**General**

**Environmental Science & Technology**

**Tutorial Booklet**

**Exam Date: \_\_\_\_\_\_\_\_\_\_\_\_\_**

**Simplified atomic model and Isotopes**

• The neutron is one of the particles that make up an atom. With the proton, it forms the nucleus. It has no electrical charge, so it is neutral (p. 16).

• The simplified atomic model is a representation of the atom indicating the number of protons and neutrons in the nucleus and the number of electrons in each of the electron shells (p. 16).

• The atomic number represents the number of protons in the nucleus of an atom. It distinguishes one element from another (p. 24).

• The relative atomic mass is the mass of an atom measured by comparison with a reference element, carbon-12 (p. 25).

• The mass number is a whole number indicating the sum of the numbers of protons and neutrons in an atom (p. 25).

• An isotope is an atom of an element with the same number of protons as another atom of the same element but with a different number of neutrons (p. 26).

• In the simplified atomic model, atoms are represented with numbers, symbols and arcs. This representation clearly shows the number of protons and neutrons in an atom. It also shows the number of electrons in each shell. Protons and electrons are placed in almost the same way as in the Rutherford-Bohr model, with the following differences: the number of protons in the nucleus is followed by the letter *p* and a superscript “+” sign, arcs replace circles for the electron shells, and the number of electrons is indicated by a number followed by the letter *e* and a superscript “–” sign. The number of neutrons (calculated by subtracting the atomic number from the mass number, which is the relative atomic mass rounded to the nearest whole number) is shown in the nucleus, followed by the letter *n* (p. 28).

1. The atomic number of fluorine (F) is 9 and its mass number is 19. Which of the following diagrams correctly represents the simplified atomic model of a fluorine atom?

|  |  |  |  |
| --- | --- | --- | --- |
| A) |  | C) |  |
| B) |  | D) |  |

1. Which of the following diagrams represents the simplified atomic model of the phosphorus atom, ?

|  |  |  |  |
| --- | --- | --- | --- |
| A) |  | C) |  |
| B) |  | D) |  |

1. Which of the following diagrams correctly represents the simplified atomic model of the beryllium (Be) atom?

|  |  |  |  |
| --- | --- | --- | --- |
| A) |  | C) |  |
| B) |  | D) |  |

1. Which of the following characteristics describe an atom in terms of the simplified model?

|  |  |
| --- | --- |
| 1. | The number of electrons is equal to the number of protons. |
| 2. | The number of protons is equal to the number of neutrons. |
| 3. | The nucleus is made up of neutrons, protons and electrons. |
| 4. | The nucleus is made up of neutrons and electrons. |
| 5. | The nucleus is made up of protons and neutrons. |
| 6. | Protons revolve around the nucleus. |
| 7. | Electrons revolve around the nucleus. |

1. 1, 2 and 3 B) 1, 4 and 6 C) 1, 5 and 7 D) 2, 5 and 7

1. The mass number of lithium (Li) is 7 and its atomic number is 3. Which of the following diagrams represents the simplified atomic model of a lithium atom?

|  |  |  |  |
| --- | --- | --- | --- |
| A) |  | C) |  |
| B) |  | D) |  |

1. What is the mass number of an element?
2. It is the number of neutrons only. C) It is the sum of the protons and neutrons.
3. It is the number of electrons only. D) It is the sum of the protons and electrons.
4. The atomic number of the element potassium (K) is 19 and its mass number is 40.

Which combination of particles corresponds to the simplified Rutherford-Bohr model of the potassium atom?

