**Questions**

**Q1.**

The first ionization energies, in kJ mol-1, of four elements with consecutive atomic  
 numbers are shown below.

**A**    1680

**B**    2080

**C**    496

**D**    738

(a) Which element could be an inert gas?

**(1)**

   **A**

   **B**

   **C**

   **D**

(b) Which element could be X in a covalent compound with formula HX?

**(1)**

   **A**

   **B**

   **C**

   **D**

(c) Which element could be Y in an ionic compound with formula YH2?

**(1)**

   **A**

   **B**

   **C**

   **D**

**(Total for question = 3 marks)**

**Q2.**

Which of the following covalent bonds is the shortest?

   **A**     H—F

   **B**     H—Cl

   **C**     H—Br

   **D**     H—I

**(Total for question = 1 mark)**

**Q3.**

The bonding in magnesium oxide, MgO, is

   **A**      ionic.

   **B**      metallic and ionic.

   **C**      ionic and covalent.

   **D**      metallic and covalent.

**(Total for question = 1 mark)**

**Q4.**

Covalent bonding results from the strong electrostatic attractions between

   **A**    instantaneous dipoles.

   **B**    electron clouds.

   **C**    electrons in the bonding pair.

   **D**    bonding pairs of electrons and nuclei.

**(Total for Question = 1 mark)**

**Q5.**

The bonding in lithium iodide has some covalent character because

   **A**    the lithium ion polarizes the iodide ion.

   **B**    the iodide ion polarizes the lithium ion.

   **C**    there is a very large difference in electronegativity between lithium and iodine.

   **D**    there is a very small difference in electronegativity between lithium and iodine.

**(Total for question = 1 mark)**

**Q6.**

Which of the following data is **not** needed to calculate the lattice energy of sodium chloride when using a Born-Haber cycle?

   **A**    Enthalpy change of formation of sodium chloride.

   **B**    Enthalpy change of atomization of sodium.

   **C**    First ionization energy of chlorine.

   **D**    Electron affinity of chlorine.

**(Total for question = 1 mark)**

**Q7.**

Which of the following contains a dative covalent bond?

   **A**    N2

   **B**    NH3

   **C**    NH2−

   **D**    NH4+

**(Total for question = 1 mark)**

**Q8.**

Which of these equations represents the electron affinity of chlorine?

   **A**   Cl2(g) + 2e-  → 2Cl-(g)

   **B**   Cl2(g) - 2e-   → 2Cl-(g)

   **C**   ½Cl2(g) + e- → Cl-(g)

   **D**   Cl(g) + e-     → Cl-(g)

**(Total for question = 1 mark)**

**Q9.**Which of the equations below represents the first electron affinity for oxygen?

   **A**    O2(g) + 2e− → 2O−(g)

   **B**    O2(g) − 2e− → 2O−(g)

   **C**    ½O2(g) + e− → O−(g)

   **D**    O(g) + e− → O−(g)

**(Total for Question = 1 mark)**

**Q10.**Which of the following has the largest ionic radius?

   **A**    S2−

   **B**    Cl−

   **C**    K+

   **D**    Ca2+

**(Total for Question = 1 mark)**

**Q11.**

In which of the following electronic configurations are only two of the electrons unpaired?

   **A**    1s2 2s2

   **B**    1s2 2s2 2p3

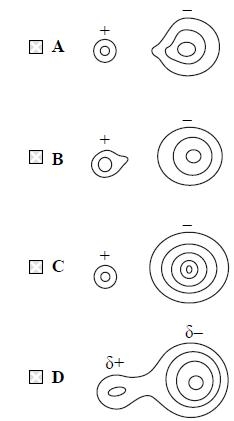
   **C**    1s2 2s2 2p4

   **D**    1s2 2s2 2p5

**(Total for question = 1 mark)**

**Q12.**

Which of these electron density maps best represents the bonding in the compound  
 lithium iodide, LiI?



**(Total for question = 1 mark)**

**Q13.**

Which of the following does **not** have exactly 10 electrons?

   **A**     An ion of fluorine, F−

   **B**     A molecule of methane, CH4

   **C**     A molecule of nitrogen, N2

   **D**     An ion of sodium, Na+

**(Total for question = 1 mark)**

**Q14.**

A drop of concentrated nickel(II) sulfate solution, which is green, is placed on moist  
 filter paper on a microscope slide and the ends of the slide are connected to a 24 V DC  
 power supply. After ten minutes,

   **A**      a blue colour has moved towards the negative terminal and a yellow colour  
                 towards the positive terminal.

