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GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2012 series

9700 BIOLOGY

9700/51 Paper 5 (Planning, Analysis and Evaluation), maximum raw mark 30

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.

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;	separates marking points
/	alternatives answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or extra guidance)
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants excepted)
max	indicates the maximum number of marks that can be given

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Question	Expected answer	Extra guidance	Mark
1 (a) (i)	*independent* : (sodium) nitrate concentration *dependent* : number of (leaf-like) thalli (of flowering plant);	**A** allow leaves ignore growth unqualified	[1]
(ii)	2 of: (initial) number / three thalli / three plants ; time (of investigation) / ten days ; source of plants ; temperature ; activity / interference by microorganisms (in the water) ;	*If more than two given, mark the first 2.* **A** allow thalli without any buds e.g. from the same pond / same environment allow room temperature ignore sterile	[max 1]
(iii)	2 x 2 of: 1 same volume of the sodium nitrate solution in each dish; ref. to a suitable method of measuring ; 2 light (intensity / wave length / duration) ; ref. to a method of giving standard intensity / wave length / time of illumination per day ; 3 aeration / oxygen concentration (of water) ; ref. to a method of supplying (sterile) air / oxygen ; 4 nitrate concentration ; add fresh nitrate solution daily / regularly ; 5 pH ; ref. to using a buffer ; 6 carbon dioxide (concentration) ; method of supplying carbon dioxide ; 7 size / diameter / surface area of starting thalli ; ref. to suitable method of measuring	*Read the whole. Identifying a variable is free standing, method linked to the variable. Ignore plant species, bleach.* 1 e.g. measuring cylinder, (graduated) pipette, burette, accept graduated beaker / graduated conical flask 2 e.g. lamp at fixed distance / same wattage bulb / filter of known wave length for duration, allow 12 hours / 48 hours of light OR exposure to daylight hours 3 e.g. pump / oxygen cylinder / bubbler / diffuser allow bubbling of air / oxygen 4 **A** stated time interval up to 48 hours / 2 days 5 **R** phosphate buffer 6 e.g. (sodium) hydrogen carbonate / sodium bicarbonate / CO_2 gas from a cylinder 7 e.g. ruler / grid /callipers ; ignore mass	[max 4]

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(b) (i)	4 of: *Allow marks on a labelled diagram.* 1 ref. to using (sterile) pond water to make dilutions ; 2 ref. to sterile conditions to make dilutions; 3 ref. to serial dilution ; 4 ref. to 50 : 50 dilution (each time); 5 detail in order to make all of the solutions ; 6 ref. to stirring / swirling solutions (between dilutions);	*If a method other than serial dilution is used then marks can be allowed for correct proportions of nitrate solution and pond water* 2 **A** descriptions of sterile technique 3 **A** formula $c_1/m_1.v_1 = c_2/m_2.v_2$ 4 **A** adding different proportions of nitrate solution and (pond) water / example of using formula 5 correct proportions given 1:1, 1: 3, 1:7, 1:15 if volumes are quoted, units are needed	[max 4]
(ii)	(a dish) containing <u>sterilised pond water</u> only (with same volume of water added as the sodium nitrate solution);		[1]
(c) (i)	shows the spread of data from the mean ; indicates / measures the reliability of the data ;	*Can allow both marks in (ii) if only 1 mark awarded in part (i)* **A** descriptions e.g. large deviation indicates low reliability. **A** figures from the table if any qualification of reliability given, then it must have both parts (large **and** idea of not very reliable , or small **and** idea of reliable)	
(ii)	*idea of:* (that over time) there are a larger the number of thalli / plants; *idea of:* (the longer the time for growth) the greater the difference between the individual replicates or samples ;	ignore difficulty on counting. **R** mean number of thalli. idea that there will be different growth rates so that individual replicates / samples will show grow greater variation.	[max 3]

