Homeostasis and Blood Glucose: AQA A Level Biology Exam Questions

15 questions · 36 marks · about 47 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · A level Paper 2 · June 2025 · Q02.1 · 1 mark

0 2 . 1 What term is used to describe the maintenance of a stable internal environment?

[1 mark]

Question 2 · A level Paper 2 · June 2025 · Q02.2 · 2 marks

0 2 . 2 A high blood glucose concentration can cause dehydration of body cells.

Explain why.

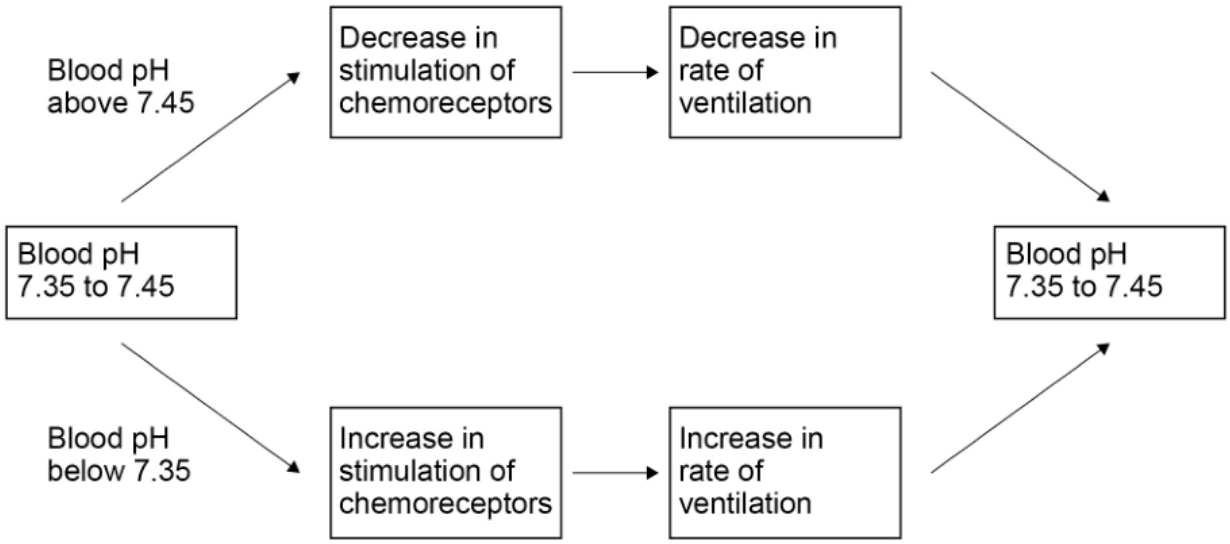
Do **not** refer to ADH or the role of the kidneys in your answer.

[2 marks]

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0 2 . 4 **Figure 1** shows one of the physiological systems involved in controlling blood pH.

Figure 1



Use the information in **Figure 1** to outline the principles of negative feedback.

[2 marks]

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Question 4 · A level Paper 2 · June 2025 · Q02.5 · 2 marks

0 2 . 5 Vigorous exercise causes a change in blood pH and in the rate of ventilation.

Use **Figure 1** to describe and explain these changes.

[2 marks]

