CHEMISTRY ONLINE
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CHEMISTRY

Physical Chemistry

Level & Board	AQA (A-LEVEL)
TOPIC:	ATOMIC STRUCTURE
PAPER TYPE:	SOLUTION -2
TOTAL QUESTIONS	11
TOTAL MARKS	32

Atomic Structure Mark Scheme - 2

1. (a)

Current model includes: Neutrons and protons in the nucleus whereas Rutherford doesn't

Current model shows electrons revolving around in different energy levels whereas Rutherford model doesn't.

(b)

$^{54}Fe^{+}$

Relative Atomic mass = Σ isotopic mass ×abundance / Total abundance
First, calculate the missing abundance

Isotope	Abundance
54	5.8%
56	91.8%
57	2.1%

Add all percentages together so = 5.8 + 91.8 + 2.1 = 99.7%
(one mark for this)
Therefore, the abundance of isotope 58 is = 100 – 99.7 = 0.3%
Now put in the values into the R.A.M formulae =

= (54×5.8) + (56×91.8) +(57×2.1) + (58×0.3) / 100
= 313.2 + 5140.8 + 119.7 + 17.4 / 100
= 5591.1 / 100
= 55.91

2. (d)
3. (a)
4. (c)
5. (d)

6. (a)

The number of protons and electrons in the nucleus is called the mass number.

(b)

^{50}Cr

Protons = 24
Neutrons = 26
Electrons = 24

$^{54}Cr^{2+}$
Protons = 24
Neutrons = 30
Electrons = 22

Now let's:
Calculating the percentage abundance of
^{56}Ni is the sample;
Let's $^{59}Ni^{+}$ be y
So, $^{57}Ni^{+} = 2y$
$^{58}Ni^{+} = 2y$
$^{61}Ni = 2y$

Let's apply the formulae R.A.M calculation
$58.1 = (56 \times (100 - 7y)) + (57 \times 2y) + (58 \times 2y) + (59 \times y) + (61 \times 2y) / 100$
$58.1 \times 100 = (5600 - 392y) + (114y) + (116y) + (59y) + (112y)$
$5810 = 5600 - 392y + 114y + 116y + 59y + 112y$
$5810 = 5600 - 392y + 114y + 411y$
$5810 - 5600 = 19y$
$210 / 19 = 19y / 19$
$y = 11\%$

So, abundance is as follows:
$^{59}Ni^{+} = 11\%$
$^{57}Ni^{+} = 22\%$
$^{58}Ni^{+} = 22\%$
$^{59}Ni^{+} = 11\%$
$^{61}Ni^{+} = 22\%$

Now, the abundance of $^{56}Ni^{+}$
$= [100 - (11 + 22 + 22 + 11 + 22)]$
$= [100 - 88]$
$= 12\%$

7. (c)

8. (a)

Average mass of an atom of an element compound to $1/12^{th}$ of the mass of an atom of $carbon^{-12}$
Tip: Don't forget to use the word average in R.A.M. definition.

(b)

Relative atomic mass = (54×4) + (56×2) + (57×14) + (58×6) / 26
= 216 + 112 + 798 + 348 / 26
= 1474 / 26
= 56.6

(c)

Important information:
K.E = 3.63×10^{-14}J
Time: 1.2×10^{-3}s
Ion: $^{58}Fe^{+}$

Step 1: Calculate the mass of the single ion
= Ion mass / Avogadro's No
= 58 / 6.02×10^{23}
= 9.63×10^{-23}g

Step 2: K.E = 1/ 2 mv^2

Tip: Don't forget to convert the mass of a single into kg before plugging in the value of mass.
3.63×10^{-14} = 1/ 2 $(9.63\times10^{-26})(v^2)$
(3.63×10^{-14}) 2 = $(9.63\times10^{-26})(v^2)$
v = $\sqrt{(3.63\times10^{-14})}$ 2 / (9.63×10^{-26})
868270 m/s

Step 3: Distance traveled = velocity x time
= 868270×(1.2×10^{-3})
=1041m

9. (a)

10. (c)

11. (a)
The average mass of an atom of an element compound to 1/12th of the mass of an atom of carbon^{-12}
Tip: Don't forget to use the word average in the R.A.M. definition.

(b)

^{45}Sc is 76.1% abundant
Let x be the abundance of ^{43}Sc
Therefore, the abundance of ^{46}Sc is = (100 – 76.1) – x

$= (23.9 - x)$

Now let's calculate abundance and apply R.A.M calculation formulae
$44.9 = (43xx) + (45x76.1) + (46 x (23.9 - x)) / 100$
$44.9x100 = 43x + 3424.5 + 1099.4 - 46x$
$4490 = 43x + 4523.9 - 46x$
$4490 - 4523.9 = -3x$
$-33.9 = -3x$
$x = 11.3\%$

(c)

Similarity: same number of protons
Difference: different number of neutrons

(d)

Reason: Ions could be accelerated
Reason: Ions create a current when it hits the detector.

(e)

Important information:
Length of tube = 1.35m
Kinetic energy = 1.3×10^{-12}J
Ion = $^{43}Sc^{+}$

Step 1: calculate mass of single in of Sc
= Mass / N_A = 43 / 6.02×10^{23} = 7.14×10^{-23}g
Convert into kg to be used in K.E equation
= 7.14×10^{-23} / 1000 = 7.14×10^{-26}kg

Step 2:
K.E = 1/ 2 mv^2
1.3×10^{-12} = 1/ 2(7.14×10^{-26}) (v^2)
(1.3×10^{-12}) 2 = (7.14×10^{-26}) (v^2)
(1.3×10^{-12}) / (7.14×10^{-26}) = v^2
$\sqrt{2.6 \times 10^{-12}}$ / (7.14×10^{-26}) = v
v = 6034448m/s

Step 3:
velocity = distance / time
6034448 = 1.35 / time
time = 1.35/ 6034448
= 2.2×10^{-7}

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