1. 19 protons, 21 neutrons, 19 electrons C) 40 protons, 19 neutrons, 40 electrons
2. 19 protons, 40 neutrons, 19 electrons D) 40 protons, 21 neutrons, 21 electrons

1. What general observation can be made regarding the atomic radius across a row or a period of the Periodic Table?
2. It increases with increasing atomic number, Z.
3. It decreases with increasing atomic number, Z.
4. It remains constant with increasing atomic number, Z.
5. It varies in an irregular fashion, with no relation to the atomic number.
6. The atomic number of chlorine is 17 and its mass number is 35. Which of the following diagrams correctly represents the simplified atomic model of a chlorine atom?

|  |  |  |  |
| --- | --- | --- | --- |
| A) |  | C) |  |
| B) |  | D) |  |

1. An atom is composed of 23 protons, 23 electrons and 28 neutrons. What is the mass number of the atom?
2. 23 B) 28 C) 51 D) 46
3. For a neutral atom the atomic number, Z, is equal to which of the following?
4. The sum of the number of protons and neutrons
5. The number of neutrons or the number of electrons
6. The number of protons or the number of electrons
7. The number of protons or the number of neutrons
8. The following graph shows the number of neutrons and the number of protons in the isotopes of different elements.



Using this graph, determine the mass number for each of the three different isotopes of carbon, C.

1. Choose the correct answer to complete the following sentence. In all neutral atoms there are always...
2. as many protons as electrons. C) as many electrons as neutrons.
3. as many protons as neutrons. D) more neutrons than protons.

1. Associate each particle with its description. (Each description can only be used once)

|  |  |
| --- | --- |
| **Particles** | **Descriptions** |
| 1. Neutron  2. Proton  3. Electron | a) Positive particle situated in the nucleus of the atom.  b) Neutral particle situated in the nucleus of the atom  c) Negative particle revolving outside the nucleus |

1. In the Periodic Table, what is the relationship between the atomic mass of an element and its atomic number, Z ?
2. In general, the atomic mass of an element decreases as the atomic number, Z, increases.
3. In general, the atomic mass of an element increases as the atomic number, Z, increases.
4. In general, there is no relationship between the atomic mass of an element and the atomic number, Z.
5. In general, the atomic mass of an element increases by the same amount as the atomic number, Z.
6. The element hydrogen has three isotopes : and

Which of the following statements is **false** ?

1. The three atoms have the same number of protons.
2. The three atoms have the same number of electrons.
3. The three atoms have the same number of neutrons.
4. The three atoms have the same chemical properties.
5. Given the isotope of oxygen,

How many neutrons, electrons and protons does this atom have?

1. 8 neutrons, 10 electrons and 10 protons. C) 10 neutrons, 8 electrons and 8 protons.
2. 8 neutrons, 18 electrons and 8 protons. D) 18 neutrons, 8 electrons and 8 protons.
3. Two isotopes of chlorine are found in nature. What is the difference between these two isotopes?
4. The number of electrons C) The number of neutrons
5. The number of protons D) The number of electron orbits (energy levels)
6. An oxygen atom has 8 protons, 8 neutrons and 8 electrons. Which of the following describes an isotope of an oxygen atom?
7. It has 8 protons, 8 neutrons and 10 electrons.
8. It has 10 protons, 8 neutrons and 8 electrons.
9. It has 8 protons, 10 neutrons and 8 electrons.
10. It has 10 protons, 10 neutrons and 8 electrons.
11. Following his experiments dealing with the deflections of alpha particles passing through a thin sheet of gold foil, Rutherford modified the atomic model Thomson had proposed. Which of the following statements are the direct result of Rutherford's experiments.

1- The number of protons is equal to the number of electrons.

2- The electrons are contained in a positive sphere made up of protons.

3- Protons are concentrated in a very small positive area in the center of the atom.

4- Electrons move about in specific orbits.

5- An atom contains a very large amount of empty space.

1. 1 and 2 B) 1 and 4 C) 3 and 4 D) 3 and 5
2. An isotope of the element magnesium (Mg) has an atomic mass of 25 atomic mass units.

Which of the illustrations below represents the simplified atomic model for this isotope of magnesium?

|  |  |
| --- | --- |
| A) | B) |
|  |  |
| C) | D) |
|  |  |

**Periodic Trends**

• The periodicity of properties is the repetition of patterns in properties from one period to another (p. 24).

• Atomic radius decreases across a period because there are more electrons in the last orbital therefore there is a stronger attraction to the positive nucleus (the orbitals "squeeze" inwards).

• Electronegativity is the ability of an [atom](http://en.wikipedia.org/wiki/Atom) to attract [electrons](http://en.wikipedia.org/wiki/Electron) towards itself. The smaller the atomic radius the greater the electronegativity.

