The Periodic Table

Question 1 (2015 - Section B - Question 4 - Part a)

(*a*) HOW MANY: (*i*) **10** //
(*ii*) **14** (2 × 3)

Question 2 (2015 - Section B - Question 4 - Part b)

(*b*) EXPLAIN: **average of** mass numbers of the **isotopes** of an element /
average mass of all (an) **atom**(s) of an element (6)
[Explanations based on sub-atomic particles not having masses that are in whole amu or stating that the exact masses of the neutron and proton differ may be acceptable.]

Question 3 (2014 - Section B - Question 10 - Part (b))

(*b*) DEFINE: (*i*) **number of nucleons (protons and neutrons)** in the atoms of an isotope (3)

(*ii*) **average mass of atom(s)** of element / **average mass of the isotopes** of an element **taking** their **abundances into account //**
relative to $\frac{1}{12}$ of mass of **carbon–12** atom (2 × 3)
[Relative to half (or any other incorrect fraction) of the mass of carbon–12 is a contradiction and cancellation applies.]

WHAT: **ionisation** to form positive ions **// separation** (2 × 3)
[Deflection not acceptable.]

LIST: **vaporisation, ionisation, acceleration, separation, detection** (3)
[Deflection not acceptable.]

CALCULATE: **69.798 (69.8)** **(7)**

69 × 60.1	=	4146.9	(2)
71 × 39.9	=	2832.9	(2)
100 atoms	=	6979.8	
A_r	=	69.798 (69.8)	(3)

[69.72 on its own from *Formulae and Tables* booklet is not acceptable.]
[Where candidate doesn't round off correctly - deduct 1 mark.]
[Where candidate includes unit deduct 1 mark.]

Question 4 (2013 - Section B - Question 4 - Part (b))

(b) DEFINE: **average mass of atom(s)** of element / **average of isotopes taking abundances into account //**
relative to (based on) $^1/_{12}$ mass of **carbon–12** atom (2 × 3)
[Mass of 1 mole of element when 1 mole of carbon-12 is taken as 12 grams. (3)]

Question 5 (2013 - Section B - Question 5)

(a) WHAT: an element **cannot be broken (split, divided) into** anything **simpler***
an element is **a simple substance**
[Do not accept "smaller". Accept "further" and "simpler by chemical means".]* (5)

(b) USE: **the electron** in a hydrogen atom **occupies (is restricted to) fixed energy levels (fixed energy values** or **discrete energies)** //

in the ground state **electrons occupy the lowest** available **energy levels** //

the electron can move (jump, become excited) to a higher energy **level if it receives** a certain amount of **energy (heat, light, a photon** of energy**)** //

the energy (photon) absorbed must exactly **equal the energy difference between ground state (lower level) and excited state (higher level)** /
absorbing light (energy, photon) according to $E_2 - E_1 = hf$ ($h\upsilon$), [$E_2 - E_1$ *symbols must be explained*] //

excited state unstable / excited state temporary / electron falls back to a lower level //

emitting (giving out) the excess energy in the form of **a photon** of light **(hf, $h\upsilon$)** /
emitting (giving out) light of **definite frequency (wavelength)** /
emitting light* according to $E_2 - E_1 = hf$ ($h\upsilon$), [$E_2 - E_1$ *symbols must be explained*]
[Accept "energy" for "light" if f(υ) is explained as frequency.]
ANY FIVE: (5 × 3)
[Marks may be awarded where the required information is clearly provided in diagrams.]

EXPLAIN: metal atoms of different elements have **different** sets of **energy levels (values){different electron configurations (arrangement), different numbers of electrons in shells}** / **individual (different, characteristic)** set of **electron transitions** for each metal //

therefore they **emit different (characteristic, unique, their own) frequencies (wavelengths,** *not colours*) of light /
therefore they have **different (characteristic, unique, their own) spectra** (2 × 3)

WHAT: **red (crimson)** (3)

DESCRIBE: **salt on platinum (nichrome) probe (wire) / salt on soaked** wooden **splint (stick) / salt in solution** //

hold **in (over, against edge, at top) of flame*** / for solution **spray into flame*** (2 × 3)
*[*Accept "Bunsen" for "flame."]*

(c) EXPLAIN **not possible to measure (find, know, get, etc,) the** exact **position (location)** //

and momentum (energy, velocity, speed) of electron (particle, named particle) in an atom **simultaneously (at the same time)** (2 × 3)
["position" and "momentum" are interchangeable.]

GIVE: **wave nature (properties)** of electron (**wave-particle** duality) / **higher resolution spectra / sublevels / Zeeman effect (splitting of spectral lines) / electron spin / failure** of theory **with higher elements (except for hydrogen, with multi-electron systems)** *[Do not accept "orbitals."]* ANY ONE: (3)

WHAT: **region (space, volume** *but not "area" or "place"***)** around the nucleus of an atom //

where there is a 99% (high) probability (possibility) of finding an electron /
where electron most **likely to be (has a high possibility of being) found**
or
space occupied by electron // described by solution of Schrödinger equation (2 × 3)

Question 6 (2011 - Section B - Question 5 - Part (a))

(a) DEFINE: (i) **number of protons** in the nucleus of an atom of the element (5)
[*Do not accept 'number of electrons.'*]

