**M1.**(a)    number

**1**

0

*allow 8*

**1**

(b)     beryllium **or** magnesium **or** strontium **or** barium **or** radium

*allow correct symbols*

**1**

(c)     (i)      an alkali metal

**1**

(ii)     a transition metal

**1**

(d)     for undiscovered elements

*accept so elements with similar properties were in the same groups*

*accept so elements fitted the pattern of properties*

**1**

**[6]**

**M2.**         (a)     Mendeleev

**1**

(b)          atomic weight

**1**

(c)          groups

**1**

(d)          undiscovered

**1**

(e)          electronic structures

**1**

**[5]**

**M3.**(a)     (i)      hydrogen

*accept H2*

*allow H*

**1**

(ii)     hydroxide

*accept OH–*

*allow OH*

*do* ***not*** *accept lithium hydroxide*

***1***

*(b)     any* ***two*** *from:*

*‘it’ = potassium*

*potassium:*

*accept converse for lithium*

*•        reacts / dissolves faster*

*allow reacts more vigorously / quickly / violently / explodesignore reacts more*

*•        bubbles / fizzes faster*

*allow fizzes more*

*allow more gas*

*•        moves faster (on the surface)*

*allow moves more*

*•        melts*

*allow forms a sphere*

*•        produces (lilac / purple) flame*

*allow catches fire / ignites*

*do* ***not*** *accept other colours*

***2***

***[4]***

***M4.****(a)     (i)      gas*

***1***

*(ii)     Increases*

***1***

*(b)     (i)      –1*

*allow Cl –*

*allow –*

*allow negative*

***1***

*(ii)     sodium + chlorine → sodium chloride*

*allow correct symbol equation*

***1***

*(c)     reduce microbes*

*accept sterilise*

*accept prevent diseases*

*allow disinfect*

*allow kill bacteria / germs / microbes / micro-organisms*

*allow to make it safe to drink*

*ignore get rid of bacteria*

***1***

*(d)     any* ***one*** *from:*

*•        no freedom of choice*

*allow unethical*

*•        fluoride in toothpaste*

*•         too much can cause fluorosis*

*allow too much can cause damage to teeth*

***1***

***[6]***

***M5.****(a)     any* ***two*** *from:*

*•        react with water* ***or*** *very reactive*

*•        (react with water) releasing gas / hydrogen / fizzing*

*•        (react with water) to form an alkaline / hydroxide solution*

*•        form ions with a 1+ charge*

*allow lose one electron from the outer shell*

*ignore other references to electronic structure*

*ignore physical properties*

***2***

*(b)     any* ***three*** *from:*

*•        some boxes contain two elements*

*allow specific examples:*

*Co, Ni* ***or*** *Ce, La* ***or*** *Di, Mo* ***or*** *Ro, Ru* ***or*** *Ba, V* ***or*** *Pt, Ir*

