

**MARK SCHEME for the October/November 2010 question paper  
for the guidance of teachers**

**9709 MATHEMATICS**

**9709/61**

Paper 6, maximum raw mark 50

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

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Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2010	9709	61

## Mark Scheme Notes

Marks are of the following three types:

**M** Method mark, awarded for a valid method applied to the problem. Method marks are not lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

**A** Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated method mark is earned (or implied).

**B** Mark for a correct result or statement independent of method marks.

- When a part of a question has two or more "method" steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly when there are several B marks allocated. The notation DM or DB (or dep\*) is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.
- The symbol  $\surd$  implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only. A and B marks are not given for fortuitously "correct" answers or results obtained from incorrect working.
- Note: B2 or A2 means that the candidate can earn 2 or 0.  
B2/1/0 means that the candidate can earn anything from 0 to 2.

The marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.
- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking  $g$  equal to 9.8 or 9.81 instead of 10.

<b>Page 3</b>	<b>Mark Scheme: Teachers' version</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>GCE A LEVEL – October/November 2010</b>	<b>9709</b>	<b>61</b>

The following abbreviations may be used in a mark scheme or used on the scripts:

AEF	Any Equivalent Form (of answer is equally acceptable)
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
BOD	Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)
CAO	Correct Answer Only (emphasising that no "follow through" from a previous error is allowed)
CWO	Correct Working Only – often written by a 'fortuitous' answer
ISW	Ignore Subsequent Working
MR	Misread
PA	Premature Approximation (resulting in basically correct work that is insufficiently accurate)
SOS	See Other Solution (the candidate makes a better attempt at the same question)
SR	Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)

### **Penalties**

MR –1	A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become "follow through $\sqrt{}$ " marks. MR is not applied when the candidate misreads his own figures – this is regarded as an error in accuracy. An MR–2 penalty may be applied in particular cases if agreed at the coordination meeting.
PA –1	This is deducted from A or B marks in the case of premature approximation. The PA –1 penalty is usually discussed at the meeting.

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2010	9709	61

<p><b>1</b> mean = 18.2 sd = <math>\sqrt{876/50}</math> = 4.19</p>	<p>B1 M1 A1 [3]</p>	<p>Correct unsimplified expression seen Correct answer</p>
<p><b>2</b> mean = <math>200 \times 2/15</math> (= 26.67) (80/3) variance = <math>200 \times 2/15 \times 13/15</math> (= 23.11)(208/9)  P(21 &lt; X &lt; 35) = <math display="block">P\left(\frac{21.5 - 26.67}{\sqrt{23.11}} &lt; z &lt; \frac{34.5 - 26.67}{\sqrt{23.11}}\right)</math>  = P(-1.075 &lt; z &lt; 1.629) = 0.8589 + 0.9483 - 1 = 0.807</p>	<p>B1 M1 M1 M1 A1 [5]</p>	<p>mean and variance correct  standardising, <math>\pm</math>, with or without cc, must have sqrts continuity corrections 20.5 or 21.5, 34.5 or 35.5  <math>\Phi_1 + \Phi_2 - 1</math> answer rounding to 0.807</p>
<p><b>3 (i)</b> P(X &gt; 20) = P(z &gt; -6.4/3.7) = P(z &gt; -1.730) = 0.9582  Number of students = 335 or 336</p>	<p>M1 A1 A1ft [3]</p>	<p>Standardising no cc no sq rt Prob rounding to 0.958 Correct answer ft their prob, must be integer</p>
<p><b>(ii)</b> P(very slow) = 0.05  P(0, 1, 2) = <math>(0.95)^8 + {}^8C_1(0.05)^1(0.95)^7 + {}^8C_2(0.05)^2(0.95)^6</math>  = 0.6634 + 0.2793 + 0.0515 = 0.994</p>	<p>B1 M1 M1 A1 [4]</p>	<p>0.05 or 0.95 seen  Binomial term with <math>{}^8C_r p^r (1-p)^{8-r}</math> seen any p Correct expression for P(0, 1, 2), p close to 0.05 Answer rounding to 0.994</p>
<p><b>4 (i)</b> <math>3 = 2x / 10</math> <math>x = 15</math> height = freq / class width  = <math>x / 20 = 0.75</math> cm</p>	<p>M1 A1 M1 A1 [4]</p>	<p>Attempt at using freq density = freq / cw Correct answer Attempt at using fd = freq / cw with different cw from above Correct answer</p>
<p><b>(ii)</b> mean wt = <math>(5.5 \times 30 + 15.5 \times 60 + 23 \times 45 + 28 \times 75 + 40.5 \times 60 + 60.5 \times 15) / 285</math>  = 26.6 grams</p>	<p>M1 M1 A1 [3]</p>	<p>Using freqs or frequency ratios and mid-points, attempt not ucb, not cw (can do it without x) Correct unsimplified answer can have fr ratios Correct answer</p>

