

| Question | Answer | Marks | Guidance |
|----------|--------|-------|----------|
| 1        | D      | 1     |          |

| Question | Answer | Marks | AO element | Guidance |
|----------|--------|-------|------------|----------|
| 2        | C      | 1     | AO2.2      |          |

| Question | Answer | Marks | AO element | Guidance |
|----------|--------|-------|------------|----------|
| 3        | A      | 1     | AO1.2      |          |

| Question | Answer | Marks | AO element | Guidance |
|----------|--------|-------|------------|----------|
| 4        | D      | 1     | AO1.1      |          |

| Question |     |  | Answer                                                                                                                                                                                                                                               | Marks | AO element | Guidance                                                                                                                                                                                                    |
|----------|-----|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5        | (a) |  | s-block<br><b>AND</b> highest energy <b>or</b> outer <b>electron</b> is in a s orbital <b>or</b> s sub-shell ✓                                                                                                                                       | 1     | 1.1        | <b>ALLOW</b> 'outer' or 'valence' for 'highest energy'<br><b>IGNORE</b> electron configurations<br><b>DO NOT ALLOW</b> s shell / energy level                                                               |
|          | (b) |  | <b>FIRST CHECK THE ANSWER ON ANSWER LINE</b><br><b>If answer = 25.982 award 2 marks</b><br><br>$\frac{78.99 \times 23.985 + 10.00 \times 24.986 + 11.01 \times m}{100} = 24.305 \checkmark$ Relative isotopic mass = 25.982 (must be 5 <b>SF</b> ) ✓ | 2     | 2.2 × 2    | <b>ALLOW</b> any correct rearrangement of this sum for first mark<br>eg $11.01 \times m = 2430.5 - 1894.575 - 249.86$<br><br><b>ALLOW</b> ecf for transcription errors in first sum but answer must be 5 sf |

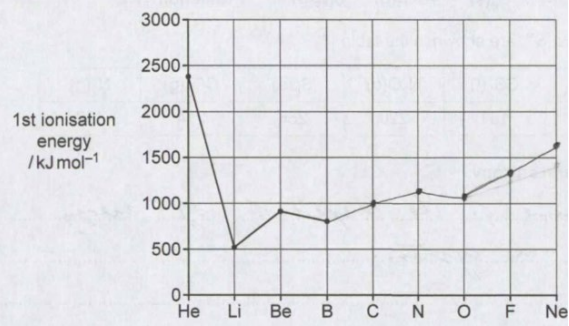
| Question |     |  | Answer                                            | Marks | AO element | Guidance                                                                                  |
|----------|-----|--|---------------------------------------------------|-------|------------|-------------------------------------------------------------------------------------------|
| 6        | (a) |  | <i>For sodium</i><br><b>atomic</b> radius smaller | 2     | 1.1 ×2     | <b>ALLOW</b> 'Na/sodium is smaller'<br><b>IGNORE</b> smaller radius / fewer shells / less |

| Question |  |  | Answer                                                                                                                                                   | Marks | AO element | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|--|--|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |  |  | <p><b>OR</b><br/>fewer shells ✓</p> <p>nuclear <b>attraction</b> increases<br/><b>OR</b><br/>(outer) electron(s) experience more <b>attraction</b> ✓</p> |       |            | <p>shielding if applied to ions but<br/><b>DO NOT ALLOW</b> responses which refer to ions losing electrons<br/><b>DO NOT ALLOW</b> molecules</p> <p><b>ALLOW</b> energy levels for shells<br/><b>IGNORE</b> fewer orbitals <b>OR</b> fewer sub–shells</p> <p><b>ALLOW less</b> (electron) shielding <b>OR</b> electron repulsion between shells<br/><b>IGNORE</b> just 'shielding'</p> <p><b>ALLOW</b> more/stronger/bigger nuclear attraction etc</p> <p><b>IGNORE</b> 'pull' for attraction<br/><b>IGNORE</b> electrons more tightly held<br/><b>IGNORE</b> 'nuclear charge' for 'nuclear attraction'<br/><b>IGNORE</b> more energy (in question)</p> <p><b>ALLOW</b> reverse argument for potassium throughout</p> |

| Question |     |  | Answer                                                                                | Marks | AO element | Guidance                                                                                                    |
|----------|-----|--|---------------------------------------------------------------------------------------|-------|------------|-------------------------------------------------------------------------------------------------------------|
| 7        | (a) |  | (The mean/average mass) taking into account the relative abundances of the isotopes ✓ | 1     | 1.1        | <b>ALLOW</b><br>sum of (isotopic mass × %abundance)<br>sum of (isotopic mass × abundance) / total abundance |

| Question | Answer | Marks | AO element | Guidance |
|----------|--------|-------|------------|----------|
| 8        | A      | 1     | AO1.1      |          |