   **B**      a blue colour has moved towards the positive terminal and a yellow colour  
                 towards the negative terminal.

   **C**      a green colour has moved towards the negative terminal but there is no other  
                 visible change.

   **D**      a green colour has moved towards the positive terminal but there is no other  
                 visible change.

**(Total for question = 1 mark)**

**Q15.**

Which of the following represents the process occurring when the enthalpy change of atomization of bromine is measured?

   **A**   ½Br2(l) → Br(g)

   **B**   ½Br2(g) → Br(g)

   **C**   Br2(l) → Br+(g) + Br−(g)

   **D**   Br2(g) → Br+(g) + Br−(g)

**(Total for question = 1 mark)**

**Q16.**

Which of the following statements is evidence for the existence of ions in ionic compounds?

   **A**     Ionic compounds, in the solid state, conduct electricity.

   **B**     When **any** ionic compound in solution is electrolysed, the migration of ions  
                can be seen.

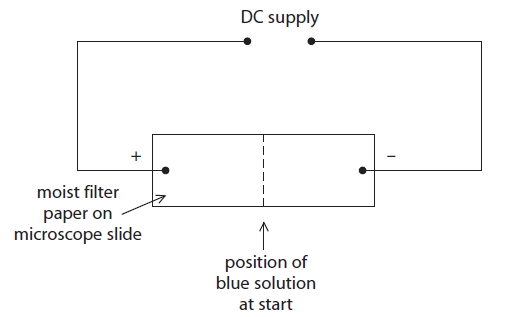
   **C**     In electron density maps for ionic compounds, there is no single line  
                representing electron density that surrounds both cations and anions.

   **D**     In electron density maps for ionic compounds, there are some single lines  
                representing electron density that surround both cations and anions.

**(Total for question = 1 mark)**

**Q17.**

A spot of blue solution was placed in the centre of a piece of moist filter paper supported on a microscope slide and the following experiment was carried out.



After some time, a blue colour moved towards the negative terminal, but no change was visible in the region of the positive terminal. This is because

   **A**    the negative ions in the solution were colourless and the positive ions were blue.

   **B**    the positive ions in the solution were colourless and the negative ions were blue.

   **C**    the negative ions in the solution had not moved but the positive ions had moved.

   **D**    the positive ions in the solution had not moved but the negative ions had moved.

**(Total for question = 1 mark)**

**Q18.**Which of the following quantities, used in the calculation of the lattice energy of lithium oxide, Li2O, has a negative value?

   **A**    The enthalpy change of atomization of lithium.

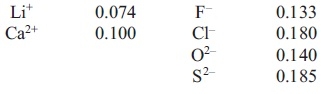
   **B**    The first ionization energy of lithium.

   **C**    The first electron affinity of oxygen.

   **D**    The second electron affinity of oxygen.

**(Total for Question = 1 mark)**

**Q19.**The ionic radii in nm of some ions are given below.



(a) Which of the following compounds has the most exothermic lattice energy? They all  
       have the same crystal structure.

**(1)**

**A**      LiF

**B**      LiCl

**C**      CaO

**D**      CaS

(b) Which of the following compounds will show the greatest difference between the  
       experimental (Born-Haber) lattice energy and that calculated from a purely ionic  
       model?

**(1)**

**A**      LiF

**B**      Li2O

**C**      CaO

**D**      CaS

**(Total for question = 2 marks)**

**Q20.**A drop of sodium manganate(VII) solution is placed at the centre of a piece of moist filter paper on a microscope slide. The ends of the paper are clipped to a 30 V DC power supply. After a few minutes,

   **A**    a purple colour has moved towards the positive terminal.

   **B**    a purple colour has moved towards the negative terminal.

   **C**    an orange colour has moved towards the positive terminal.

   **D**    an orange colour has moved towards the negative terminal.

**(Total for Question = 1 mark)**

**Q21.**

Which of the following ions would be deflected **most** in a mass spectrometer?