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(d)	3 of: 1 increase in concentration (of nitrate) causes increase in the number of thalli / growth compared to control / AW ; 2 for concentrations up to 1000 mg dm^{-3} increase in number of thalli / growth increases (proportional to nitrate concentration) ; 3 above 1000 / 2000 mg dm^{-3} the rate of increase in number of thalli / growth is slower ; 4 optimum nitrate concentration is between 500 – 2000 mg dm^{-3}; 5 with time the standard deviations overlap / there is no difference in the effect of nitrate for the control / 250 mg dm^{-3} / 500 mg dm^{-3}	*Ignore references to individual data. Answers that have no reference to nitrogen concentration figures: max 1 for the idea that the growth rate increases and then decreases.* 1 *idea that* for any increase in nitrogen will increase number or growth in comparison to added nitrogen / control 3 *idea that* the rate of increase in thalli starts to decrease (above 1000 / 2000 mg dm^{-3}) Allow: 6 increase in nitrate allows more growth as more protein / DNA / chlorophyll can be synthesised; 7 high levels of nitrate reduce / inhibit growth or decrease the <u>water potential</u> of the solution or causes the plants to lose water;	[max 3]
(e)	*idea of:* using concentrations with smaller intervals within the range 500 - 2000 mg dm^{-3};	**A** if repeat the whole range with smaller intervals **A** answers in a table with values shown	[1]
(f)	graph axes with phosphate (concentration) / time on *x*-axis and thalli / growth on *y*-axis ; line(s) showing correlation between thalli number and phosphate concentration / time ; or starts high and then falls ;	units not needed **A** a line that increases, levels off and then decreases at high concentration **R** a line that start at 0 if number is on the *y*-axis if more than 1 line drawn they should be labelled: with time if phosphate is the *x*-axis with phosphate (concentration) if time is the *x*-axis	[2]
		Total:	**[20]**

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2 (a)	2 of: ref. using a counting grid / haemocytometer; ref. to counting cells in sample of known volume; ref. to using a microscope and suitable magnification; ref. to multiplication of the cell count to find the actual / original number of cells ;	**A** ref. to systematic counting method max. volume $1cm^3$ min x 400 / high magnification **A** high power **R** electron microscope Ignore resolution	[max 2]
(b)	number of stained / living cells counted in a sample; divide by total number of cells counted (in same sample) and multiply by 100;	**A** the idea of a viable count **A** both marks for a complete formula number of living / stained cells x 100; total number of cells **A** original cells for total cells	[2]
(c) (i)	idea of : there is no significant difference in the number of cells (between the two culture systems) ;		[1]
(ii)	38;	**A** as a formula (20-1) + (20-1) / 40 -2 if use (n-1) + (n-1) must state the value of n Ignore ref. to 'reject the null hypothesis'	[1]
(iii)	the difference in the cell number is significant / not due to chance (at 0.05 but not at 0.01);	ignore qualifications of significance	[1]
(d)	3 of: 1 correct ref. to population size; 2 any correct ref. to figures (from population size); 3 correct ref. to cell survival; 4 glucose / nutrient supply more consistent / not limiting; 5 lactic acid increase not high enough to become toxic / reduce pH;	*Assume that answers refer to the perfusion system* 1 e.g. greater number of cells in the culture / rate of cell increase greater / cell division faster ; 2 e.g. max. in batch 2.2 million, perfusion 32.1million 3 e.g. perfusion is always higher than batch / batch falls to 80%, perfusion stays close 100% allow any pair of figures from table 2.1 5 idea that lactic acid is not inhibiting growth rate	[max 3]
		Total:	**[10]**

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9700/52 Paper 5 (Planning, Analysis and Evaluation), maximum raw mark 30