*•        groups / columns contain elements with different properties*

*allow groups / columns contain both metals and non-metals*

*ignore examples*

*•        Newlands not a well-known / respected scientist*

*ignore references to sugar factory*

*•        new idea (not readily accepted by other scientists)*

*allow musical scales thought to be silly by some scientists*

***3***

*(c)     one for improvement* ***and*** *one for explanation from:*

*•        left gaps (for undiscovered elements) (1)*

*•        so that elements were in their correct group (1)*

*allow so the elements fitted the pattern of properties*

***or***

*•        did not always follow order of relative atomic weights / masses (1)*

*ignore references to atomic number / electronic structure*

*•        so that elements were in their correct group (1)*

*allow so the elements fitted the pattern of properties*

***2***

***[7]***

***M6.****(a)     transition elements*

***1***

*(b)     These metals do not react with air*

***1***

*These metals do not react with water*

***1***

***[3]***

***M7.****(a)     (iron) is a metal*

*accept transition element*

*allow (iron) had different properties (to oxygen and sulfur)*

*ignore electrons*

***1***

*(b)     so that elements with similar properties could be placed together*

*allow to make the pattern fit*

*ignore undiscovered elements*

***1***

*(c)     atomic number(s)*

*allow proton number(s)*

***1***

*(d)     all have one electron in the outer shell (highest energy level)*

*allow same number of electrons in the outer shell (highest energy level)*

***1***

*(so they) have similar properties*

***or***

*react in the same way*

*allow specific reactions e.g. with water*

***1***

***[5]***

***M8.****(a)     gold*

***1***

*(b)     atom (s)*

***1***

*(c)     (i)      protons*

*any order*

*allow proton*

***1***

*neutrons*

*allow neutron*

***1***

*(ii)     3 / three*

***1***

*(d)     (i)      Al*

*ignore any numbers / charges*

***1***

*(ii)     any* ***two*** *from:*

*•        limited resource*

*•        expensive in terms of energy / mining*

*•        effects on the environment, such as, landfill, atmospheric pollution, quarrying*

*allow uses a lot of energy to extract.*

***2***

*(e)     resistant to corrosion*

***1***

*does not react (with water or food)*

*allow* ***one*** *mark for low density with a suitable reason given*

***1***

***[10]***

***M9.****(a)     (i)      E*

***1***

*(ii)     C*

***1***

*(iii)    A*

***1***

*(b)     (i)      quickly melted*

*allow melts in contact with water,*

*allow bp 100 °C (of water) shows mp is low*

*ignore one other piece of information*

***1***

*(ii)     easily cut*

*ignore one other piece of information*

***1***

*(iii)    effervescence / fizzing / bubbling*

*ignore named gas*

*ignore one other piece of information*

***1***

***[6]***

***M10.****(a)     (i)      atomic weight*

***1***

*(ii)     groups*

***1***

*(iii)    left a gap*

***1***

*(iv)    had not been discovered by 1869*

***1***

*(b)     protons*

*must be in correct order*

***1***

*electrons*

***1***

*(c)     sodium and nickel are both metals*

***1***

*sodium is more reactive than nickel*

***1***

*(d)     (i)      bromine*

*allow Br2 / Br*

*do* ***not*** *allow bromide*

***1***

*(ii)     iodine is less reactive (than bromine)*

*it = iodine*

*allow converse*

*do* ***not*** *allow bromide*

***1***

***[10]***

***M11.****(a)     the conclusion is that chlorine and bromine are more reactive  
than iodine*

***1***

*any suitable comparisons about the extent to which the iron  
wool glowed eg because iron glowed with chlorine and bromine  
but did not glow with iodine*

***1***

*(b)     iodine is less reactive than bromine because the iodine (atom)  
is bigger* ***or*** *outer electrons (level / shell) further from the nucleus*

*accept converse for bromine*

***1***

*therefore the forces attracting an incoming electron are  
weaker* ***or*** *there is more shielding of the forces attracting  
an incoming electron*

***1***

*therefore the outer electron gained less easily*

*Max 2 if no mention of outer energy level / shell* ***or*** *of outer electron(s)*

***1***

***[5]***

***M12.****(a)     increase*

***1***

*(b)     (i)      Na+* ***and*** *Br−*

*both required*

***1***

*(ii)     sodium chloride*

*allow NaCl*

*do* ***not*** *allow sodium chlorine*

***1***

*(iii)    chlorine is more reactive than bromine*

*allow converse argument*

*allow symbols Cl, Cl2, Br and Br2*

*allow chlorine / it is more reactive*

*do* ***not*** *allow chloride* ***or*** *bromide*

***1***

*(iv)    fluorine*

*allow F / F2.*

*do* ***not*** *allow fluoride.*

***1***

***[5]***

***M13.****(a)     argon / Ar*

***1***

*(b)     (i)      0*

***1***

*(ii)     unreactive*

***1***

*(c)     (i)      94.96(%)*

***1***

*(ii)     any* ***two*** *from:*

*•        plants or photosynthesis*

*•        absorbed in oceans / seas*

*allow oceans store* ***or*** *take in* ***or*** *dissolve carbon dioxide*

*•        locked up in (sedimentary) rocks*

*•        locked up in fossil fuels*

***2***

***[6]***

***M14.****(a)     similar properties*

*allow same properties*

*allow correct example of property*

*ignore answers in terms of atomic structure*

***1***

*(b)     (i)      in order of atomic / proton number*

*allow increasing number (of protons)*

***1***

*(ii)     elements in same group have same number (of electrons) in outer shell* ***or*** *highest energy level*