   **A**    35Cl+

   **B**    37Cl+

   **C**    37Cl2+

   **D**    (35Cl — 37Cl)+

**(Total for question = 1 mark)**

**Q22.**Which of the following oxides would be expected to have the most exothermic lattice energy?

   **A**    Na2O

   **B**    MgO

   **C**    CaO

   **D**    K2O

**(Total for Question = 1 mark)**

**Q23.**

Going down Group 1 from lithium to rubidium

   **A**      the radius of the atom decreases.

   **B**      the radius of the ion decreases.

   **C**      the first ionization energy decreases.

   **D**      the polarizing power of the ion increases.

**(Total for question = 1 mark)**

**Q24.**

Which of the following ions has the **largest** ionic radius?

   **A**    F−

   **B**    Mg2+

   **C**    Na+

   **D**    O2−

**(Total for question = 1 mark)**

**Q25.**

Magnesium chloride, MgCl2, has two lattice energy values quoted in the data booklet. The first is the experimental value, obtained from the Born-Haber cycle, −2526 kJ mol−1; the second is the theoretical value, −2326 kJ mol−1. Why are the two values different?

   **A**    The cation polarizes the anion leading to some covalent bonding.

   **B**    The anion polarizes the cation leading to some covalent bonding.

   **C**    Magnesium chloride is a covalent substance.

   **D**    The results from the Born-Haber cycle are too inaccurate to be reliable.

**(Total for question = 1 mark)**

**Q26.**

Which equation represents the reaction for which the enthalpy change is the lattice  
 energy of sodium fluoride, NaF?

   **A**     Na(s) + ½F2(g) → NaF(s)

   **B**     Na(g) + F(g) → NaF(s)

   **C**     Na+(g) + F−(g) → NaF(s)

   **D**     Na(g) + ½F2(g) → NaF(s)

**(Total for question = 1 mark)**

**Q27.**

The lattice energy of magnesium oxide is more negative than the lattice energy of magnesium fluoride because

   **A**    oxide ions are larger than fluoride ions.

   **B**    oxide ions are larger than magnesium ions.

   **C**    oxide ions are more highly charged than fluoride ions.

   **D**    there is only one oxide ion but two fluoride ions per magnesium ion.

**(Total for question = 1 mark)**

**Q28.**

Metals are good conductors of electricity because

   **A**     metal atoms are arranged in a regular lattice.

   **B**     metal ions are very close to each other.

   **C**     metal ions are free to move through the lattice.

   **D**     electrons are free to move through the lattice.

**(Total for question = 1 mark)**

**Q29.**

Which of these statements is **incorrect?**

   **A**   The atomic radius of metals increases down a Group.

   **B**   The trend in the melting temperature of successive elements across Period 2 is  
              similar to that in Period 3.

   **C**   A metallic structure is held together by attractions between metal atoms and  
              delocalized electrons.

   **D**   Na+ and O2- ions are isoelectronic.

**(Total for question = 1 mark)**

**Q30.**

Element **R** is in Group 1 of the Periodic Table and element **T** is in Group 6. **R** and **T** are not the symbols for the elements.

(a) The compound of **R** and **T** will have the formula

**(1)**

   **A**      **RT**

   **B**      **RT**6

   **C**      **RT**2

   **D**      **R**2**T**

(b) The compound of **R** and **T** will have bonding which is predominantly

**(1)**

   **A**       ionic.

   **B**       covalent.

   **C**       dative covalent.

   **D**       metallic.

(c) In terms of its electrical conductivity, the compound of **R** and **T** will

**(1)**

   **A**       conduct when solid and liquid.

   **B**       conduct when solid but not when liquid.

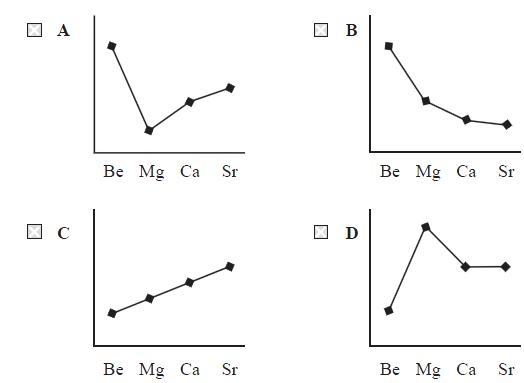
   **C**       conduct when liquid but not when solid.

   **D**       not conduct when solid or liquid.

**(Total for question = 3 marks)**

**Q31.**

Which of the following graphs shows the variation in the ionic radius of the Group 2  
 elements?



