1.

	$\underline{\text{LIST 5}}$		$\underline{\text{List 6}}$		$\underline{\text{List 7}}$
	ACT		ACT		ACT
	NSW		NSW		NSW
	QLD		QLD		NT
$\xrightarrow[\text{1 comp}]{}$	TAS	$\xrightarrow[\text{3 comps}]{}$	SA	$\xrightarrow[\text{5 comps}]{}$	QLD
	$\underline{\text{VIC}}$		TAS		SA
	SA		$\underline{\text{VIC}}$		TAS
	NT		NT		$\underline{\text{VIC}}$
	WA		WA		WA

2.

$\underline{\text{LIST}\,1}$		$\underline{\text{LIST}\,2}$		$\underline{\text{LIST}\,3}$		$\underline{\text{LIST}\,4}$	$\vdots$		$\underline{\text{LIST}\,n-1}$		$\underline{\text{LIST}\,n}$
$\underline{\boldsymbol{n}}$		$n-1$		$n-2$		$n-3$	$\vdots$		2		1
$n-1$	$\xrightarrow[\text{1 comp}]{}$	$\underline{\boldsymbol{n}}$	$\xrightarrow[\text{2 comps}]{}$	$n-1$	$\xrightarrow[\text{3 comps}]{}$	$n-2$	$\vdots$	$\xrightarrow[n-2]{}$	3	$\xrightarrow[n-1]{}$	2
$n-2$		$n-2$		$\underline{\boldsymbol{n}}$		$n-1$	$\vdots$	comps	4	comps	3
$n-3$		$n-3$		$n-3$		$\underline{\boldsymbol{n}}$	$\vdots$		5		4
$n-4$		$n-4$		$n-4$		$n-4$	$\vdots$		$\vdots$		$\vdots$
$\vdots$		$\vdots$		$\vdots$		$\vdots$	$\vdots$		$\underline{\boldsymbol{n}}$		$n-1$
1		1		1		1	$\vdots$		1		$\underline{\boldsymbol{n}}$

3. (a) $I(4) = 1 + 2 + 3$. **(b)** $I(5) = 1 + 2 + 3 + 4$.

4. (a) As 1 more element is sorted at each pass, the process will terminate with LIST n. Since for each $i \in \{1,\ 2, \cdots, n\}$ LIST i adds $i - 1$ comparisons we have

$$I(n) = 1 + 2 + 3 + \cdots + (n - 1)$$

(b) $2I(n) = (n - 1)n$, so $I(n) = \frac{n(n-1)}{2} = \frac{1}{2}n^2 - \frac{1}{2}n$.

5. $I(n) \in \boldsymbol{O}(n^2)$ if there exist positive numbers c and M such that

$$|I(n)| \leqslant cn^2 \quad \text{for} \quad n \geqslant M.$$

6. Note that for $n \geqslant 1$, $\frac{n(n-1)}{2} \geqslant 0$ so that $|I(n)| = I(n) = \frac{1}{2}n^2 - \frac{1}{2}n \leqslant \frac{1}{2}n^2$.
Choosing $c = \frac{1}{2}$ and $M = 1$, we have; $|I(n)| \leqslant cn^2$ for $n \geqslant M$,
so, $I(n) \in \boldsymbol{O}(n^2)$.

(Using the triangle inequality could result in values of $c = 1$ and $M = 1$.)

7. (a)

List 1		List 2		List 3
$\underline{1}$	$\xrightarrow[\text{1 comp}]{}$	1	$\xrightarrow[\text{1 comp}]{}$	1
2		$\underline{2}$		2
3		3		$\underline{3}$

(b) $J(3) = 1 + 1 = 2$

(c) $J(4) = 1 + 1 + 1 = 3$

(d) $J(n) = n - 1$. Hence, for any $n \in \mathbb{N}$, $|J(n)| = J(n) = n - 1 \leqslant n$ so (using $c = 1$ and $M = 1$) $J(n) \in \boldsymbol{O}(n)$.

8. (a) $123, 132, 213, 231, 312, 321.$

(b)

LIST 1	LIST 2	LIST 3	LIST 1	LIST 2	LIST 3
$\underline{1}$	1	1	$\underline{2}$	1	1
2	$\underline{2}$	2	1	$\underline{2}$	2
3	3	$\underline{3}$	3	3	$\underline{3}$

(c) 2 extra comparisons (one for each list)

(d)

LIST 1	LIST 2	LIST 3	LIST 1	LIST 2	LIST 3
$\underline{1}$	1	1	$\underline{3}$	1	1
3	$\underline{3}$	2	1	$\underline{3}$	2
2	2	$\underline{3}$	2	2	$\underline{3}$

This requires $4 = 2 \times 2$ extra comparisons (2 for each list)

(e)

LIST 1	LIST 2	LIST 3	LIST 1	LIST 2	LIST 3
$\underline{2}$	2	1	$\underline{3}$	2	1
3	$\underline{3}$	2	2	$\underline{3}$	2
1	1	$\underline{3}$	1	1	$\underline{3}$

This requires $4 = 2 \times 2$ extra comparisons (2 for each list).

(f) The lists ending with 3 require a total of $T_2 + 2$, those ending in 2 require a total of $T_2 + 4$ and those ending in 1 require a total of $T_2 + 4$, giving altogether $3T_2 + 2 + 4 + 4 = 3T_2 + 2(1 + 2 + 2)$.

9. We have to consider $n - 1$ different insertions, one to move from List 1 to List 2, one to move from List 2 to List 3 and so on. The fewest comparisons at each stage is 1, so the minimum total number is $(n-1) \times 1 = J(n)$. In moving from List i to List $i + 1$ the $(i + 1)$st element must be compared with some of the first i elements. The most comparisons required is i. Thus $I(n) = 1 + 2 + \cdots + (n - 1)$ gives the maximum number of comparisons needed.