• Ionization energy is the minimum amount of energy required to remove an electron from the atom. The smaller the atomic radius the greater the ionization energy.

1. The graph below shows the electronegativity of some elements.

Describe: the progression of this property for elements within the 3rd period on the periodic table.



1. In parts of the periodic table, as the atomic number increases, the atomic mass decreases. Argon (Ar) and potassium (K) are examples of this.Which of the following statements helps to explain this irregularity?
2. The radius of an atom increases with the period number.
3. The atomic mass of alkali metals is smaller than that of inert gases.
4. The number of isotopes differs from one element to another.
5. The atomic number corresponds to the number of protons of the atom.
6. The properties of the elements in the periodic table vary from one element to another. Four of these variations are :

1. Increase in electrical conductivity

2. Increase in chemical activity

3. Decrease in atomic radius

4. Decrease in metallic luster

Which of these variations occur as one goes from an element with a lower atomic number to one with a higher atomic number within the same period?

1. 1 and 2 B) 1 and 3 C) 2 and 4 D) 3 and 4
2. The graphs below show the measurement of atomic radius and the measurement of electronegativity of certain elements as a function of their atomic number.

|  |  |
| --- | --- |
| ***Graph 1***  Atomic Radius versus Atomic Number | ***Graph 2***  Electronegativity versus Atomic Number |
|  |  |

According to the graphs, which of the statements below is TRUE?

1. Both atomic radius and electronegativity increase from left to right across a period.
2. Both atomic radius and electronegativity decrease from left to right across a period.
3. The atomic radius increases and electronegativity decreases from left to right across a period.
4. The atomic radius decreases and electronegativity increases from left to right across a period.
5. Consider the graph below.



Based on this graph, which of the following statements is correct?

1. The atomic radius increases across the period and decreases down a group.
2. The atomic radius decreases across the period and increases down a group.
3. The atomic radius increases across the period and increases down a group.
4. The atomic radius decreases across the period and decreases down a group.
5. Which of the following elements has the greatest atomic radius?
6. Boron (B) B) Lithium (Li) C) Neon (Ne) D) Nitrogen (N)
7. The graph below shows the electronegativity index of some elements of the periodic table.



Which of the following statement is true?

1. The electronegativity index steadily increases within the same family.
2. The electronegativity index steadily increases, then drops to 0 within the same period.
3. The electronegativity index remains constant within the same family period as one goes from left to right on the periodic table.
4. The electronegativity index steadily decreases within the same period.
5. Which one of the following graphs represents the progression of the atomic masses in the periodic table?

|  |  |
| --- | --- |
| A) |  |
| B) |  |
| C) |  |
| D) | 1. The following graphs illustrate various trends of the atoms on the periodic table.   1   |  |  | | --- | --- | | II |  | | III |  |   Which graphs represent the trend for ionization energy and for atomic radius?   1. Ionization energy I and atomic radius II 2. Ionization energy III and atomic radius II 3. Ionization energy II and atomic radius III 4. Ionization energy I and atomic radius III |

1. The atomic mass of an element varies irregularly form one element to the next in the periodic table. Which of the following is the reason that the atomic mass varies irregularly?
2. The number of protons increases irregularly from one element to the next.
3. The number of neutrons increases irregularly from one element to the next.
4. The atomic number increases irregularly form one element to the next.
5. The number of electrons increases irregularly from one element to the next.

1. The graph below illustrates the atomic radius of certain elements as a function of their atomic numbers.



According to this graph, which statement best describes the change in the atomic radius as you move across a period?

1. The size of the atomic radius increases as you move from left to right across a period.
2. The size of the atomic radius decreases then increases across a period.
3. The size of the atomic radius decreases as you move from left to right across a period.
4. The size of the atomic radius increases and then decreases across a period.

1. The following graph shows the ionization energies of certain elements as a function of their atomic numbers.



According to this graph, which of the following statements is TRUE?