*allow number (of electrons) increases across a period*

***1***

*(c)     any* ***two*** *from:*

*statements must be comparative*

*•        stronger / harder*

*ignore higher densities*

*•        less reactive*

*•        higher melting points*

*ignore boiling point*

***2***

*(d)     reactivity increases down group*

*allow converse throughout*

*for next three marks, outer electron needs to be mentioned once otherwise max =* ***2***

***1***

*outer electron is further from nucleus*

*allow more energy levels / shells*

*allow larger atoms*

***1***

*less attraction between outer electron and nucleus*

*allow more shielding*

***1***

*therefore outer electron lost more easily*

***1***

***[9]***

***M15.****(a)      (i)     a correct link between any two named elements eg same group / column  
same properties / number of outer electrons*

*allow some link between any two elements in the same group (in both Newlands and or the modern periodic table)*

***1***

*(ii)     any* ***two*** *from:*

*ignore statements about lack of evidence / proof*

*•        elements still being discovered*

***or****no gaps for undiscovered elements*

*•        some boxes have 2 elements in them*

*•        metals and non-metals in same column / mixed up*

*accept some elements in same column have different properties.*

*allow any sensible suggestion about misplaced elements eg*

*copper in group 1 elements*

*•        pattern for first 16 or so elements only*

*allow did not work for all elements*

***2***

*(b)     (i)      Cl > Br > I*

*accept reactivity / it decreases down the group*

***or***

*I < Br < Cl*

***1***

*Cl has 2 reactions, Br has 1 reaction, I doesn’t react*

*owtte*

*allow Cl has most / more reactions and I has least / less reactions (must be clear about where Br fits in)*

***1***

*(ii)     Br2*

*allow multiples / fractions if correctly completed and balanced*

***1***

*(iii)    (they) have 7 outer electrons*

*allow (they) have 7 electrons in highest occupied (energy) level / shells / rings*

***1***

*(c)                        outer / last / final must be mentioned once in correct context,  
                   otherwise max* ***2*** *marks comparative required on all three points  
                   accept converse ie less reactive up group*

*down group (atom / elements) bigger*

***or***

*outer electrons (level / shell /ring) further from nucleus / centre*

*ignore more electrons*

***or***

*more shells / level / rings*

*do* ***not*** *accept more outer shells for this mark*

***1***

*force(s) / attraction(s) are weaker*

*allow electron(s) attracted less easily*

*allow electron(s) less under influence (of nucleus)*

***or***

*more shielding*

***or***

***1***

*attracts less*

*do* ***not*** *accept magnetic / gravitational / intermolecular forces*

*electron(s) lost more easily*

*allow electron(s) more likely to be lost*

*allow easier to give away*

***1***

***[10]***

***M16.****(a)     any* ***two*** *from:*

*•        do not react with water*

*•        do not react with air*

*allow unreactive* ***or*** *stay shiny* ***or*** *do not tarnish* ***or*** *do not corrode*

*for either of first two points for* ***1*** *mark*

*ignore rusts*

*ignore durable*

*•        malleable*

*ignore hard / strong*

*•        high melting point*

*ignore boiling point*

*ignore other correct properties*

***2***

*(b)     (transition elements have) same number / two electrons in outer shell /  
energy level / fourth shell*