**(Total for question = 1 mark)**

**Q32.**

Going across the Periodic Table from sodium to aluminium,

   **A**      the melting temperature increases.

   **B**      the radius of the atom increases.

   **C**      the radius of the metal ion increases.

   **D**      the bonding in the element changes from metallic to covalent.

**(Total for question = 1 mark)**

**Q33.**In which of the following compounds is the **anion** most polarized?

   **A**    LiF

   **B**    LiI

   **C**    LiI

   **D**    KI

**(Total for Question = 1 mark)**

**Q34.**

Which of these ions has the greatest ability to polarize an anion?

   **A**   Ba2+

   **B**   Ca2+

   **C**   Cs+

   **D**   K+

**(Total for question = 1 mark)**

**Q35.**

Metals usually have high melting temperatures and boiling temperatures because there are

   **A**     strong attractions between the ions.

   **B**     strong attractions between the delocalised electrons.

   **C**     strong attractions between the ions and the delocalised electrons.

   **D**     strong intermolecular forces.

**(Total for question = 1 mark)**

**Q36.**

Which of the following has the smallest ionic radius?

   **A**     F−

   **B**     Na+

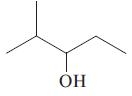
   **C**     Mg2+

   **D**     O2−

**(Total for question = 1 mark)**

**Q37.**

An organic compound is represented by the skeletal formula shown below.



The compound is

   **A**   CH3CH2CH2CH(OH)CH2CH3

   **B**   (CH3)2CHC(OH)(CH3)2

   **C**   (CH3)2CHCH2CH(OH)CH3

   **D**   (CH3)2CHCH(OH)CH2CH3

**(Total for question = 1 mark)**

**Q38.**In the Born-Haber cycle for potassium iodide, which of the following steps is **exothermic**?

   **A**    K(s) → K(g)

   **B**    K(g) → K+(g) + e−

   **C**    ½I2(s) → I(g)

   **D**    I(g) + e− → I−(g)

**(Total for Question = 1 mark)**

**Q39.**Which of the graphs shows (from left to right) the trend in the ionic radius of the  
 isoelectronic ions N3−, O2−, F−, Na+, Mg2+, Al3+?



**(Total for question = 1 mark)**

**Q40.**

**Theoretical** lattice energies can be calculated from electrostatic theory.  Which of the  
 following affects the magnitude of the theoretical lattice energy of an alkali metal halide,  
 M+X− ?

   **A**     The first electron affinity of X.

   **B**     The first ionization energy of M.

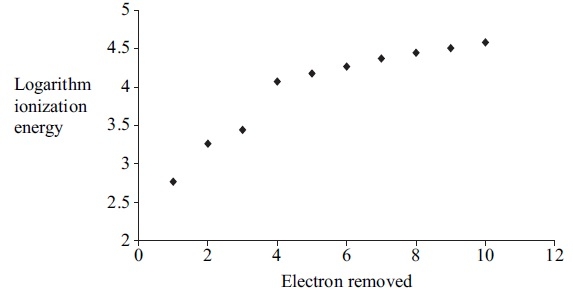
   **C**     The enthalpy of atomization of M.

   **D**     The radius of the X− ion.

**(Total for question = 1 mark)**

**Q41.**

The graph below represents the successive ionization energies of an element **X** plotted against the number of the electron removed. **X** is not the symbol for the element.



(a) From this graph it is possible to deduce the group in the Periodic Table to which **X** belongs. **X** is in

**(1)**

   **A**      Group 1

   **B**      Group 3

   **C**      Group 5

   **D**      Group 7

(b) From the graph it is possible to deduce that the most stable ion of **X** will be