| Question |     |       | Answer                                                                                                                                                                                                                                                                                                                                                                                 | Marks | AO element | Guidance                                                                                                                                                                                                                       |   |   |    |    |    |   |    |    |    |   |  |   |   |   |  |  |  |   |  |   |  |   |
|----------|-----|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|----|----|----|---|----|----|----|---|--|---|---|---|--|--|--|---|--|---|--|---|
| 9        | (a) | (i)   | $\text{Mg}^{3+}(\text{g}) \rightarrow \text{Mg}^{4+}(\text{g}) + \text{e}^-$ ✓                                                                                                                                                                                                                                                                                                         | 1     | AO1.2      | State symbols required (ignore states on electrons)<br><b>ALLOW</b> $\text{Mg}^{3+}(\text{g}) - \text{e}^- \rightarrow \text{Mg}^{4+}(\text{g})$<br><b>ALLOW</b> $\text{Mg}^{+3}(\text{g})$<br><b>ALLOW</b> e for $\text{e}^-$ |   |   |    |    |    |   |    |    |    |   |  |   |   |   |  |  |  |   |  |   |  |   |
|          |     | (ii)  | Big jump/larger difference between 2 and 3 ✓                                                                                                                                                                                                                                                                                                                                           | 1     | AO1.2      | <b>IGNORE</b> big jump between 10 and 11<br><b>DO NOT ALLOW</b> other combinations.                                                                                                                                            |   |   |    |    |    |   |    |    |    |   |  |   |   |   |  |  |  |   |  |   |  |   |
|          |     | (iii) | 1st <b>AND</b> 3rd <b>AND</b> 4th <b>AND</b> 5th <b>AND</b> 9th <b>AND</b> 11th ✓<br>i.e.<br><table border="1"><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr><tr><td>✓</td><td></td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td>✓</td><td></td><td>✓</td><td></td></tr></table> | 1     | 2          | 3                                                                                                                                                                                                                              | 4 | 5 | 6  | 7  | 8  | 9 | 10 | 11 | 12 | ✓ |  | ✓ | ✓ | ✓ |  |  |  | ✓ |  | ✓ |  | 1 |
| 1        | 2   | 3     | 4                                                                                                                                                                                                                                                                                                                                                                                      | 5     | 6          | 7                                                                                                                                                                                                                              | 8 | 9 | 10 | 11 | 12 |   |    |    |    |   |  |   |   |   |  |  |  |   |  |   |  |   |
| ✓        |     | ✓     | ✓                                                                                                                                                                                                                                                                                                                                                                                      | ✓     |            |                                                                                                                                                                                                                                |   | ✓ |    | ✓  |    |   |    |    |    |   |  |   |   |   |  |  |  |   |  |   |  |   |

|    | Question | Answer                                                                                                                                                                                                                                                                                                                     | Marks | AO element                | Guidance                                                                                                                                                          |
|----|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10 | (a)      |  <p>1st ionisation energy / kJ mol<sup>-1</sup></p> <p>All points show a <b>general</b> increase from B (i.e ignore O) <b>AND</b> Ne lower than He ✓</p> <p>O lower than N <b>AND</b> O is higher than C <b>AND</b> F higher than O ✓</p> | 2     | <p>AO1.1</p> <p>AO1.2</p> |                                                                                                                                                                   |
|    | (b)      | <p><math>8.3 \times 10^{-22}</math> (kJ) ✓</p> <p>From <math>\frac{500}{6.02 \times 10^{23}}</math></p> <p>Answer <b>MUST</b> be to 2 SF <b>AND</b> in standard form.</p>                                                                                                                                                  | 1     | AO2.2                     | <p><b>ALLOW</b> use of IEs close to 500 giving a range:</p> <p><math>8.3 \times 10^{-22}</math> (from 500)<br/>to <math>9.1 \times 10^{-22}</math> (from 550)</p> |

| Question |     | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Marks | AO element                                          | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10       | (c) | <p><b>Explanation for He</b><br/> <i>Distance/shielding</i><br/>           (Outer) electrons are in a lower energy/closer shell/smaller atomic radius/fewer shells ✓</p> <p><b>Explanation for Be</b><br/> <i>Nuclear charge</i><br/>           number of protons/proton number increases<br/> <b>OR</b><br/>           greater <b>nuclear</b> charge ✓</p> <p><i>Distance/shielding</i><br/>           (Outer) electrons are in the same shell <b>OR</b> sub-shell<br/> <b>OR</b><br/>           (Outer) electrons experience the same/similar shielding<br/> <b>OR</b><br/>           Atomic radius decreases ✓</p> <p><b>For either Be or He</b><br/> <i>Attraction</i><br/> <b>Greater</b> nuclear attraction (on outer electrons)<br/> <b>OR</b><br/>           (outer) electrons attracted more strongly to the nucleus ✓</p> | 4     | <p>AO1.1</p> <p>AO1.1</p> <p>AO1.2</p> <p>AO1.2</p> | <p>FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED</p> <p><b>ORA</b> throughout<br/>           Comparison needed for each mark<br/> <b>ALLOW</b> change of <b>shell</b> (i.e 2s and 1s)<br/> <b>IGNORE</b> 'different <b>sub</b>-shell'</p> <p><b>IGNORE</b> atomic number increases<br/> <b>IGNORE</b> nucleus gets bigger<br/> <b>IGNORE</b> 'effective nuclear charge increases'</p> <p><b>ALLOW</b> same orbital</p> <p><b>IGNORE</b> 'there is shielding'<br/> <b>ALLOW</b> 'greater repulsion from inner shells'</p> <p><b>IGNORE</b> just 'greater attraction' <b>OR</b> greater force<br/> <b>IGNORE</b> 'pull' for 'attraction'<br/> <b>IGNORE</b> 'held' for attracted,<br/> <i>e.g. IGNORE 'held more strongly'</i></p> |