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Question	Expected answer	Extra guidance	Mark
1 (a) (i)	*independent* : (sodium) nitrate concentration *dependent* : number of (leaf-like) thalli (of flowering plant);	**A** allow leaves ignore growth unqualified	[1]
(ii)	2 of: (initial) number / three thalli / three plants ; time (of investigation) / ten days ; source of plants ; temperature ; activity / interference by microorganisms (in the water) ;	*If more than two given, mark the first 2.* **A** allow thalli without any buds e.g. from the same pond / same environment allow room temperature ignore sterile	[max 1]
(iii)	2 x 2 of: 1 same volume of the sodium nitrate solution in each dish; ref. to a suitable method of measuring ; 2 light (intensity / wave length / duration) ; ref. to a method of giving standard intensity / wave length / time of illumination per day ; 3 aeration / oxygen concentration (of water) ; ref. to a method of supplying (sterile) air / oxygen ; 4 nitrate concentration ; add fresh nitrate solution daily / regularly ; 5 pH ; ref. to using a buffer ; 6 carbon dioxide (concentration) ; method of supplying carbon dioxide ; 7 size / diameter / surface area of starting thalli ; ref. to suitable method of measuring	*Read the whole. Identifying a variable is free standing, method linked to the variable. Ignore plant species, bleach.* 1 e.g. measuring cylinder, (graduated) pipette, burette, accept graduated beaker / graduated conical flask 2 e.g. lamp at fixed distance / same wattage bulb / filter of known wave length for duration, allow 12 hours / 48 hours of light OR exposure to daylight hours 3 e.g. pump / oxygen cylinder / bubbler / diffuser allow bubbling of air / oxygen 4 **A** stated time interval up to 48 hours / 2 days 5 **R** phosphate buffer 6 e.g. (sodium) hydrogen carbonate / sodium bicarbonate / CO_2 gas from a cylinder 7 e.g. ruler / grid /callipers ; ignore mass	[max 4]

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(b) (i)	4 of: *Allow marks on a labelled diagram.* 1 ref. to using (sterile) pond water to make dilutions ; 2 ref. to sterile conditions to make dilutions; 3 ref. to serial dilution ; 4 ref. to 50 : 50 dilution (each time); 5 detail in order to make all of the solutions ; 6 ref. to stirring / swirling solutions (between dilutions);	*If a method other than serial dilution is used then marks can be allowed for correct proportions of nitrate solution and pond water* 2 **A** descriptions of sterile technique 3 **A** formula $c_1/m_1.v_1 = c_2/m_2.v_2$ 4 **A** adding different proportions of nitrate solution and (pond) water / example of using formula 5 correct proportions given 1:1, 1: 3, 1:7, 1:15 if volumes are quoted, units are needed	[max 4]
(ii)	(a dish) containing <u>sterilised pond water</u> only (with same volume of water added as the sodium nitrate solution);		[1]
(c) (i)	shows the spread of data from the mean ; indicates / measures the reliability of the data ;	*Can allow both marks in (ii) if only 1 mark awarded in part (i)* **A** descriptions e.g. large deviation indicates low reliability. **A** figures from the table if any qualification of reliability given, then it must have both parts (large **and** idea of not very reliable , or small **and** idea of reliable)	
(ii)	*idea of:* (that over time) there are a larger the number of thalli / plants; *idea of:* (the longer the time for growth) the greater the difference between the individual replicates or samples ;	ignore difficulty on counting. **R** mean number of thalli. idea that there will be different growth rates so that individual replicates / samples will show grow greater variation.	[max 3]