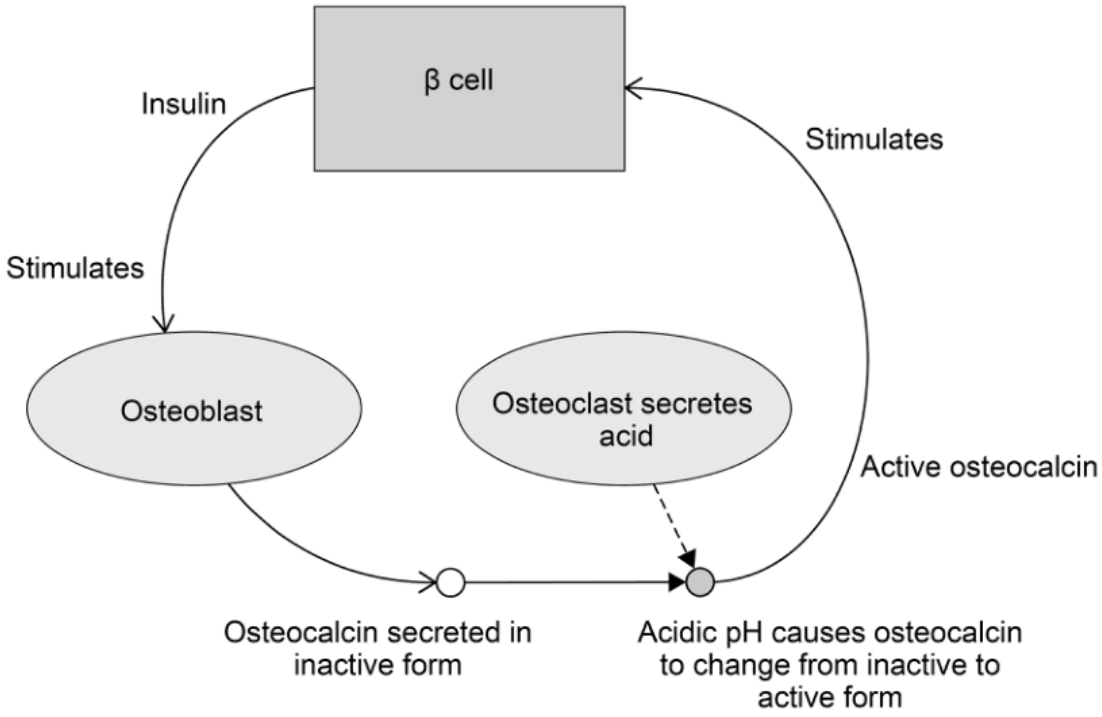
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0 1 Broken bones are repaired by cells called osteoclasts and osteoblasts.

Osteoblasts secrete a hormone called osteocalcin in an inactive form. Osteocalcin is a protein. The active form of osteocalcin binds to a receptor on beta (β) cells in the pancreas, stimulating them to release insulin. Osteoblasts have receptors for insulin.

Figure 1 shows how the production of osteocalcin by osteoblasts is controlled by positive feedback.

Figure 1



0 1 . 1 The secretion of osteocalcin (in an inactive form) by osteoblasts is controlled by positive feedback.

Use information from **Figure 1** to explain why this is positive feedback.

[2 marks]

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Question 6 · A level Paper 2 · June 2019 · Q05.1 · 2 marks

0 5 . 1 Describe the role of glucagon in gluconeogenesis.

Do **not** include in your answer details on the second messenger model of glucagon action.

[2 marks]

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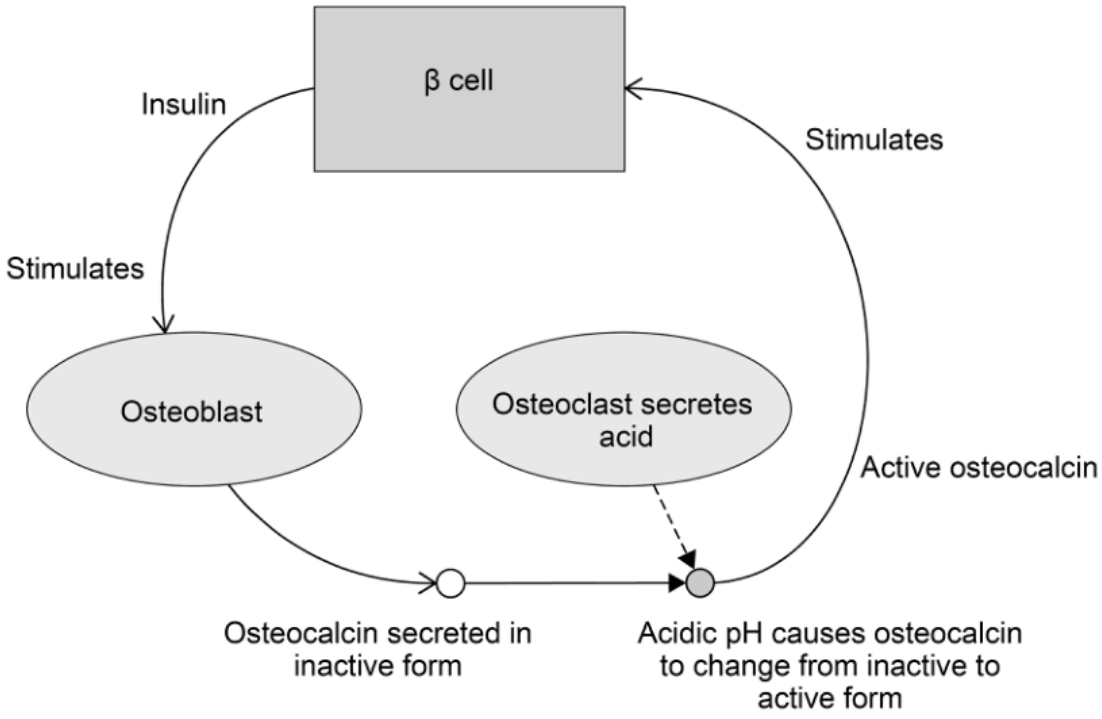
Question 7 · information from earlier in the question

