = 5Mg$ $F = \mu R$ so $F = \frac{3}{20}(5Mg) = \frac{3}{4}Mg$ for A, resolve \rightarrow $T - F = 5Ma$, $T - \frac{3}{4}Mg = 5Ma$ (1) for B, resolve \downarrow $3Mg - T = 3Ma$ (2) (1) + (2) gives $\frac{9}{4}Mg = 8Ma \Rightarrow a = \frac{9}{32}g \text{ ms}^{-2}$	M1 M1 A1 M1 A1 M1 M1 A1	
	(b) $s = 1, u = 0, a = \frac{9}{32}g$, use $v^2 = u^2 + 2as$ $v^2 = \frac{9}{16}g \Rightarrow v = \frac{3}{4}\sqrt{g}$ ($\approx 2.35 \text{ ms}^{-1}$)	M1 M2 A1	
	(c) after string goes slack, $-F = 5Ma$ so $a = \frac{-\frac{3}{4}Mg}{5M} = \frac{-3}{20}g$ $u^2 = \frac{9}{16}g, v = 0, a = \frac{-3}{20}g$ use $v^2 = u^2 + 2as$ $0 = \frac{9}{16}g - \frac{3}{10}gs \Rightarrow s = 1.875 \text{ m} + 1 \text{ m before } B \text{ hit the ground}$ $= 2.875$ so A is 0.125 m from pulley when it comes to rest	M2 A1 M1 M1 A1 A1	(19)
<hr/>			
		Total	(75)

Performance Record – M1 Paper E

Question no.	1	2	3	4	5	6	7	8	Total
Topic(s)	i, j, forces	velocity – time graph	statics	moments	cons. of mom.	uniform accel.	i, j, accel.	connected bodies	
Marks	4	7	8	8	8	10	11	19	75
Student									