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(d)	3 of: 1 increase in concentration (of nitrate) causes increase in the number of thalli / growth compared to control / AW ; 2 for concentrations up to 1000 mg dm^{-3} increase in number of thalli / growth increases (proportional to nitrate concentration) ; 3 above 1000 / 2000 mg dm^{-3} the rate of increase in number of thalli / growth is slower ; 4 optimum nitrate concentration is between 500 – 2000 mg dm^{-3}; 5 with time the standard deviations overlap / there is no difference in the effect of nitrate for the control / 250 mg dm^{-3} / 500 mg dm^{-3}	*Ignore references to individual data. Answers that have no reference to nitrogen concentration figures: max 1 for the idea that the growth rate increases and then decreases.* 1 *idea that* for any increase in nitrogen will increase number or growth in comparison to added nitrogen / control 3 *idea that* the rate of increase in thalli starts to decrease (above 1000 / 2000 mg dm^{-3}) Allow: 6 increase in nitrate allows more growth as more protein / DNA / chlorophyll can be synthesised; 7 high levels of nitrate reduce / inhibit growth or decrease the <u>water potential</u> of the solution or causes the plants to lose water;	[max 3]
(e)	*idea of:* using concentrations with smaller intervals within the range 500 - 2000 mg dm^{-3};	**A** if repeat the whole range with smaller intervals **A** answers in a table with values shown	[1]
(f)	graph axes with phosphate (concentration) / time on *x*-axis and thalli / growth on *y*-axis ; line(s) showing correlation between thalli number and phosphate concentration / time ; or starts high and then falls ;	units not needed **A** a line that increases, levels off and then decreases at high concentration **R** a line that start at 0 if number is on the *y*-axis if more than 1 line drawn they should be labelled: with time if phosphate is the *x*-axis with phosphate (concentration) if time is the *x*-axis	[2]
		Total:	**[20]**

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2 (a)	2 of: ref. using a counting grid / haemocytometer; ref. to counting cells in sample of known volume; ref. to using a microscope and suitable magnification; ref. to multiplication of the cell count to find the actual / original number of cells ;	**A** ref. to systematic counting method max. volume $1cm^3$ min x 400 / high magnification **A** high power **R** electron microscope Ignore resolution	[max 2]
(b)	number of stained / living cells counted in a sample; divide by total number of cells counted (in same sample) and multiply by 100;	**A** the idea of a viable count **A** both marks for a complete formula number of living / stained cells x 100; total number of cells **A** original cells for total cells	[2]
(c) (i)	idea of : there is no significant difference in the number of cells (between the two culture systems) ;		[1]
(ii)	38;	**A** as a formula (20-1) + (20-1) / 40 -2 if use (n-1) + (n-1) must state the value of n Ignore ref. to 'reject the null hypothesis'	[1]
(iii)	the difference in the cell number is significant / not due to chance (at 0.05 but not at 0.01);	ignore qualifications of significance	[1]
(d)	3 of: 1 correct ref. to population size; 2 any correct ref. to figures (from population size); 3 correct ref. to cell survival; 4 glucose / nutrient supply more consistent / not limiting; 5 lactic acid increase not high enough to become toxic / reduce pH;	*Assume that answers refer to the perfusion system* 1 e.g. greater number of cells in the culture / rate of cell increase greater / cell division faster ; 2 e.g. max. in batch 2.2 million, perfusion 32.1million 3 e.g. perfusion is always higher than batch / batch falls to 80%, perfusion stays close 100% allow any pair of figures from table 2.1 5 idea that lactic acid is not inhibiting growth rate	[max 3]
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AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants excepted)
max	indicates the maximum number of marks that can be given
efc	error carried forward
mp	marking point (with relevant number)
ora	or reverse argument

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Question	Expected answer	Extra guidance	Mark
1 (a) (i)	*independent* : (sodium) nitrate concentration *dependent* : number of, cells / *Chlorella* **;**	**R** amount / frequency for number **Ignore** growth / population growth	[1]
(ii)	2 of: 1 source of, *Chlorella* culture / *Chlorella* / culture ; 2 time (of investigation) / time (of sampling) / AW ; 3 volume of growth medium ; 4 volume of (*Chlorella*) culture (added to growth medium / in haemocytometer) ; 5 size of flask ;	*Mark first two suggestions* 1 **A** age. **A** species of *Chlorella* 2 AW = e.g. intervals, etc 3 or 4 **Ignore** amount / quantity **A** if volumes stated Accept: 6 **A** (room) temperature 7 **A** (sun)light	[max1]