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Figure 1



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Question 7 · A level Paper 3 · June 2018 · Q01.3 · 2 marks

0 1 . 3 Binding of insulin leads to an increase in the rate of respiration in cells such as osteoblasts.

Explain how.

[2 marks]

There are no questions on this page

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Question 8 · A level Paper 2 · June 2019 · Q05.3 · 2 marks

Metformin is a drug commonly used to treat type II diabetes. Metformin's ability to lower the blood glucose concentration involves a number of mechanisms including:

- increasing a cell's sensitivity to insulin
- inhibiting adenylate cyclase.

0 5 . 3 Explain how increasing a cell's sensitivity to insulin will lower the blood glucose concentration.

[2 marks]

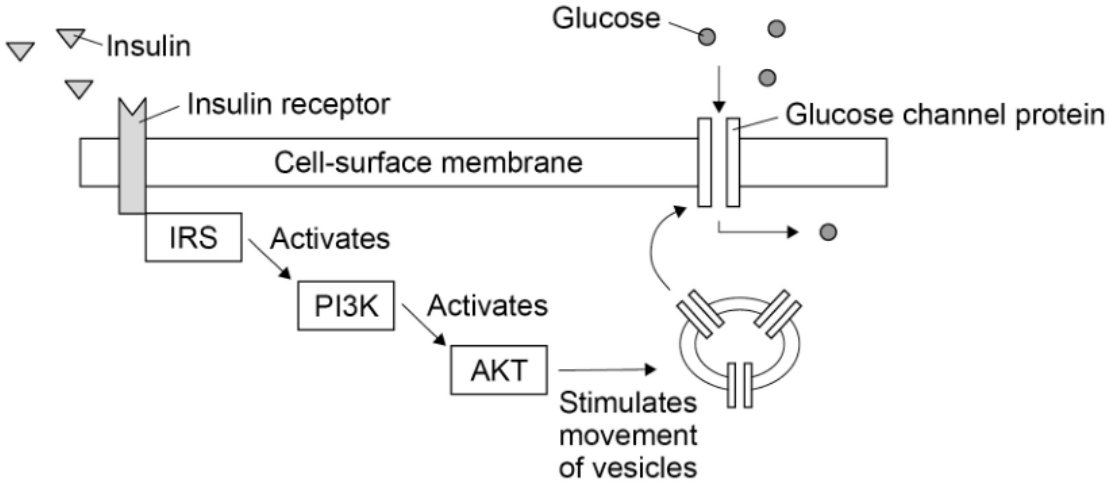
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Question 9 · A level Paper 2 · November 2021 · Q05.2 · 3 marks

Phosphoinositide 3-kinase (PI3K) is an enzyme in several metabolic processes.

Figure 5 shows the role of PI3K in the control of blood glucose concentration.