| Question |     | Answer                                                                                                                                                                                                                           | Marks    | AO element  | Guidance                                                                                                                                                                                                                                                                                                            |
|----------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10       | (d) | <p><b>Sub-shells</b><br/>Be electron is in (2)s<br/><b>AND</b><br/>B electron is in (2)p ✓</p> <p><b>Energy levels</b><br/>B / (2)p is higher <b>energy</b> (level)<br/><b>OR</b> Be / (2)s is lower <b>energy</b> (level) ✓</p> | 2        | AO1.2<br>×2 | <p><b>IGNORE</b> number before s and p<br/><b>DO NOT ALLOW</b> “shell”<br/><b>IGNORE</b> block</p> <p><b>DO NOT ALLOW</b> unpaired electron removed more easily (<b>ORA</b>)<br/><b>IGNORE</b> ‘less energy to remove’</p> <p><b>IGNORE</b> comments about distance from nucleus<br/><b>IGNORE</b> 2s shielding</p> |
|          |     | <b>Total</b>                                                                                                                                                                                                                     | <b>9</b> |             |                                                                                                                                                                                                                                                                                                                     |

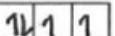
| Question | Answer | Marks | AO element | Guidance |
|----------|--------|-------|------------|----------|
| 11       | A      | 1     | AO1.2      | ALLOW Li |

| Question |     |  | Answer                                                                                                                                                                                                     | Marks | AO element                                          | Guidance                                                                                                                                                                                                                                                                                                                       |
|----------|-----|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12       | (a) |  | <p><b>1st IE of Mg and Sr</b><br/>(Mg) removes electron from shell closer to the nucleus / smaller <b>atomic</b> radius ✓</p> <p>Greater nuclear <b>attraction</b> (between atom and outer electron) ✓</p> | 4     | <p>AO1.1</p> <p>AO1.2</p> <p>AO1.1</p> <p>AO1.2</p> | <p><b>ORA throughout</b><br/><b>ALLOW</b> going down the group for comparison of Mg/Sr<br/>Assume 'it' means Mg<br/><b>ALLOW</b> (Mg) fewer shells<br/><b>ALLOW</b> less shielding<br/><b>ALLOW</b> removal of electron from 3s rather than 5s</p> <p><b>ALLOW</b> Greater attraction between nucleus (and outer electron)</p> |

| Question |  |  | Answer                                                                                                                                                                                                                                                                                  | Marks | AO element | Guidance                                                                                                                                                                                                                                                       |
|----------|--|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |  |  | <b>2nd/1st IE of Sr</b><br>2 <sup>nd</sup> electron removed from cation/positively charged <b>ion</b><br><b>OR</b><br>proton:electron ratio (in (1)+ ion) is greater (than in atom)<br>✓<br><br>Greater nuclear <b>attraction</b> / <b>attraction</b> between ion (and outer electron)✓ |       |            | <b>ALLOW</b> Sr <sup>+</sup> <b>ion</b> smaller (than Sr atom)<br><br><b>ALLOW same</b> number of protons/nuclear charge <b>attracting</b> one fewer electron<br><br><b>IGNORE</b> repulsion between electrons in the s orbital<br><br><b>IGNORE</b> shielding |

| Question | Answer | Marks | Guidance |
|----------|--------|-------|----------|
| 13       | D      | 1     |          |

| Question | Answer | Marks | Guidance |
|----------|--------|-------|----------|
| 14       | C      | 1     |          |

| Question |     |      | Answer                                                                                                  | Mark | Guidance                                                                                                                                                                                                                                                                                           |
|----------|-----|------|---------------------------------------------------------------------------------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15       | (a) | (i)  | $\text{S(g)} \rightarrow \text{S}^+(\text{g}) + \text{e}^-$ ✓                                           | 1    | <b>IGNORE</b> state symbols on the electron                                                                                                                                                                                                                                                        |
|          |     | (ii) | Paired electrons in (p-) orbital / sub shell (in S) ✓<br><br>Repulsion (between the paired electrons) ✓ | 2    | <b>ALLOW</b> if seen in a diagram<br>i.e. <br><b>ALLOW</b> 2 electrons in an (p-) <u>orbital</u><br><b>DO NOT ALLOW</b> shell alone<br><b>DO NOT ALLOW</b> s-orbital<br><br><b>IGNORE</b> distance from nucleus |