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	2 × 2 of: 1 volume of (sodium) nitrate added to growth medium ; ref. to using a (graduated) pipette / burette / measuring cylinder ; 2 method of counting cells; descriptions of any method of systematic counting using haemocytometer ; 3 light (intensity / wave length / duration) ; ref. to a method of giving standard, intensity / wave length / time of illumination per day ; 4 temperature; ref. to a suitable method of maintaining temperature ; 5 pH ; buffer ; 6 aeration / oxygen (concentration of water) ; ref. to a method of supplying air / oxygen ; 7 carbon dioxide (concentration) ; method of supplying carbon dioxide ; 8 nitrate concentration in each culture should be kept constant; ref. to replacing / adding, new solution, daily / regularly; 9 *idea of* even density of *Chlorella* in culture added ; stir / swirl / agitate / AW, culture before adding ;	*Only give mps 3 or 4 if factors not mentioned in (a)(ii) Read the whole. Identifying a variable must be free standing, method must be linked to the variable* 1 **Ignore** amount **A** graduated, beaker / flask. **A** volumetric flask 3 e.g. lamp at fixed distance / same wattage bulb / filter of known wave length **A** stated fixed duration **A** fixed voltage for intensity 4 e.g. temperature controlled room / AW **A** thermostatically controlled water bath **A** incubator 5 **R** phosphate buffer / add H^+ /add OH^- 6 e.g. pump / oxygen cylinder / bubbler / diffuser /air lift **A** bubbling of air /oxygen 7 e.g. (sodium)<u>hydrogen</u> carbonate / CO_2 gas from a cylinder **A** bicarbonate **R** carbonate 8 **A** stated time interval up to 48 hours / 2 days 9 **R** ideas on same, mass / density	[max 4]

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Question	Expected answer	Extra guidance	Mark
(b) (i)	1 ref. to (weighing), 0.025 of molecular mass in g / 2.125 g ; 2 ref. to adding 1 dm^3 (deionised) water ; 3 ref. to using deionised / distilled water ; 4 ref. to adding different proportions of nitrate solution and water ; 5 ref. making suitable dilutions to give range of dilutions in Fig. 1.2; (allow in a table) 6 ref. to stirring / swirling / AW, solution ;	1 **A** if weigh 85 g and make 1 M solution then must dilute by factor of 0.025 or 25 × 10^{-3} **A** rounding of decimal places 3 **A** pure / sterile, water. 4 **A** formula $c_1 / m_1 . v_1 = c_2 / m_2 . v_2$ **Ignore** serial dilution 5 look for a description of measuring known volumes of 25 $mmoldm^{-3}$ and adding water to make a dilution. (4:1, 3:2, 2:3, 1:4 ratio for the sequence in Fig. 1.2). <u>All</u> must be correct 6 **A** mix, thoroughly / with a glass rod / AW **R** 'mix' unqualified	[max 4]
(ii)	(a flask containing) only growth medium and water or (a flask with) water added in place of (sodium) nitrate (solution);	*idea that* nitrate is being replaced by water	[1]
(c) (i)	1 find / calculate, means of cultures; 2 find the, difference / increase, between the new count and original count; 3 divide (the difference) by the original count and multiply by 100;	1 **A** average for mean 2 and 3 **A** as a formula. <u>(mean of) new sample – (mean of) original</u> × 100 (mean of) original subtraction must be correct way round if shown **A** original described in terms of the control 3 Apply **ecf**	[3]
(ii)	idea of: (easier) to make comparisons between different samples / different starting numbers;	**A** differences easier to see / cell numbers harder to compare	[1]

