**IB Chemistry – SL**

**Topic 2 Questions**

**1.** Consider the composition of the species W, X, Y and Z below. Which species is an anion?

|  |  |  |  |
| --- | --- | --- | --- |
| **Species** | **Number of protons** | **Number of neutrons** | **Number of electrons** |
| W | 9 | 10 | 10 |
| X | 11 | 12 | 11 |
| Y | 12 | 12 | 12 |
| Z | 13 | 14 | 10 |

A. W

B. X

C. Y

D. Z

(Total 1 mark)

**2.** Energy levels for an electron in a hydrogen atom are

A. evenly spaced.

B. farther apart near the nucleus.

C. closer together near the nucleus.

D. arranged randomly.

(Total 1 mark)

**3.** Which is related to the number of electrons in the outer main energy level of the elements from the alkali metals to the halogens?

I. Group number

II. Period number

A. I only

B. II only

C. Both I and II

D. Neither I nor II

(Total 1 mark)

**4.** How do bond length and bond strength change as the number of bonds between two atoms increases?

|  |  |  |
| --- | --- | --- |
|  | **Bond length** | **Bond strength** |
| A. | Increases | increases |
| B. | Increases | decreases |
| C. | Decreases | increases |
| D. | Decreases | decreases |

(Total 1 mark)

**5.** Which of the following is true for CO2?

|  |  |  |
| --- | --- | --- |
|  | **C=O bond** | **CO2 molecule** |
| A. | Polar | non-polar |
| B. | non-polar | polar |
| C. | Polar | polar |
| D. | non-polar | non-polar |

(Total 1 mark)

**6.** The molar masses of C2H6, CH3OH and CH3F are very similar. How do their boiling points compare?

A. C2H6 < CH3OH < CH3F

B. CH3F < CH3OH < C2H6

C. CH3OH < CH3F < C2H6

D. C2H6 < CH3F < CH3OH

(Total 1 mark)

**7.** What is the correct number of each particle in a fluoride ion, 19F – ?

|  |  |  |  |
| --- | --- | --- | --- |
|  | **protons** | **neutrons** | **electrons** |
| A. | 9 | 10 | 8 |
| B. | 9 | 10 | 9 |
| C. | 9 | 10 | 10 |
| D. | 9 | 19 | 10 |

(Total 1 mark)

**8.** Which statement is correct for the emission spectrum of the hydrogen atom?

A. The lines converge at lower energies.

B. The lines are produced when electrons move from lower to higher energy levels.

C. The lines in the visible region involve electron transitions into the energy level closest to the nucleus.

D. The line corresponding to the greatest emission of energy is in the ultraviolet region.

**9.** Which is the correct description of polarity in F2 and HF molecules?

A. Both molecules contain a polar bond.

B. Neither molecule contains a polar bond.

C. Both molecules are polar.

D. Only one of the molecules is polar.

(Total 1 mark)

**10.** Which types of bonding are present in CH3CHO in the liquid state?

I. Single covalent bonding

II. Double covalent bonding

III. Hydrogen bonding

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(Total 1 mark)

**11.** Which statement(s) is/are generally true about the melting points of substances?

I. Melting points are higher for compounds containing ions than for compounds containing molecules.

II. A compound with a low melting point is less volatile than a compound with a high melting point.

III. The melting point of a compound is decreased by the presence of impurities.

A. I only

B. I and III only

C. II and III only

D. I, II and III

(Total 1 mark)

**12.** How many valence electrons are present in an atom of an element with atomic number 16?

A. 2

B. 4

C. 6

D. 8

(Total 1 mark)

**13.** A certain sample of element *Z* contains 60% of 69*Z* and 40% of 71*Z*. What is the relative atomic mass of element *Z* in this sample?

