Voronoi Diagrams: exam practice

10 questions · 30 marks · worked solutions and markschemes

Name _____ Date _____ Score / 30

- Answer every question before you look at the solutions. They start after the last question, with the marks for each line: M for method, A for accuracy, R for reasoning.
- Online, with more practice: ibmathrevision.com/hlai/voronoi-diagrams-exam-practice

1. **2 marks · Paper 1 style · calculator allowed**

Sites are at $A(1, 1)$, $B(5, 2)$ and $C(3, 6)$. A point is at $(4, 4)$.

Find which site is nearest. **[2]**

2. **2 marks · Paper 1 style · calculator allowed**

Three libraries are at $L_1(0, 0)$, $L_2(6, 0)$ and $L_3(2, 5)$ (km).

A reader is at $(3, 2)$. Find the nearest library. **[2]**

3. **3 marks · Paper 1 style · calculator allowed**

Two phone masts are at $A(2, 3)$ and $B(6, 7)$.

Find the equation of the perpendicular bisector of AB. **[3]**

4. **3 marks · Paper 1 style · calculator allowed**

The perpendicular bisector of $P(1, k)$ and $Q(5, 3)$ passes through $(3, 4)$.

Find k, given $k \neq 3$. **[3]**

5. **3 marks · Paper 2 style · calculator allowed**

A new shop is to be built as far as possible from existing shops at $A(0, 0)$, $B(10, 0)$ and $C(0, 4)$, inside triangle ABC.

Find the best location and the distance to each shop. **[3]**

6. **3 marks · Paper 1 style · calculator allowed**

In a Voronoi diagram, the edge between the cells of sites $S(2, 6)$ and $T(8, 2)$ is part of a line.

Find the equation of that line in the form $ax + by = c$. **[3]**

7. **3 marks · Paper 2 style · calculator allowed**

Two hospitals are at $H_1(-2, 4)$ and $H_2(6, 0)$ (km).

Find the boundary line between their cells and the point where it meets the x-axis. **[3]**

8. **3 marks · Paper 1 style · calculator allowed**

A town has three bus depots at $(0, 0)$, $(10, 0)$ and $(5, 10)$ (km). The town wants a fourth depot at the point inside the triangle furthest from all three.

Find the coordinates of this point. **[3]**

9. **4 marks · Paper 2 style · calculator allowed**

Sites are at $A(0, 0)$, $B(12, 0)$ and $C(2, 8)$. The Voronoi cells meet at a vertex V.

Find the coordinates of V and its distance from each site. **[4]**

10. **4 marks · Paper 2 style · calculator allowed**

Sites $A(0, 0)$, $B(6, 0)$ and $C(6, 4)$ are given.

Find the Voronoi vertex and show that it lies on AC. **[4]**

Answers and worked solutions

Question 1 — 2 marks

Answer: B and C, equally squared distances 18, 5, 5 **M1**

B and C are equally near, so $(4, 4)$ lies on the edge between their cells **A1**

Question 2 — 2 marks

Answer: L_3

distances $\sqrt{13}$, $\sqrt{13}$, $\sqrt{10}$ **M1**

L_3 **A1**

Question 3 — 3 marks

Answer: $y = -x + 9$

midpoint $(4, 5)$ **A1**

gradient -1 **A1**

$y = -x + 9$ **A1**

Question 4 — 3 marks

Answer: 5

$(3-1)^2 + (4-k)^2 = (3-5)^2 + (4-3)^2$ **M1**

$(4-k)^2 = 1$ **A1**

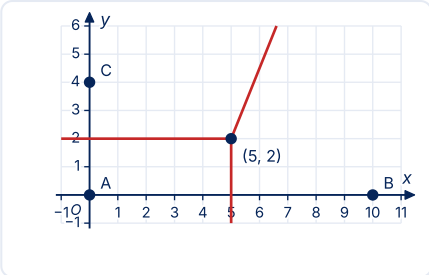
$k = 5$ **A1**

Question 5 — 3 marks

Answer: $(5, 2)$; 5.39

equidistant point: $x = 5$, $y = 2$ $M1$**A1**

$\sqrt{29} = 5.39$ **A1**



New shop at (5, 2)

Question 6 — 3 marks

Answer: $3x - 2y = 7$

midpoint $(5, 4)$ **A1**

gradient $\frac{3}{2}$ **A1**

$3x - 2y = 7$ **A1**

Question 7 — 3 marks

Answer: $y = 2x - 2$; $(1, 0)$

midpoint $(2, 2)$, gradient 2 **A1**

$y = 2x - 2$ **A1**

$(1, 0)$ **A1**

Question 8 — 3 marks

Answer: $(5,\ 3.75)$

bisector of first two: $x = 5$ **A1**

$(5-0)^2 + y^2 = (10-y)^2$ **M1**

$(5,\ 3.75)$ **A1**

Question 9 — 4 marks

Answer: $(6,\ 2.75)$; 6.60

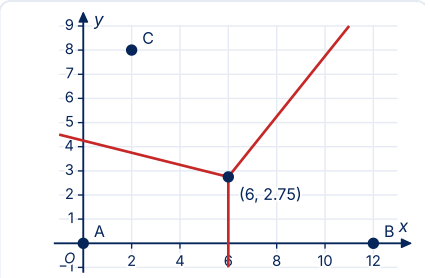
bisector of AB: $x = 6$ **A1**

bisector of AC:

$y - 4 = -\frac{1}{4}(x - 1)$ **A1**

$V(6,\ 2.75)$ **A1**

6.60 **A1**



Vertex (6, 2.75), 6.60 from each site

Question 10 — 4 marks

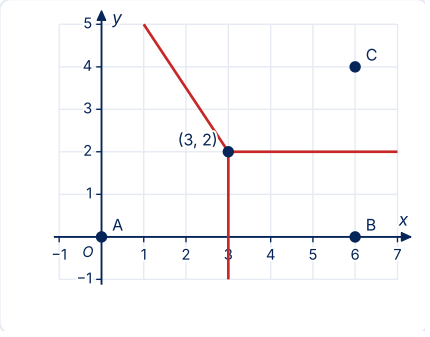
Answer: $(3, 2)$, the midpoint of AC

bisector of AB: $x = 3$ **A1**

bisector of BC: $y = 2$ **A1**

$V(3, 2)$ **A1**

midpoint of AC is $(3, 2)$ **R1**



Vertex (3, 2) lies on AC

Every solution is also on ibmathrevision.com/hlai/voronoi-diagrams-exam-practice
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