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(d)	3 of: 1 (for all concentrations of nitrate) the number of cells / *Chlorella* / population, increases compared to, control / 0 mmol dm^{-3} ; 2 for concentrations up to 15 / 20 mmol dm^{-3} number of cells / Chlorella / population, increases (proportional to nitrate concentration) ; 3 from 15 / 20 – 25 mmol dm^{-3} the rate of increase in, number of cells / Chlorella / population, is slower ; 4 optimum nitrate concentration is between 10 – 20 mmol dm^{-3} ; If no mention of figures for nitrate concentration **Allow Max 1** for a general statement giving idea that as nitrate increases the cell % increase increases up to a point above which the rate decreases.	*Ignore references to individual data* *Units not needed, if used must be correct. Wrong units – penalise once then ecf here and part (e)* mp 1,2,3 **A** in terms of growth 2 Look for the idea of an increase in numbers / AW with concentration (of nitrate) 3 Look for the idea that the increase in numbers / AW starts to decrease Can accept: **A** 5 increase in nitrate allows more growth as more, protein / DNA can be synthesised ; **A** 6 high levels of nitrate, reduce / inhibit growth **or** decrease the water potential of the solution **or** cause the cells to lose water ;	[max 3]
(e)	*idea of*: using, more concentrations / concentrations with smaller intervals, within the range 10– 20 mmol dm^{-3};	**A** if whole range used at smaller intervals **A** answers in a table / actual values quoted	[1]
(f)	*y*-axis: *Chlorella* / cells / population / growth / % increase, *x*-axis: phosphate (concentration) / time ; line shows a correlation between population increase and concentration **OR** population increase and then starting to plateau /decrease ;	units not needed **Do not allow** lines that start at 0 if raw numbers given on *y*-axis if more than one line drawn they should be labelled with days if phosphate is *x*-axis. if time is the *x*-axis at least 2 lines must be shown and labelled with appropriate phosphate concentrations	[2]
		Total:	**[21]**

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Question	Expected answer	Extra guidance	Mark
2 (a)	ref. to (obtaining) a suitable sample ; *idea of* using test strips to measure urea level with reference to colour change / AW ;	e.g. a dialysis fluid sample after use (by the patient); e.g. blood sample before and after dialysis / AW ; **A** urine sample before and after dialysis / AW *idea of* comparison to standard / change of colour related to urea level	[2]
(b) (i)	idea of: measures the reliability (of the estimate) of a mean ; the larger the standard error the less reliable ; ora	**A** how close a sample mean is to the, actual / population mean **R** 'spread from mean'	[2]
(ii)	the data is continuous / comparing <u>means</u>;	**A** normal distribution **A** not discrete	[1]
(iii)	*idea that* the, means / data (of the patients), before treatment /in test A, <u>do not</u> overlap with the means of test B / test C for, iron / haemoglobin;	**Ignore** comparisons between **B** and **C** **A** one correct comparison between **A** and **B** / **C** **A** no overlap between **A** and **C** for ferritin **A** only **A** and **B** for ferritin does overlap **A** most do not overlap between **A** and **B** / **C**	[1]

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(c) (i)	2 of: 1 haemoglobin / iron / ferritin / all, increase more, if given by injection / in treatment **C** ; ora 2 any comparative data quote which compares, provision by injection and mouth / treatments **C** and **B** ; 3 *idea of:* provision by injection increases, haemoglobin / iron, to within the normal range ; **ora**	*Can allow both marks in (ii) if only 1 mark awarded in part (i)* 1 only one needed but must be comparative 2 e.g. results with injected iron increase haemoglobin 40 (g dm^{-3})but only 10 (g dm^{-3}) by mouth / (30 g dm^{-3}) more in injected than by mouth **A** pairs of suitable raw figures e.g. for haemoglobin 100 (g dm^{-3}) v 130 (g dm^{-3}) **A** processed data e.g. % differences *units not needed but if given must be correct need to indicate to which substance the data refers*	
(ii)	2 of: 1 small sample size / 14 people ; 2 limited age range ; 3 gender bias / 10 men to 4 women ; 4 treatment with iron by mouth may influence results for injected iron;	*Ignore other suggestions and look for two acceptable ones* 2 **A** mean age 63 3 **A** more men / AW	[max 3]
		Total:	**[9]**

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