(ii) **average mass of atom(s)** of element / **average of isotopes taking abundances into account //**
relative to (based on) $^{1}/_{12}$ mass of **carbon-12** atom (2 × 3)

Question 7 (2009 - Section B - Question 10 - Part (c))

(c) (i) atoms of **same element (same atomic number, same number of protons)** having **different mass** numbers **(different numbers of neutrons)** (4 + 3)

(ii) positive **ions (charged particles) separated (deflected, spread out)** *[For diagram give not more than (3)]* (3)
based on (according to) relative **mass(es) (charge-to-mass ratio)** (3)
when moving **in a magnetic field** [Allow "weight" for "mass"] (3)
[Allow "between (electro)magnets" for "in a magnetic field"]

(iii) **20.19** (9)

90.5 x 20 / 1810					(3)
9.5 x 22 / 209					(3)
100.0	= 2019	=>	A_r =	20.19	(3)

[Alternative method: 90.5 % of 20 / 18.1 (3) + 9.5 % of 22 / 2.09 (3) = 20.19 (3)]

[Marks for 20.19 not awarded if answer is given rounded off. If candidate shows 20.19 and rounds off, 1 mark is lost. The earlier partial marks are still available if shown.]

Question 8 (2005 - Section B - Question 5 - Part (a))

QUESTION 5

(a) ISOTOPES: atoms of **same element (same atomic number, same Z, same number of protons)** with **different mass numbers (different A, different number of neutrons)** (5)

NAME: **Becquerel** (3)

GIVE: **Example** (mass number essential) (6) **Use** (3)

Deuterium, H-2; (nuclear fusion); carbon-13 (tracers in biosynthesis); carbon-14 (dating of ancient remains); caesium-135 (measurement of second); cobalt-60 (radiotherapy, cancer treatment, sterilisation); americium-241 (smoke alarms); phosphorus-32 (plant nutrient tracer, medical e.g. bone scans, radiotherapy); iodine-125 (medical tracer); caesium-137 (radiotherapy); oxygen-18 (reaction mechanisms); technetium-99 (medical tracer); uranium-235/uranium-238 (weapons, power); etc.,
[Must be matched. Note: mass number essential]

Question 9 (2011 - Section B - Question 5 - Part (b) - (d))

(b) BASIS: when arranged **according to (in order of)** increasing **atomic weight (**relative **atomic mass) //**
there is a **periodic occurrence (repeat) of similar elements (**elements with similar **properties) / similar elements (**elements with similar **properties) recur at intervals /** arranged elements **grouped by similar properties** (2 × 3)

SPACES: so that **similar elements (elements with same properties)** were **in same group /**
because **next element wouldn't fit /** because of **undiscovered elements /**
because **next** known **element (e.g. As) unlike next group (B group, Grp. III) /**
because **next** known **element (e.g. As)** more **like group further on (N group, Group V)** (3)

REVER: to **suit (fit) properties to groups /**
the **lower atomic mass element fitted better in the higher group** and *vice versa* **/ tellurium fitted better with (has properties like) the O group (Grp. VI) / iodine fitted better with (has properties like) the halogens (F group, Group VII)** (3)

(c) EXPL: (i) **readily lose single (an) electron** in outer shell **/ low** first **ionisation energy** (6)
[*Allow 3 marks for: due to 'small effective nuclear charge (high shielding effect by inner shells)'/ 'to give stable octet (noble gas configuration)'*]

(ii) **increase in atomic radius / atoms getting bigger / outer electron** getting **further from nucleus / decrease in** first **ionisation energy / outer electron more easily lost** (3)

(d) (i) DEFINE: **region (space,** *accept 'area'***)** around the nucleus of an atom //
where there is a 99 % (high) probability of finding an electron /
where electron most **likely to be found** (2 × 3)

or

space occupied by electron //
described by solution of Schrödinger equation (2 × 3)

(ii) WRITE: **$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$ / [Ar]$4s^2 3d^5$ / $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$ / [Ar]$3d^5 4s^2$** (6)
[*Accept $p_x^2 y^2 z^2$ for $p_x^2 p_y^2 p_z^2$ or p^6; accept subscripts.*]

(iii) WHAT: **electrons entering (occupying) 3d** sublevel (**All end in $3d_x$)** (6)
[*Accept 'their outer electrons in 3d,' 'their outer sublevel is 3d,' all have electrons in 3d.' Do not accept 'partially filled 3d.' Accept 'partially or completely filled 3d'*]

Question 10 (2008 - Section B - Question 4 - Part (b))

(b) **characteristic positive charge** for element / **atomic number / number of protons** in nucleus (6)
[Accept "arranged in increasing atomic number".]

Question 11 (2003 - Section B - Question 4 - Part (i))

(i) Mendeleev {Moseley}*: **order of atomic mass (weight) {order of atomic number} / gaps (fewer elements) {fewer gaps (no gaps), more elements } / reversed elements {no reversing} / man-made elements absent {man-made elements present} / transition elements not in separate block {transition elements in separate block} / lanthanides (rare earths) not in separate block {lanthanides in separate block} / actinides not in separate block {actinides in separate block} / no detectable naturally-occurring radioactive elements {detectable naturally-occurring radioactive elements present}** *[Accept: noble gases absent {noble gases present}]*

Note: the differences may be given from either point of view. ANY TWO: (2 × 3)

**If Mendeleev right but Moseley wrong (or vice versa) for same point, the (3) not given.*