4. This question is about the molecule twistane

(a) 120° − 109.5° = 10.5° **1**

Accept 10-11°

(b) -1-2-3-9-10-7- *or* -1-7-10-9-3-2-
-1-6-5-8-10-7- *or* -1-7-10-8-5-6-
-3-4-5-8-10-9- *or* -3-9-10-8-5-4- **1**

If a set of numbers does not start with the lowest number it must be marked incorrect. All three correct 1 mark. Two correct ½ mark. If four answers are written, maximum score is ½ if all correct answers are present. If five or more answers are written then zero marks. There is no credit for writing out the example in the question (-1-2-3-4-5-6-), but do not penalise them for writing this answer i.e. do not include in your count of the total number of answers.

(c) 2 **1**

(d) -1-2-3-10-9-6- *or* -1-6-9-10-3-2- **½**
-1-2-7-8-5-6- *or* 1-6-5-8-7-2- **½**
-3-4-5-6-9-10- *or* -3-10-9-6-5-4- **½**
-2-3-4-5-8-7- *or* -2-7-8-5-4-3- **½**

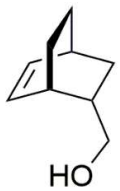
½ mark each. If they do not start with the lowest number then no marks for that answer. For each additional set of numbers over the first four, minus ½ mark per additional set down to zero. There is no credit for writing out the example in the question (-1-2-3-4-5-6-), but do not penalise them for writing this answer i.e. do not include in your count of the total number of answers.

(e) 3 **1**

(f) $C_{10}H_{16}$ **1**

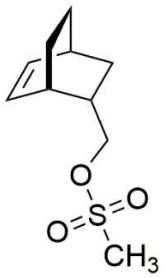
(g) *ECF can be awarded for Compounds **B**,**C**,**G**,**H** and Anion **I**$^-$ only. It cannot be awarded for the others because there is a known compound to work forward from or back from. An example where ECF could be used for Compound **B**,**C**,**G**,**H** or Anion **J**$^-$ is in the case of a small error such as an extra CH_2 in the chain. This should of course be penalised when it first occurs, but ECF can be awarded if the rest of the chemistry in subsequent intermediates is correct after the initial mistake.*

Compound A



One mark

Compound B



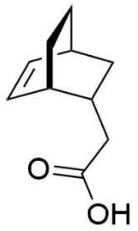
One mark

2

Compound C

One mark

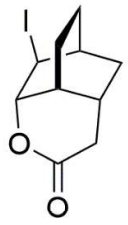
Compound D



One mark

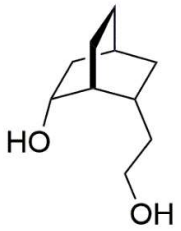
2

Compound E



One mark

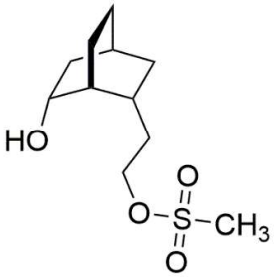
Compound F



One mark

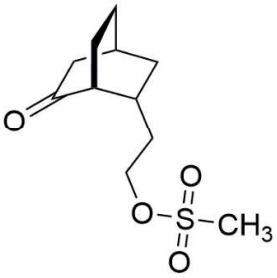
2

Compound G



One mark

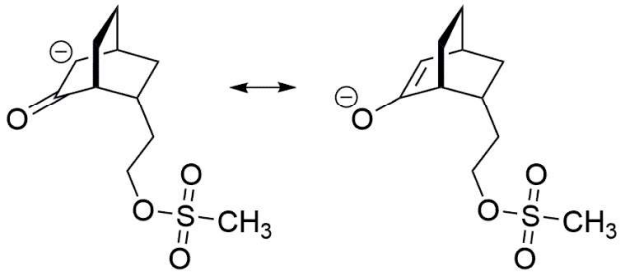
Compound H



One mark

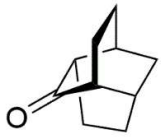
2

Anion J$^{\ominus}$



Only one of the two structures is needed to score two marks. No partial credit.

Compound K



One mark

3

(h) (i) How many planes of symmetry does twistane contain?

None ✓ **1**
One
Two or more

(ii) How many rotational axes of symmetry does twistane contain?

None
One
Two or more ✓ **1**

(iii) Is twistane superimposable on its mirror image?

Yes
No ✓ **1**

Question Total 21