1. Within a period, the ionization energy usually increases as the atomic number increases.
2. Within a period, the ionization energy usually decreases as the atomic number increases.
3. In general, the ionization energy of the elements in Period 3 is greater than the ionization energy of the elements in Period 2.
4. The ionization energy of the elements in Period 4 varies regularly when the atomic number increases regularly.
5. The following graph shows the measurement of a property of certain elements as a function of their atomic number.



According to this graph, which of the following statements is TRUE?

1. The measurement of this property is always greater at the end of a period than at the beginning of a period.
2. The measurement of this property decreases and then increases across a period.
3. The measurement of this property decreases from left to right across a period.
4. The measurement of this property is greater for the last element of Period 2 than for the first element of Period 3.
5. Which of the following statements are true for the atomic radius within the same period?

I) Moving from left to right across a given period, there is an increase in the number of electrons, protons and neutrons, and thus the atomic radius increases.

II) The atomic radius decreases with the increasing atomic number across a given period.

III) The atomic radius is independent from the type of atom within a given period.

IV) Moving from left to right across a given period, there is an increase in the number of protons and electrons. Therefore the electric forces between nucleus and shell increases, thus reducing the atomic size.

1. I and III B) I, II and IV C) II and III D) II and IV
2. The histogram below shows the distribution of the **melting points** of elements within the first four periods of the periodic table.



What pattern can be observed for the melting points?

1. The melting points increase among the alkali metals.
2. The melting points increase among the alkaline earth metals.
3. The melting points increase among the halogens.
4. The melting points increase among the metals across period 4.

**Radioactivity**

• Radioactivity is a natural process in which an unstable atom spontaneously transforms into a more stable atom, or several more stable atoms, while releasing radioactive particles and energy.

• The three types of radioactive particles/energy are alpha (α) particles with a positive charge, beta (β) particles with a negative charge and gamma (γ) rays which are neutral.

• Rutherford used alpha (α) particles to conduct his gold foil experiment. The positive nucleus of the gold atoms repelled the alpha particles which were also positive.

1. The following statements describe characteristics of alpha, beta, or gamma rays.

1. They are attracted to the negative plate of an electric field.

2. They are attracted to the positive plate of an electric field.

3. They are attracted to electrons.

4. They are deflected by a magnetic field.

Which of the characteristics above are associated with alpha rays?

1. 1 and 3 B) 1 and 4 C) 2 and 3 D) 2 and 4

1. The diagram below shows the path of the alpha (α) particles, beta (β) particles and gamma (γ) rays emitted by a radioactive source during an experiment on radioactivity.



What conclusion can you draw from this experiment?

1. The alpha (α) and beta (β) particles are positively charged.
2. The alpha (α) particles and the gamma (γ) rays carry opposite charges.
3. The alpha (α) particles, the beta (β) particles, and the gamma (γ) rays are negatively charged.
4. The gamma (γ) rays carry no charges.
5. The following diagrams illustrate the paths of particles emitted from a radioactive source as they pass between charged plates. Which diagram shows the correct paths?

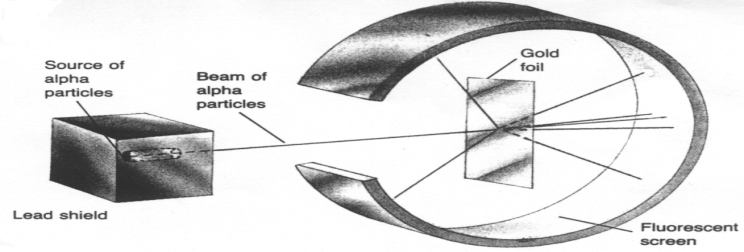
|  |  |  |  |
| --- | --- | --- | --- |
| A) |  | C) |  |
| B) |  | D) |  |

1. The diagram below illustrates the results of an experiment on radioactivity:



Which of the following conclusions can be drawn from this diagram?

1. The alpha and beta particles are electrically charged.
2. The atom contains a positive nucleus surrounded by negative electrons
3. The alpha and beta particles and the gamma rays can all penetrate matter.
4. The alpha and beta particles and the gamma rays all have different masses.
5. In Rutherford's experiment, a beam of alpha particles was directed at a very thin sheet of gold, as illustrated below.