Figure 5



0 5 . 2 A decrease in the activity of PI3K can cause type II diabetes.

Use **Figure 5** to explain why.

[3 marks]

Question 10 · information from earlier in the question

Metformin is a drug commonly used to treat type II diabetes. Metformin's ability to lower the blood glucose concentration involves a number of mechanisms including:

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- inhibiting adenylate cyclase.

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Question 10 · A level Paper 2 · June 2019 · Q05.4 · 3 marks

0 5 . 4 Explain how inhibiting adenylate cyclase may help to lower the blood glucose concentration.

[3 marks]

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Question 11 · A level Paper 2 · June 2024 · Q09.1 · 2 marks

0 9 A person with diabetes is in diabetes remission if their blood glucose concentration is below the diabetes threshold concentration for at least 3 months. This diabetes remission is achieved without taking medication.

Scientists investigated whether a weight-loss programme would result in type II diabetes remission.

The scientists:

- used a computer-generated list to select 380 volunteers from a large number of health centres
- selected volunteers aged 25 to 60 years, each with less than 5 years duration of type II diabetes
- divided the volunteers in the ratio 1 : 1 between experimental group **P** and control group **Q**
- placed group **P** on a weight-loss programme for the 2-year duration of this investigation
- recorded loss of mass and percentage of volunteers in each group in type II diabetes remission after 2 years.

0 9 . 1 Give **two** reasons why a weight-loss programme could be used to treat type II diabetes but **not** type I diabetes.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

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Question 12 · information from earlier in the question

0 8 Scientists investigated the production of laboratory rats with the characteristics of type II diabetes. The scientists used the following method.

- They divided the rats into two groups, **A** and **B**, and fed them different diets for 2 weeks.
- They fed the rats in group **A** the normal diet containing 12% fat.
- They fed the rats in group **B** a high-fat diet containing 56% fat.
- After 2 weeks, they injected both groups of rats with 35 mg kg^{-1} of the drug streptozotocin (STZ) to induce diabetes.
- 1 week later, the scientists determined the mean body mass and mean blood glucose concentration for each group.

Table 3 shows the results.

Table 3

A value of ±2 × SD from the mean includes over 95% of the data.

Group	Mean body mass / g (±2 × SD)	Mean blood glucose concentration / mg dm^{-3} (±2 × SD)
A	221.07 (± 3.28)	129.41 (± 8.34)
B	233.34 (± 5.73)	385.02 (± 7.75)

Question 12 · A level Paper 2 · June 2022 · Q08.4 · 2 marks

0 8 . 4 The scientists repeated the investigation using much higher doses of STZ. This led to destruction of pancreatic cells. The scientists concluded that these rats would **not** be suitable for studying type II diabetes.

Give **two** reasons why the scientists made this conclusion.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

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Question 13 · A level Paper 2 · June 2022 · Q08.3 · 5 marks

0 8 . 3 The scientists concluded that group **B** rats could be used for studying type II diabetes in humans.

Use all the information and your knowledge of type II diabetes to evaluate this conclusion.

[5 marks]

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Question 14 · information from earlier in the question

0 9 A person with diabetes is in diabetes remission if their blood glucose concentration is below the diabetes threshold concentration for at least 3 months. This diabetes remission is achieved without taking medication.

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0 9 . 3 **Table 3** shows some of the scientists' results.

Table 3

	Group P	Group Q
Percentage achieving diabetes remission	42.1	4.7
Percentage achieving weight loss ≥15 kg	15.8	2.1
Percentage with weight loss ≥15 kg achieving diabetes remission	70.0	75.0
Percentage with weight gain achieving diabetes remission	1.9	1.9

Use the information provided to calculate the difference in number of volunteers between the two groups who achieved diabetes remission.

Show your working.

[2 marks]

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Question 14 · A level Paper 2 · June 2024 · Q09.4 · 4 marks

0 9 . 4 Use all the information to evaluate whether a weight-loss programme is an effective treatment for type II diabetes.

