

## Life cycle assessments (LCAs)

Q1. (2018)

A)

|      |                                                                             |                                                                                                                                                                             |   |                 |
|------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------|
| 06.7 | to assess the environmental impact (of the stages in the life of a product) | allow to see the effect / harm / damage on the Earth / environment / planet<br><br>ignore references to energy, pollution, carbon footprint, carbon dioxide, sustainability | 1 | AO1<br>5.10.2.1 |
|------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------|

B)

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     |                                 |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|---------------------------------|
| 06.8 | <b>Level 2:</b> Scientifically relevant features are identified; the ways in which they are similar / different is made clear and the magnitude of the similarity / difference noted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 3–4 | AO3                             |
|      | <b>Level 1:</b> Relevant features are identified and differences noted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1–2 | AO2                             |
|      | <b>No relevant content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0   |                                 |
|      | <b>Indicative content</b> <ul style="list-style-type: none"> <li>burning 10 000 bags produces 10 kg more of carbon dioxide than landfill</li> <li>putting 10 000 bags in landfill produces 0.02 kg more of solid residue than burning.</li> <li>putting 10 000 bags in landfill produces 50% more sulfur dioxide than burning</li> <li>burning 10 000 bags produces 25 kg of carbon dioxide, but landfill only produces 15 kg</li> <li>putting 10 000 bags in landfill produces 0.07 kg of solid residue but burning only produces 0.05 kg</li> <li>landfill produces less carbon dioxide than burning</li> <li>landfill produces more solid residue than burning</li> <li>burning produces less sulfur dioxide than landfill</li> </ul> |     | 5.10.2.1<br>5.10.2.2<br>5.9.2.2 |

Q2. (2019)

|      |                              |   |                |
|------|------------------------------|---|----------------|
| 02.2 | it has a giant structure     | 1 | AO1<br>5.2.2.6 |
|      | it has strong covalent bonds | 1 | 5.2.1.4        |

Q3. (2019)

A)

|      |                                                                                                                                                                                                                                                                         |            |                               |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------------------------|
| 02.3 | <pre> graph LR     Control[Control] --- Length[Length of concrete beam]     Control --- Mass[Mass of small stones in concrete]     Independent[Independent] --- Time[Time taken to add weights]     Independent --- Weight[Weight needed to break concrete beam] </pre> | 1<br><br>1 | AO3<br><br>AO2<br><br>5.8.1.2 |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------------------------|

B)

|      |                              |                                                                                                      |   |                  |
|------|------------------------------|------------------------------------------------------------------------------------------------------|---|------------------|
| 02.4 | all points correctly plotted | allow a tolerance of $\pm \frac{1}{2}$ a small square<br>allow 1 mark for 3 points correctly plotted | 2 | AO2.2<br>5.8.1.2 |
|      | line of best fit             | allow reasonable attempt at line of best fit using incorrectly plotted points                        | 1 |                  |

C)

|      |                        |                                                                                                                                                            |   |                |
|------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---|----------------|
| 02.5 | 1500 (g)               | allow range from 1400 (g) to 1600 (g)<br>allow ecf from graph drawn in <b>Figure 2</b>                                                                     | 1 | AO3<br>5.8.1.2 |
|      | highest point on graph | MP2 dependent on MP1<br>allow highest / largest / greatest / most weight needed to break concrete.<br>ignore numbers quoted from graph<br>ignore strongest | 1 |                |

D)

|      |                        |                                                                                                                                                     |   |                |
|------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---|----------------|
| 02.6 | take more measurements | allow indication of a greater range of values<br>or<br>allow indication of measurements at smaller intervals<br><br>ignore repeat the investigation | 1 | AO3<br>5.8.1.2 |
|------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---|----------------|

Q4. (2019)

|      |                                      |                                      |   |                |
|------|--------------------------------------|--------------------------------------|---|----------------|
| 05.3 | (617 + 258) – 648<br>or<br>875 – 648 | an answer of 227 (kg) scores 2 marks | 1 | AO2<br>5.3.1.1 |
|      | = 227 (kg)                           |                                      | 1 |                |