What can be concluded from Rutherford's experiment?

1. Electrons circulate in energy levels. 3. An atom is mostly empty space.

2. Atoms can lose or gain electrons. 4. The nucleus of an atom consists of protons.

A) 1 and 2 B) 1 and 3 C) 2 and 4 D) 3 and 4

1. Radioactive substances emit three types of radiation : alpha, beta and gamma radiation. Scientists have observed that alpha radiation is attracted towards a negatively charged electrode and beta radiation is attracted towards a positive electrode. What do these observations permit us to conclude?
2. Radioactive substances contain only radiation with a negative charge.
3. Radioactive substances contain only radiation with a positive charge.
4. Radioactive substances contain radiation with no charge.
5. Radioactive substances contain radiation charged positively and radiation charged negatively
6. Becquerel’s discovery of radioactivity led to an understanding of the properties and structure of matter. Which of the following statements best describes radioactive decay?
7. Radioactive substances can emit neutral alpha particles, negatively charged beta particles, or positively charged gamma rays.
8. Radioactive substances can emit negatively charged alpha particles, neutral beta particles, or positively charged gamma rays.
9. Radioactive substances can emit positively charged alpha particles, neutral beta particles, or negatively charged gamma rays.
10. Radioactive substances can emit positively charged alpha particles, negatively charged beta particles, or neutral gamma rays.
11. Which of the following diagrams accurately represents the behaviour of the different types of radioactivity?

|  |  |  |  |
| --- | --- | --- | --- |
| A) |  | C) |  |
| B) |  | D) |  |

1. Which of the following best explains why a small number of alpha particles were weakly deflected during Rutherford’s alpha scattering experiment?
2. These alpha particles collided with the positively charged nucleus.
3. These alpha particles were deflected because of electrical attraction of the nucleus.
4. These alpha particles were deflected because they had a charge opposite to the nucleus.
5. These alpha particles were deflected because they collided with the electrons in the orbitals.

1. A radioactive source emits both beta, β, and gamma,γ, radiation. The radiation is focused into a beam and fired between two charged plates as shown in the diagram below.



What results would be expected?

1. β and γ radiation would pass straight through the plates with no deflection.
2. β and γ radiation would be deflected towards the negative plate.
3. Some radiation would be deflected towards the negative plate and some would pass straight through the plates.
4. Some radiation would be deflected towards the positive plate and some would pass straight through the plates.
5. The famous experiment that Rutherford carried out is illustrated by the following diagram



Which of the following statements is in agreement with Rutherford's results?

1. Most of the alpha particles are not deflected because the nucleus is composed of neutrons.
2. Most of the alpha particles are not deflected because the atom is composed mostly of empty space.
3. Most of the alpha particles are deflected because they are attracted to the nucleus.
4. Most of the alpha particles are deflected because they are repelled by the protons.
5. Which of the following diagrams correctly represents the different types of radiation?

|  |  |  |  |
| --- | --- | --- | --- |
| A) |  | C) |  |
| B) |  | D) |  |

1. The apparatus illustrated below is used to study the behaviour of alpha, beta and gamma radiation.



The radiation that passed through the wooden screen was not deflected as it passed through the electric field. Which of the following types of radiation passed through the wooden screen?

1. Alpha radiation C) Gamma Radiation
2. Beta radiation D) Alpha, beta and gamma radiation
3. The alpha (α), beta (β) and gamma (γ) radiation emitted by radioactive matter have characteristic properties. Which of the following correctly matches the type of radiation with its charge?

|  |  |  |  |
| --- | --- | --- | --- |
| A) | alpha (α) = neutral  beta (β) = positive  gamma (γ) = negative | C) | alpha (α) = positive  beta (β) = negative  gamma (γ) = neutral |
| B) | alpha (α) = neutral  beta (β) = negative  gamma (γ) = positive | D) | alpha (α) = negative  beta (β) = positive  gamma (γ) = neutral |

1. Following a nuclear accident, environmentalists detected radiation that had the following characteristics:

• It was attracted to a negative charge.

• It was able to partially penetrate the walls of home.

What is the name of this type of radiation?