*ignore references to (metallic) structure / bonding*

***1***

*any* ***one*** *from:*

*•        because lower energy level / inner shell being filled*

*•        because third energy level can hold up to eighteen electrons*

***1***

***[4]***

***M17.****(a)     6* ***or*** *16*

***or*** *transition metal or F block  
element or actinide*

***1***

*(b)     (elements in group 6 have) six (electrons)  
in the outer shell or needs 2 electrons to gain a full shell*

*accept has 98 electrons*

***1***

***[2]***

***M18.****(a)      (i)                 it = copper*

*(copper) stops barnacles / seaweed (sticking)*

*accept lead doesn’t stop barnacles / seaweed (sticking)*

*ignore all other properties*

***1***

*(ii)                it = Muntz Metal*

*(Muntz Metal) is less expensive / cheaper / cheapest*

*must be a comparison*

*accept copper is more expensive*

*ignore other properties*

***1***

*(b)     (i)      atomic absorption spec(troscopy) / spectrometry* ***or*** *mass spec(trometry) / spectroscopy*

*accept spectroscopy / spectrometry alone*

*allow AAS / MS*

*do* ***not*** *allow NMR spectroscopy*

***or*** *IR spectrometry* ***or*** *chromatography*

***1***

*(ii)                it = instrumental method*

*sensitive* ***or*** *detect (very) small amounts****or*** *only small sample needed*

*allow (more) precise*

*ignore accurate*

*allow converse for chemical method*

*ignore metal contains small amount / low concentration of iron*

***1***

*(c)     any* ***two*** *from:*

*transition elements (= they)*

*•        unreactive / not very reactive*

*allow does not corrode*

*ignore reference to rust*

*•        strong / hard*

*ignore tough / durable / hard wearing*

*•        malleable / easy to shape*

*ignore ductile / density / melting point*

***2***

***[6]***

***M19.****(a)     (i)      any* ***two*** *from:*

*•        bubbles / effervescence / fizzing*

*ignore hydrogen / gas produced*

*•        lithium disappears / gets smaller*

*allow dissolves  
do* ***not*** *allow melts / burns*

*•        lithium moves on the surface of the water*

*ignore floats*

*•        (universal indicator) turns blue / purple*

***2***

*(ii)     2*

*left-hand side correct*

***1***

*2*

*right-hand side correct*

*allow multiples for full credit*

***1***

*(iii)    light / burn, which will give a (squeaky) pop / explosion*

***1***

*(iv)    all have 1 electron in their outer shell / energy level*

*allow have the same number of electrons in their outer shell / energy level*

***1***

*(b)     They react with oxygen*

***1***

*They have low melting points*

***1***

*(c)     (i)      electronic structure [2,8,8] is drawn*

*incomplete inner shells scores a maximum of* ***1*** *mark*

***1***

*charge is +*

*allow [2,8,8]+ for* ***1*** *mark*

***1***

*(ii)     because (in potassium) the outer shell electron is further away from the nucleus* ***or*** *because potassium atoms are larger than sodium atoms*

*it should be clear that the candidate is referring to the outer shell electron: if this is not clear a maximum of* ***2*** *marks can be awarded*

***1***

*therefore the outer shell electron is less strongly attracted to the nucleus* ***or*** *is more shielded from the attraction of the nucleus and so the outer shell electron in potassium is more easily lost*

***1***

***3*** *marks can be scored for answering the question in terms of sodium*

***1***

***[13]***

***M20.****(a)     for undiscovered elements*

***1***

*(b)     because the elements are in order of number of electrons  
or proton number*

***1***

*because the number of energy levels / shells is the  
number of the period*

***1***

*because the number of electrons in the outer energy level /  
shell is the number of the group, except in the case of the  
noble gases*

***1***

***[4]***

***M21.****(a)     (i)      Na*

*allow sodium*

***1***

*(ii)     Cu*

*allow copper*

***1***

*(iii)    C*

*allow carbon*

***1***

*(iv)    He*

*allow helium*

***1***

*(b)     H*

*allow hydrogen*

*do* ***not*** *allow H2*

***1***

***[5]***