[4 marks]

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[2 marks]

Answer _____

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Mark schemes

Question 1 · A level Paper 2 · June 2025 · Q02.1 · 1 mark

02.1	Homeostasis;	1 (1 x AO1)	Accept homeostatic Accept homeostatis, homestasis homostasis and phonetic spellings of homeostasis

Question 2 · A level Paper 2 · June 2025 · Q02.2 · 2 marks

02.2	1. Water potential of blood decreases/low(ers) **OR** Water potential of blood becomes more negative; 2. (Body cells) lose water by <u>osmosis</u>;	2 (2 x AO2)	1. Accept increase in water potential gradient between blood and cells 1. Accept Ψ for 'water potential', but ignore WP 1. Accept Ψ of cells/ tissues higher than blood but not if context suggests due to increase of Ψ of cells 2. Accept water enters blood by osmosis Ignore any references to insulin, or to glucose entering cells

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Question 3 · A level Paper 2 · June 2025 · Q02.4 · 2 marks

02.4	1. Increase/decrease/change in pH is detected **OR** Increase/decrease/change in pH affects (stimulation of chemo)receptors **OR** Separate mechanisms/systems controls increase/decrease/change	2 (2 x AO2)
	OR Separate mechanisms/systems gives greater (degree of) control; 2. Returned/restored to norm/set point/original **OR** (pH) returned/restored to 7.35 - 7.45;	

2. Accept other terms for norm/set point/original e.g. optimum

2. Accept any pH value from pH 7.35 to 7.45

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Question 4 · A level Paper 2 · June 2025 · Q02.5 · 2 marks

02.5	1. (Increase in aerobic) respiration produces more carbon dioxide **OR** Increase in respiration produces (more) carbon dioxide **OR** Anaerobic respiration produces lactate; 2. Decrease in (blood) pH and (increased stimulation of) chemoreceptors increase (rate of) ventilation;	2 (2 x AO2)

1. The idea of 'more' carbon dioxide or more respiration must be conveyed

1. Accept lactic acid for lactate

1. Reject anaerobic respiration produces lactate and carbon dioxide

Ignore any references to heart rate

2. Accept increase in acidity/H^+ or gives pH value below 7.35 for decrease in pH

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Question 5 · A level Paper 3 · June 2018 · Q01.1 · 2 marks

01.1	(Insulin stimulates release of osteocalcin – no mark) 1. Osteocalcin causes **more** (release of) insulin; 2. (More) insulin causes **more** (inactive) osteocalcin (release);	2	1. and 2. Idea of **more** required but other words can be used 1. and 2. Ignore ref. to further 1. and 2. Ignore ref. to more B cells / osteoblasts stimulated

Question 6 · A level Paper 2 · June 2019 · Q05.1 · 2 marks

05.1	1. (Attaches to receptors on target cells and) activates/stimulates enzymes; 2. Glycerol/amino acids/fatty acids into glucose;	2	1. Reject 'produces enzymes'. 2. Reject 'glucagon converts' as context suggests enzyme action. 2. Ignore lipids/fats/proteins but reject glycogen. 2. Reject occurs in pancreas.

Question 7 · A level Paper 3 · June 2018 · Q01.3 · 2 marks

01.3	1. (Insulin) leads to more transport proteins / channel (proteins) / carrier (proteins) for glucose; 2. More glucose (for respiration / glycolysis) enters cell;	2	Idea of more required **once** to cover both mark points 1. Ignore references to opening channels 1. Accept co-transport / GLUT 1 or 4 protein 2. Ignore references to glycogen formation / fat metabolism / enzyme activation

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Question 8 · A level Paper 2 · June 2019 · Q05.3 · 2 marks

05.3	1. (More) insulin binds to receptors; 2. (Stimulates) uptake of glucose by channel/transport <u>proteins</u> **OR** Activates enzymes which convert glucose to glycogen;	2	2. Accept activates enzymes for glycogenesis. 2. Reject active transport. 2. Accept carrier proteins or GLUT 4 for channel proteins. 2. Accept insulin stimulates addition of channel proteins in membranes.