1. α rays B) β rays C) γ rays D) X rays

**Bonding**

• A chemical bond is the union of two atoms through the transfer or sharing of one or more electrons (p. 45).

• An ionic bond is the result of a transfer of one or more electrons from one atom (usually a metal) to another atom (usually a nonmetal) (p. 46).

• A covalent bond is the result of the sharing of one or more electron pairs between two atoms (usually two nonmetals) (p. 46).

• A chemical formula is the symbolic representation of a molecule. The formula must contain the chemical symbol for each of the elements that make up the molecule (p. 48).

1. Of the following molecules, which ones have an ionic bond?

1. CO2 2. O2 3. CaCl2 4. KBr 5. H2O

1. 1 and 2 B) 1 and 5 C) 3 and 4 D) 3 and 5

1. What is the molecular formula of the compound formed from the elements phosphorus (P) and oxygen (O)?
2. In a laboratory, a salt was formed using calcium (Ca) and chlorine (Cl).

a) Determine the molecular formula of the compound formed.

b) Name the type of bond between these atoms. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Which combination below has only molecules with ionic bonds?
2. CaI2, PF3, NaF, HF C) NaF, CaI2, MgCl2, O2
3. CaI2, PF3, NaF, H2O D) NaF, CaI2, MgCl2, HF

1. Fluorine (F) and aluminum (Al) react to form a stable compound. Determine the molecular formula of the compound formed by these elements.
2. A compound is made of two hypothetical elements, X and Z. Element X belongs to family II A(2) and element Z belongs to family V A(15). Which of the formulas below correctly represents this compound?
3. X2Z3 B) X2Z5 C) X3Z2 D) X5Z2
4. The molecular formulas of six compounds are shown below :

1. BeF2 2. CaO 3. P2O3

4. CCl4 5. CO2 6. K2S

Which of these are ionic compounds?

1. 1, 2 and 6 B) 1, 4 and 5 C) 2, 3 and 5 D) 3, 4 and 6
2. Which of the following compounds are held together by ionic bonds?

1. CaF2 2. CF4 3. OF2 4. NaF

1. 1 and 2 B) 1 and 4 C) 2 and 3 D) 3 and 4

1. A compound is made of magnesium and sulfur. Give the correct molecular formula for this compound.
2. What is the correct molecular formula of a compound formed by an element "Y" from group IV A (4) and an element "Z" from group VI A (16)?
3. Which of the following molecular formulas represent ionic bonds?

1. LiCl 4. H2O 7. K2S

2. O2 5. AlCl3 8. N2O3

3. CH4 6. CaF2

1. 1, 5, 6 and 7 B) 1, 6, 7 and 8 C) 2, 3, 4 and 5 D) 2, 3, 4 and 8
2. A compound has a molecular formula of XY2. Element Y belongs to the halogen family of the periodic table. To which family does element X belong?
3. Which of the following compounds have covalent bonds?

1. Na2CO3 2. C3H8 3. Al4C3 4. Si3N4

5. Ca3N2 6. P2O5 7. PBr5 8. Mg3P2

1. 1, 3, 5 and 8 B) 1, 3 , 6 and 8 C) 2, 4, 5 and 7 D) 2, 4, 6 and 7

1. Element X has 5 valence electrons. Determine the molecular formula of the compound formed between potassium, K, and element X.
2. The following molecular formula represents an ionic compound: AlxOy

According to the rules of ionic bonding, which of the following statements correctly identifies X and Y with the appropriate explanation?

1. X is 3 because Al is in family III A (13). Y is 2 because oxygen is in family VI A (16).
2. X is 3 because Al has 2 valence electrons. Y is 6 because oxygen has 6 valence electrons.
3. X is 2 because oxygen forms 2 bonds. Y is 3 because Al forms 3 bonds.
4. X is 3 because Al is in family III A (13). Y is 6 because oxygen is in family VI A (16).
5. Four existing common compounds are listed below:

NH3 CO Al2O3 CaCl2

Which of the above compounds does not satisfy the octet rule?

Explain your answer by taking into account bonding potential or valence electrons.