A. 69.2

B. 69.8

C. 70.0

D. 70.2

(Total 1 mark)

**14.** What is the difference between two neutral atoms represented by the symbols Co and Ni?

A. The number of neutrons only.

B. The number of protons and electrons only.

C. The number of protons and neutrons only.

D. The number of protons, neutrons and electrons.

(Total 1 mark)

**15.** How many electrons are there in one 2+ ion?

A. 10

B. 12

C. 14

D. 22

(Total 1 mark)

**16.** The electron arrangement of sodium is 2.8.1. How many occupied main electron energy levels are there in an atom of sodium?

A. 1

B. 3

C. 10

D. 11

(Total 1 mark)

**17.** Information is given about four different atoms:

|  |  |  |
| --- | --- | --- |
| Atom | neutrons | protons |
| W | 22 | 18 |
| X | 18 | 20 |
| Y | 22 | 16 |
| Z | 20 | 18 |

Which **two** atoms are isotopes?

A. W and Y

B. W and Z

C. X and Z

D. X and Y

(Total 1 mark)

**18.** Which statement is correct about a line emission spectrum?

A. Electrons absorb energy as they move from low to high energy levels.

B. Electrons absorb energy as they move from high to low energy levels.

C. Electrons release energy as they move from low to high energy levels.

D. Electrons release energy as they move from high to low energy levels.

(Total 1 mark)

**19.** How many neutrons are there in the ion 18O2– ?

A. 8

B. 10

C. 16

D. 20

(Total 1 mark)

**20.** What is the electron arrangement of silicon?

A. 2.4

B. 2.8

C. 2.8.4

D. 2.8.8

(Total 1 mark)

**21.** Which statement is correct about the isotopes of an element?

A. They have the same mass number

B. They have the same electron arrangement

C. They have more protons than neutrons

D. They have the same numbers of protons and neutrons

(Total 1 mark)

**22.** What is the difference between two neutral atoms represented by the symbols Po and At?

A. The number of neutrons only.

B. The number of protons and electrons only.

C. The number of protons and neutrons only.

D. The number of protons, neutrons and electrons.

(Total 1 mark)

**23.** Which statements are correct for the emission spectrum of the hydrogen atom?

I. The lines converge at lower energies.

II. Electron transition to n =1 are responsible for lines in the UV region.

III. Lines are produced when electrons move from higher to lower energy levels.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(Total 1 mark)

**24.** What is the symbol for a species that contains 15 protons, 16 neutrons and 18 electrons?

A. 

B. 

C. 

D. 

(Total 1 mark)

**25.** What is the electron arrangement of an Al3+ ion?

A. 2, 8

B. 2, 3

C. 2, 8, 3

D. 2, 8, 8

(Total 1 mark)

**26.** What will happen to the volume of a fixed mass of gas if the pressure and the Kelvin temperature are both doubled?

A. It will remain the same.

B. It will be double its initial volume.

C. It will be one-half its initial volume.

D. It will be four times its initial volume.

(Total 1 mark)

**27.** Which species has 54 electrons and 52 protons?

A. 

B. 

C. 

D. 

(Total 1 mark)

**28.** What is the correct sequence for the processes occurring in a mass spectrometer?

A. vaporization, ionization, acceleration, deflection

B. vaporization, acceleration, ionization, deflection

C. ionization, vaporization, acceleration, deflection

D. ionization, vaporization, deflection, acceleration

(Total 1 mark)

**29.** The percentage composition by mass of a hydrocarbon is C = 85.6% and H = 14.4%.

(a) Calculate the empirical formula of the hydrocarbon.

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(2)

(b) A 1.00 g sample of the hydrocarbon at a temperature of 273 K and a pressure of   
1.01×105 Pa (1.00 atm) has a volume of 0.399 dm3.

(i) Calculate the molar mass of the hydrocarbon.

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(2)

(ii) Deduce the molecular formula of the hydrocarbon.

(1)

(Total 5 marks)

**30.** State the number of protons, electrons and neutrons in the ion N3–.

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(Total 2 marks)

**31.** A sample of germanium is analyzed in a mass spectrometer. The first and last processes in mass spectrometry are vaporization and detection.

(a) (i) State the names of the other three processes in the order in which they occur in a mass spectrometer.