**(1)**

   **A**      X3+

   **B**      X+

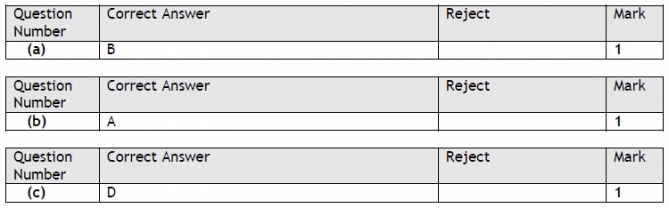
   **C**      X−

   **D**      X3−

**(Total for question = 2 marks)**

**Mark Scheme**

**Q1.**

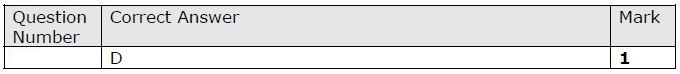


**Q2.**



**Q3.**



**Q4.**

**Q5.**



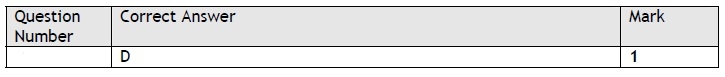
**Q6.**



**Q7.**



**Q8.**



**Q9.**



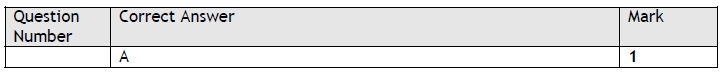
**Q10.**



**Q11.**



**Q12.**



**Q13.**



**Q14.**



**Q15.**



**Q16.**



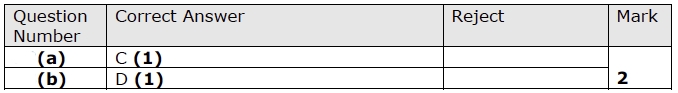
**Q17.**



**Q18.**



**Q19.**



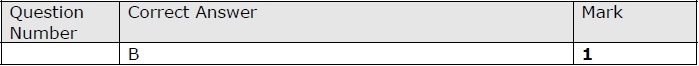
**Q20.**



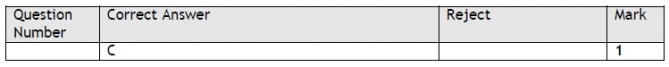
**Q21.**



**Q22.**



**Q23.**



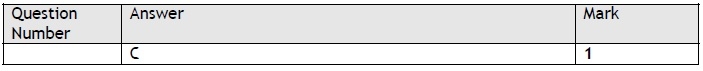
**Q24.**



**Q25.**



**Q26.**



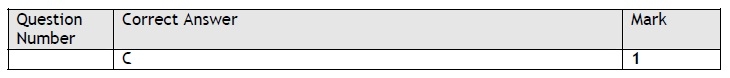
**Q27.**



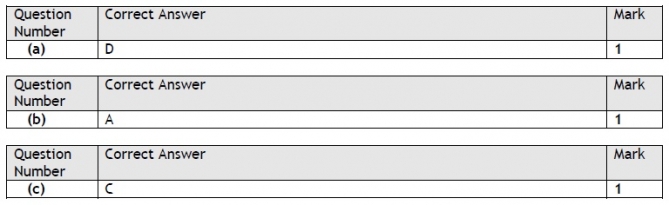
**Q28.**



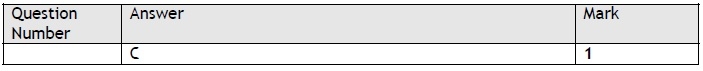
**Q29.**



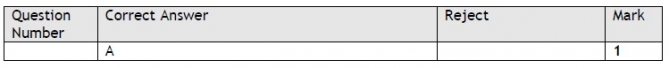
**Q30.**



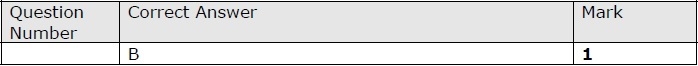
**Q31.**



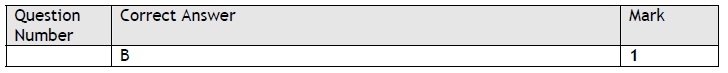
**Q32.**



**Q33.**



**Q34.**



**Q35.**



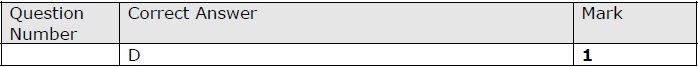
**Q36.**



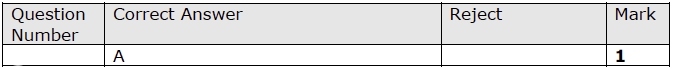
**Q37.**



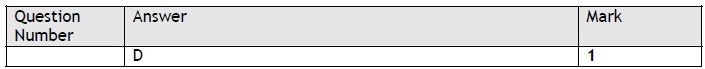
**Q38.**



**Q39.**



**Q40.**



**Q41.**