<p><b>5 (i)</b></p> <table border="1"> <thead> <tr> <th></th> <th><i>A</i></th> <th><i>B</i></th> <th><i>C</i></th> <th><i>D</i></th> </tr> </thead> <tbody> <tr> <td>Rick</td> <td>1/3</td> <td>2/9</td> <td>2/9</td> <td>2/9</td> </tr> <tr> <td>Brenda</td> <td>1/4</td> <td>1/4</td> <td>1/4</td> <td>1/4</td> </tr> <tr> <td>Ali</td> <td>2/35</td> <td>2/35</td> <td>2/7</td> <td>3/5</td> </tr> </tbody> </table> <p> <math>P(\text{Rick } B, \text{ Brenda } B, \text{ Ali not } B)</math>  <math>+ P(\text{Rick } B, \text{ Brenda not } B, \text{ Ali } B)</math>  <math>+ P(\text{Rick not } B, \text{ Brenda } B, \text{ Ali } B)</math>  <math>= 11/210 + 2/210 + 1/90 = 23/315</math> </p> <p> <math>P(\text{Rick } B, \text{ Brenda } B, \text{ Ali } B) = 1/315</math> </p> <p>           Prob(at least 2 at entrance <i>B</i>)  <math>= 24/315 (8/105) (0.0762)</math> </p>		<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	Rick	1/3	2/9	2/9	2/9	Brenda	1/4	1/4	1/4	1/4	Ali	2/35	2/35	2/7	3/5	M1	Obtaining probs of each person for each entrance (can be implied or awarded in part (i) or part (ii))
		<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>																	
	Rick	1/3	2/9	2/9	2/9																	
	Brenda	1/4	1/4	1/4	1/4																	
Ali	2/35	2/35	2/7	3/5																		
M1	Considering options 2 meet 1 doesn't, must have at least two 3-factor terms																					
M1	Adding option all three meet, must be added to a prob																					
A1 [4]	Correct answer																					
<p><b>(ii)</b> <math>P(\text{entrance } A) = 1/210 (0.00476)</math>  <math>P(\text{entrance } B) = 1/315 (0.00317)</math>  <math>P(\text{entrance } C) = 1/63 (0.0159)</math>  <math>P(\text{entrance } D) = 1/30 (0.0333)</math></p> <p> <math>P(\text{same entrance}) = 2/35 (0.0571)</math> </p>	M1	Obtaining a three-factor prob for any entrance																				
	M1	Adding four three-factor probabilities for the 4 entrances																				
	A1	Two or more correct entrance probabilities																				
	A1 [4]	Correct answer																				
<p><b>6 (i)</b> <math>{}^6P_4 = 6!/2!</math>  <math>= 360</math></p> <p><b>(ii)</b> <math>4!/2! = 12</math></p> <p><b>(iii)</b> <math>4! \times {}^6C_4 = 360</math> or <math>{}^6P_4</math></p> <p><b>(iv)</b> e.g. 2R 1B 1G, 1R 2B 1G, 1R 1B 2G  <math>= \frac{4!}{2!} + \frac{4!}{2!} + \frac{4!}{2!} = 36</math>, mult by <math>{}^6C_3</math>            total = 720</p> <p><b>(v)</b> <math>2R 2B = 4!/2!2! = 6</math>            Mult by <math>{}^6C_2</math>, total = 90            Answer = <math>360 + 720 + 90 = 1170</math></p>	B1 [1]	Correct answer																				
	B1 [1]	Correct answer																				
	B1 [1]	Correct final answer																				
	M1	4!/2! seen																				
	M1	Mult by ${}^6C_3$																				
A1 [3]	Correct answer																					
M1	Considering 2 colours e.g. RRBB or RBRR or...																					
A1	mult by ${}^6C_2$																					
A1ft [3]	Ft their (iii) + (iv) + (v)																					

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2010	9709	61

<p>7 (i) If <math>y = P(\text{odd number})</math> then <math>P(\text{even number}) = 2y</math>  <math>3y + 6y = 1</math> so <math>y = 1/9</math> oe. OR prob = <math>1/3</math></p>	<p>M1 A1 [2]</p>	<p>2P(Odd) shown = P(Even) and summed to 1 correct answer accept either</p>
<p>(ii) Score of 8 means throwing a 6 6 is even so <math>P(8) = 2/9</math> (AG)</p>	<p>B1 B1 [2]</p>	<p>legit justification of use of <math>2/9</math></p>
<p>(iii) <math>\text{Var}(X) = (48 + 36 + 98 + 128 + 100)/9 - (58/9)^2</math>  <math>= 4.02</math> accept <math>4.025</math> (<math>326/81</math>)</p>	<p>M1 A1 [2]</p>	<p>Correct method no dividings, <math>6.44</math> squared sub numerically Correct answer</p>
<p>(iv) <math>P(\text{score } 6,10) + P(\text{score } 10,6) + P(\text{score } 8,8)</math>  <math>= 1/81 + 1/81 + 4/81</math>  <math>= 6/81</math> (<math>2/27</math>) (<math>0.0741</math>)</p>	<p>M1 A1 [2]</p>	<p>Summing two different 2-factor probabilities Correct answer</p>
<p>(v) <math>P(\text{score } 6, 10) = 1/81</math>  <math>P(1^{\text{st}} \text{ score } 6 \text{ given total } 16)</math>  <math>= (1/81) \div (6/81)</math>  <math>= 1/6</math></p>	<p>B1 M1 A1 [3]</p>	<p><math>1/81</math> seen in numerator Dividing by their (iv) Correct answer</p>