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(2)

(ii) For each of the processes named in (a) (i), outline how the process occurs.

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(3)

(b) The sample of germanium is found to have the following composition:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Isotope | 70Ge | 72Ge | 74Ge | 76Ge |
| Relative abundance /  | 22.60 | 25.45 | 36.73 | 15.22 |

(i) Define the term *relative atomic mass*.

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(2)

(ii) Calculate the relative atomic mass of this sample of germanium, giving your answer to two decimal places.

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(2)

(Total 9 marks)

**32.** Define the following terms.

(i) *atomic number*

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(1)

(ii) *mass number*

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(1)

(Total 2 marks)

**33.** State the electron arrangements of the following species:

Si ........................................................................................................................................

P3– ........................................................................................................................................

(Total 2 marks)

**34.** Identify the numbers of protons, neutrons and electrons in the species 33S2–.

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(Total 1 mark)

**35.** State the electron arrangement for atoms of aluminium, nitrogen and fluorine.

(Total 2 marks)

**36.** The relative atomic mass of chlorine is 35.45. Calculate the percentage abundance of the two isotopes of chlorine, 35Cl and 37Cl in a sample of chlorine gas.

(Total 2 marks)

**37.** (a) Describe the following stages in the operation of the mass spectrometer.

(i) ionization

(2)

(ii) deflection

(2)

(iii) acceleration

(1)

(b) (i) State the meaning of the term *isotopes* of an element.

(1)

(ii) Calculate the percentage abundance of the two isotopes of rubidium 85Rb and 87Rb.

(2)

(iii) State **two** physical properties that would differ for each of the rubidium isotopes.

(1)

(iv) Determine the full electron configuration of an atom of Si, an Fe3+ ion and a P3– ion.

(3)

(Total 12 marks)

**38.** Naturally occurring copper has a relative atomic mass, (*A*r), of 63.55 and consists of two isotopes 63Cu and 65Cu.

(i) Define the term *relative atomic mass*, *A*r.

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(1)

(ii) State and explain which is the more abundant isotope.

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(1)

(Total 2 marks)

**39.** The element vanadium has two isotopes,  and  and a relative atomic mass of 50.94.

(a) Define the term *isotope*.

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(1)

(b) State the number of protons, electrons and neutrons in 

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(2)

(c) State and explain which is the more abundant isotope.

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(1)

(d) State the name and the mass number of the isotope relative to which **all** atomic masses are measured.

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(1)

(Total 5 marks)

**40.** (a) State a physical property that is different for isotopes of an element.

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(1)

(b) Chlorine exists as two isotopes, 35Cl and 37Cl. The relative atomic mass of chlorine is 35.45. Calculate the percentage abundance of each isotope.

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(2)

(Total 3 marks)

**41.** (a) Define the term *isotope*.

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(2)

(b) A sample of argon exists as a mixture of three isotopes.

mass number 36, relative abundance 0.337%  
mass number 38, relative abundance 0.0630%  
mass number 40, relative abundance 99.6%

Calculate the relative atomic mass of argon.

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(2)

(c) State the number of electrons, protons and neutrons in the ion 56Fe3+.

electrons: ............................. protons: ............................. neutrons: ...........................

(2)

(Total 6 marks)

**42.** The element bromine exists as the isotopes 79Br and 81Br, and has a relative atomic mass of 79.90.

(a) Complete the following table to show the numbers of sub-atomic particles in the species shown.

|  |  |
| --- | --- |
| an atom of 79Br | an ion of 81Br– |
| protons |  |  |
| neutrons |  |  |
| electrons |  |  |

(3)

(b) State and explain which of the two isotopes 79Br and 81Br is more common in the element bromine.

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(1)

(c) The element calcium is in the same period of the Periodic Table as bromine.

(i) Write the electron arrangement for an atom of calcium.

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(1)

(ii) Deduce the formula of the compound calcium bromide.