Question 9 · A level Paper 2 · November 2021 · Q05.2 · 3 marks

05.2	1. Less/no AKT activated; 2. Fewer/no vesicles move to membrane **OR** Fewer/no (channel) proteins in membrane; 3. Less/no glucose <u>diffuses</u> into cell (so high blood glucose);	3	2. Accept 'fuse with membrane'.

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05.4	1. Less/no ATP is converted to cyclic AMP/cAMP; 2. Less/no kinase is activated; 3. Less/no glycogen is converted to glucose **OR** Less/no glycogenolysis;	3

If no indication of less/no for any of the mark points award **max 2 marks**.

Accept all marks in context of adrenaline.

Ignore gluconeogenesis.

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09.1	1. Type I do not produce insulin **OR** Type II do produce insulin; 2. In type II receptors/cells less sensitive/ responsive to insulin **OR** In type II receptors/cells are insulin 'resistant'; 3. Weight **not** linked to type I diabetes **OR** Weight linked to type II diabetes;	2 (2 x AO2)

1. Accept 'Type I lack insulin' or is 'due to an immune response' or 'beta cells non-functional'.

1. Accept 'Type I do not produce enough insulin'.

2. Accept 'In Type II faulty/fewer receptors'.

3. Accept 'obesity' for 'weight'.

3. Accept 'diet' and 'exercise' for 'weight' (as weight-loss programme may involve these).

3. Ignore 'lifestyle'.

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08.4	1. (Type II) still produce/release insulin; 2. (Type II) cells/receptors less/not responsive/sensitive to insulin; 3. Pancreatic cells not destroyed (in type II diabetes); 4. Damage to pancreatic cells may affect processes/reactions (in the body);

2 max (2 x AO3)	1. Accept 'type 1 would not produce/release insulin' **or** this would cause type I diabetes. 2. Accept involves 'faulty receptors' or 'fewer receptors'. 3. Ignore pancreas is not destroyed.

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08.3	1. SDs do not overlap (for blood glucose concentration) **OR** SDs do not overlap (for mass); 2. So significant difference/increase (in blood glucose concentration) **OR** So significant difference/increase (in mass); 3.(Type II diabetes) causes high blood glucose (concentration); 4. Obesity/high body mass is a (risk) factor (in type II diabetes) **OR** High fat (diet) is a (risk) factor (in type II diabetes); 5. (Investigation) done on rats (not humans); 6. (Only shows) results after short-time period **OR** Long-term effects not known;	5 max (5 x AO3)

2. Accept 'difference/increase is not due to chance' for significant difference/increase.

Ignore reference to stats test.

3. Accept 'associated/linked/have' for causes.

6. Accept 1, 2 or 3 weeks.

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09.4	**Max 3 marks from mark points 5 to 9.** 1. Percentage/number in remission **and** percentage/number with weight loss is higher for group P; 2. High percentage with weight loss (≥15 kg) in both groups achieved remission; 3. Some with weight gain achieved remission; 4. Less than 50% in group P achieved remission; 5.Only shows results for volunteers with less than 5 years of diabetes; 6. No results for those **over** 60 years (of age) **OR** No results for those **under** 25 years of age; 7. No statistical test to see if significant <u>difference</u> (in results); 8. (Only shows remission) not cure **OR** Remission not (necessarily) long term; 9. Mass/weight (of volunteers) at beginning not known;	4 max (4 x AO3)

1 Relates to first two rows of data.

2. Relates to third row of data.

1. and 2. Accept numerical values/% for 'high(er)'.

3. Relates to fourth row of data.

3. Accept '1.9%' for some.

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Question 15 · A level Paper 2 · June 2024 · Q09.3 · 2 marks

09.3	Correct answer of 71 = **2 marks**;; Answer of 142 = **1 mark** **OR** 80 **OR** 9 in working **= 1 mark** **OR** 79.99 **OR** 8.93 in working = **1 mark;**	2 (2 x AO2)	Accept for **two marks**, an answer that rounds up or down to 71. Accept for **one mark**, an answer that rounds up or down to 142.

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