## Q5. (2019)

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |                                   |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----------------------------------|
| 07.2 | <b>Level 3:</b> A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 5–6 |                                   |
|      | <b>Level 2:</b> Some logically linked reasons are given. There may also be a simple judgement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 3–4 |                                   |
|      | <b>Level 1:</b> Relevant points are made. They are not logically linked.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1–2 |                                   |
|      | <b>No relevant content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0   |                                   |
|      | <b>Indicative content</b><br><br>Examples of relevant points might include: <ul style="list-style-type: none"> <li>car <b>C</b> produces the most CO<sub>2</sub> during manufacture</li> <li>car <b>A</b> produces the most CO<sub>2</sub> per km when driving</li> <li>car <b>C</b> produces the most CO<sub>2</sub> from manufacture and 40,000km when driving</li> <li>car <b>B</b> produces the most CO<sub>2</sub> from manufacture and 100,000km when driving</li> </ul> Examples of linked statements might include: <ul style="list-style-type: none"> <li>car <b>A</b> produces least CO<sub>2</sub> during manufacture, but most CO<sub>2</sub> per km</li> <li>car <b>C</b> produces most CO<sub>2</sub> during manufacture, but least CO<sub>2</sub> per km</li> <li>car <b>A</b> produces least CO<sub>2</sub> during manufacture, but car <b>C</b> produces the least CO<sub>2</sub> per km</li> </ul> Examples of judgements might include: <ul style="list-style-type: none"> <li>overall car <b>A</b> has the smallest carbon footprint as it has the smallest CO<sub>2</sub> production during manufacture, the smallest mass of CO<sub>2</sub> after 40,000km of driving and the smallest mass of CO<sub>2</sub> produced after 100,000km of driving.</li> <li>car <b>A</b> eventually (after 157,895km) will have the largest carbon footprint because the mass of carbon dioxide produced per km is highest.</li> </ul> |     | AO3<br>5.9.2.2<br>5.9.2.45.10.2.1 |

## Q6. (2020)

|      |                  |   |                |
|------|------------------|---|----------------|
| 02.3 | carbon footprint | 1 | AO1<br>5.9.2.4 |
|------|------------------|---|----------------|

## Q7. (2022)

|      |                                                                                                                                                                                                    |   |                 |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------|
| 05.9 | any <b>three</b> from:<br>(wood) <ul style="list-style-type: none"> <li>uses less energy</li> <li>uses less coal / oil</li> <li>produces less waste</li> <li>is renewable / sustainable</li> </ul> | 3 | AO3<br>5.10.2.1 |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------|

## Q8. (2024)

|      |                                                                                                                                                                    |   |                             |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------------------|
| 05.1 | (mass of aluminium recycled =)<br>$\frac{212 \times 68.0}{100}$                                                                                                    | 1 | AO2<br>5.10.2.1<br>5.10.2.2 |
|      | = 144 (million kg)<br><br>allow 144.16 (million kg)<br><br>allow for 1 mark only an answer of<br>144 000 000 (million kg)<br><b>or</b><br>144 160 000 (million kg) | 1 |                             |

## Q9. (2024)

|      |                                                        |                                                                                                             |   |                 |
|------|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|---|-----------------|
| 05.2 | (unit conversion 4 kg =) 4000 g                        |                                                                                                             | 1 | AO2<br>5.10.2.2 |
|      | (number of cans =) $\frac{4000}{15.8}$                 | allow correct use of an incorrect / no conversion                                                           | 1 |                 |
|      | = 253.16                                               |                                                                                                             | 1 |                 |
|      | = 253                                                  | allow correct whole number from an incorrectly determined number of cans using the values from the question | 1 |                 |
|      | <b>alternative approach 1</b>                          |                                                                                                             |   |                 |
|      | (unit conversion 15.8 g =) 0.0158 kg (1)               |                                                                                                             |   |                 |
|      | (number of cans =) $\frac{4}{0.0158}$ (1)              | allow correct use of an incorrect / no conversion                                                           |   |                 |
|      | = 253.16 (1)                                           |                                                                                                             |   |                 |
|      | = 253 (1)                                              | allow correct whole number from an incorrectly determined number of cans using the values from the question |   |                 |
|      | <b>alternative approach 2</b>                          |                                                                                                             |   |                 |
|      | (number of cans from 1000 g =) $\frac{1000}{15.8}$ (1) |                                                                                                             |   |                 |
|      | = 63.29 (1)                                            |                                                                                                             |   |                 |
|      | (number of cans from 4000 g) = 63.29 × 4 (1)           | allow correct use of an incorrectly determined number of cans from 1000 g                                   |   |                 |
|      | (= 253.16) = 253 (1)                                   | allow correct whole number from an incorrectly determined number of cans using the values from the question |   |                 |

## Q10. (2024)

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |     |                             |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----------------------------|
| 05.3 | <b>Level 2:</b> A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 3–4 | AO3<br>5.10.2.1<br>5.10.2.2 |
|      | <b>Level 1:</b> Relevant points are made. They are not logically linked.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1–2 |                             |
|      | <b>No relevant content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0   |                             |
|      | <b>Indicative content</b> <ul style="list-style-type: none"> <li>• less steel (than wood) goes to waste</li> <li>• (so) less space taken up in landfill</li> <li>• more steel (than wood) is recycled</li> <li>• (so) less non-renewable resources are needed</li> <li>• no steel is burnt</li> <li>• (so) no carbon dioxide produced</li> <li>• (so) no contribution to climate change</li> <li>• most wood is disposed of as waste</li> <li>• (so) more space taken up in landfill</li> <li>• least wood is disposed of by burning</li> <li>• (but) still produces carbon dioxide</li> <li>• (which) contributes to climate change</li> <li>• most steel is disposed of by recycling</li> <li>• (so) less non-renewable resources are needed</li> <li>• judgement</li> </ul> |     |                             |