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(1)

(Total 6 marks)

**43.** Some vaporized magnesium is introduced into a mass spectrometer. One of the ions that reaches the detector is 25Mg+.

(a) Identify the number of protons, neutrons and electrons in the 25Mg+ ion.

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(1)

(b) State how this ion is accelerated in the mass spectrometer.

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(1)

(c) The 25Mg2+ ion is also detected in this mass spectrometer by changing the magnetic field. Deduce and explain, by reference to the *m/z* values of these two ions of magnesium, which of the ions 25Mg2+ and 25Mg+ is detected using a stronger magnetic field.

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(2)

(Total 4 marks)

**44.** (a) List the following types of electromagnetic radiation in order of **increasing** wavelength (shortest first).

**I.** Yellow light

**II.** Red light

**III.** Infrared radiation

**IV.** Ultraviolet radiation

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(1)

(b) Distinguish between a continuous spectrum and a line spectrum.

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(1)

(c) The thinning of the ozone layer increases the amount of UV-B radiation that reaches the Earth’s surface.

|  |  |
| --- | --- |
| **Type of Radiation** | **Wavelength / nm** |
| UV-A | 320–380 |
| UV-B | 290–320 |

Based on the information in the table above explain why UV-B rays are more dangerous than UV-A.

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(3)

(Total 5 marks)

**IB Chemistry – SL**

**Topic 2 Answers**

**1.** A

[1]

**2.** B

[1]

**3.** A

[1]

**4.** C

[1]

**5.** A

[1]

**6.** D

[1]

**7.** C

[1]

**8.** D

[1]

**9.** D

[1]

**10.** A

[1]

**11.** B

[1]

**12.** C

[1]

**13.** B

[1]

**14.** D

[1]

**15.** A

[1]

**16.** B

[1]

**17.** B

[1]

**18.** D

[1]

**19.** B

[1]

**20.** C

[1]

**21.** B

[1]

**22.** D

[1]

**23.** C

[1]

**24.** D

[1]

**25.** A

[1]

**26.** A

[1]

**27.** A

[1]

**28.** A

[1]

**29.** (a) mole ratio C:H =  = 7.13:4.3;

No penalty for using integer atomic masses.

empirical formula is  2

(b) (i) number of moles of gas n = ;

= 56.3 (g mol–1) 2

**OR**

molar mass is the  at STP;  
= = 56.1 (g mol–1)

Accept answers in range 56.0 to 56.3.

Accept two, three or four significant figures.

(ii) C4H8; 1

No ECF.

[5]

**30.** 7 protons, 8 neutrons, 10 electrons; 2

Award **[2]** for three correct and **[1]** for two correct.

[2]

**31.** (a) (i) ionization, acceleration, deflection/separation; 2

Award **[1]** for all three names and **[1]** for correct order.

Award **[1]** for two names in correct order.

(ii) ionization: sample bombarded with high-energy or high-speed  
electrons/*OWTTE*;

acceleration: electric field/oppositely charged plates;

deflection: (electro)magnet/magnetic field; 3

(b) (i) average or (weighted) mean of masses of all isotopes of an element;

relative to (one atom of) 12C; 2

Both marks available from a suitable expression.

(ii) *A*r = (700.2260) + (720.2545) + (740.3673) + (760.1522);

= 72.89; 2

No other final answer acceptable.

Award **[2]** for correct final answer.

[9]

**32.** (i) number of protons in the nucleus/atom; 1

Do not accept protons and electrons.

(ii) number of protons and neutrons in the nucleus/atom; 1

[2]

**33.** Si 2.8.4/2,8,4;  
P3 2.8.8/2,8,8; 2

[2]

**34.** 16 protons and 17 neutrons and 18 electrons; 1

[1]

**35.** Al  2,8,3;  
N  2,5;  
F  2,7; 2

Award **[2]** for three correct, **[1]** for two or one correct.

Accept correct configuration using s,p,d notation.

[2]

**36.** *A*r(Cl) = 35.45 = ;

35Cl = 77.5% and 37Cl = 22.5%; 2

[2]

**37.** (a) (i) to produce positively charged ions;

by the bombardment of fast moving electrons; 2

(ii) magnetic field at right angles to path of ions/accept suitably  
labelled diagram;

moves ions in curve path/deflects ions;

dependent on mass/charge ratio; 2

Award **[1]** each for any 2 points.

(iii) acceleration of the ions by electric field/towards negative plate/cathode; 1

(b) (i) atoms with the same number of protons/positive charges/atomic  
number but different number of neutrons/mass number; 1

(ii) *A*r(Rb) = 85.47 = 

Accept other valid mathematical alternatives.

85Rb = 76.5 and 87Rb = 23.5%; 2

(iii) mass; density;

boiling point;

melting point;

rate of diffusion in the gas phase;

enthalpy of vaporization;

enthalpy of fusion;

rate of reaction in the gas/liquid phase; 1

Any two for one mark

(iv) Si: 1s22s22p63s23p2;

Fe3+: 1s22s22p63s23p63d5;

P3 : 1s22s22p63s23p6; 3

Allow **[1 max]** for 3 correct abbreviated structures using noble gas symbols.

**38.** (i) ratio of average mass of an atom to  the mass of C-12 isotope/  
average mass of an atom on a scale where one atom of C-12 has a mass of 12/sum  
of the weighted average mass of isotopes of an element compared to  
C-12/*OWTTE*; 1

Award no mark if ‘element’ is used in place of ‘atom’

(ii) 63Cu (more abundant) since *A*r (Cu) is closer in mass to 63; 1

Explanation needed for mark

[2]

**39.** (a) atom of same element/same number of protons but with different  
mass number/number of neutrons; 1

(b) protons 23  
electrons 23  
neutrons 27 2

Three correct **[2]**, two correct **[1]**.

(c) /51 nearer to *A*r value of 50.94; 1

(d) carbon, 12/12C; 1

[5]

**40.** (a) mass/density/for gases: rate of effusion or diffusion/melting point/  
boiling point 1

Do not accept mass number.

(b) if 35Cl = *x*, then (*x* = 35.00) + (1 – *x*) 37.00 = 35.45  
*Award* ***[1]*** *for set up.*

therefore, *x* = 0.775; 2  
35Cl = 77.5% and 37Cl = 22.5%;  
*(need both for mark);*

[3]

**41.** (a) atoms of the same element/same number of protons/same atomic number;  
having different numbers of neutrons/different (mass number); 2

Award only **[1]** max if reference made to elements but not atoms.

(b) relative atomic mass = ; 2

(c) 23 electrons;  
26 protons;  
30 neutrons; 2

Award **[2]** for three correct, **[1]** for two correct.

[6]

**42.** (a)

|  |  |
| --- | --- |
| an atom of 79Br | an ion of 81Br– |
| protons | 35 | 35 | ; |
| neutrons | 44 | 46 | ; |
| electrons | 35 | 36 | ; |

3

(b) 79Br because *A*r is closer to 79/*OWTTE*; 1

(c) (i) 2,8,8,2/2.8.8.2; 1

(ii) CaBr2; 1

[6]

**43.** (a) 12 protons and 13 neutrons and 11 electrons; 1

(b) electric field/oppositely charged plates/potential difference/*OWTTE*; 1

(c) 25Mg+;

greater *m/z* value/less highly charged ions need stronger fields to  
deflect them/*OWTTE*; 2

Do not accept greater mass with no reference to charge, or greater mass and smaller charge.

[4]

**44.** (a) IV < I < II < III/  
ultra violet radiation < yellow light < red light < infrared radiation; 1

(b) A continuous spectrum has all colours/wavelengths/frequencies whereas  
a line spectrum has only (lines of) sharp/discrete/specific colours/  
wavelengths/frequencies; 1

(c) UV-B radiation has shorter wavelength;  
hence, has higher energy;  
increases risk of damage to skin cells/OWTTE/causes cancer; 3

[5]