1. A compound is composed of hypothetical elements X and Y. X belongs to Family I A(1) and Y belongs to Family V A(15).

What is the molecular formula of this compound?Justify your answer.

1. Which of the following pairs of elements form ionic bonds?

1) C and S 4) N and O

2) Ca and O 5) C and Cl

3) Na and Cl

1. 2 and 3 B) 2 and 5 C) 1, 4 and 5 D) 1, 2 and 3
2. Six compounds are listed below:

1. K2CrO4 2. C4H9OH 3. H2O

4. Ca(HCO3)2 5. PCl3 6. KOH

Which of these are covalently bonded compounds?

1. 1, 2 and 3 B) 1, 4 and 6 C) 2, 3 and 5 D) 4, 5 and 6
2. Which of the following structures best represents carbon tetrachloride?

(Carbon : and chlorine : )



|  |  |  |  |
| --- | --- | --- | --- |
| A) |  | C) |  |
| B) |  | D) |  |

1. What is the molecular formula of sodium nitride?
2. S3N B) Na3N C) N3S D) N3Na
3. The molecule of a particular substance is represented below.



What is the chemical name of this substance according to the rules for naming binary compounds?

1. In which one of the following molecules do the atoms form ionic bonds?
2. O2 B) CH4 C) N2O3 D) CaBr2
3. Two students are playing hopscotch on a giant periodic table in the chemistry lab. The first student jumps to the alkaline earth group and lands on the element in the second period. The second student jumps to the oxygen group and lands on the element in the third period.

Identify each element

1. Which of the following substances contains ionic bonds?
2. CH4 B) MgO C) O2 D) PCl3
3. The element arsenic (As) and oxygen (O) react to form a compound. What is the molecular formula of this compound?
4. Which group of substances consists only of substances formed by covalent bonds?
5. K2O, PCl3, H2S C) CH4, CaS, NCl3
6. NaCl, MgO, AlF3 D) NH3, O2, P2O3

1. Which two compounds consist only of elements held together by covalent bonds?
2. CH4 and P2O3 B) CH4 and Na2S C) CaO and P2O3 D) CaO and Na2S
3. Element X combines with oxygen to form the compound X2O3. To which family in the periodic table could element X belong?
4. Four elements, identified only as W, X, Y and Z, have each been placed in a specific location on the periodic table below.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 |  | 3 | 4 | 5 | 6 | 7 | 8 |
|  |  |  |  |  |  |  |  |  |
|  | W |  |  |  |  |  | X |  |
|  |  |  |  |  | Y |  |  |  |
| Z |  |  |  |  |  |  |  |  |

What compound **does not** follow the octet rule?

1. WX2 B) YX3 C) ZY3 D) W3Y2
2. Which of the following substances contains ionic bonds?
3. Cl2 B) SO2 C) MgF2 D) CH4
4. The following are the molecular formulas of six pure substances.

1. LiCl 2. AlCl3 3. CO

4. CCl4 5. NH3 6. Fe2O3

Which of these substances are ionic?

1. 1,2,6 B) 1, 3, 4 C) 2, 5, 6 D) 3, 4, 5
2. Which of the following molecules is not consistent with the octet rule?
3. CF4 B) KO2 C) MgCl2 D) BaO
4. Boron, B, can react with oxygen, O, to form a compound. What is the molecular formula of this compound?
5. The molecular model of a substance is illustrated below.



|  |  |
| --- | --- |
|  | represents the atom whose atomic number is 13. |
|  |  |
|  | represents the atom that has 3 electron shells  (energy levels) and 7 valence electrons. |

With which substance could this molecular model be associated?

Write the molecular formula or the chemical name of this substance.

1. The molecular formulas for ten compounds are given below.

1- SO2 6- SiCl4

2- CS2 7- MgBr2

3- NaI 8- SiC

4- BaS 9- KF

5- AlCl3 10- BeF2

Which compounds have covalent bonds?

1. 1, 2, 6 and 8 B) 1, 2, 7 and 10 C) 3, 5, 7 and 9 D) 4, 5, 6 and 8
2. Which of the following elements does not exist in the form of a diatomic molecule?
3. Nitrogen B) Bromine C) Oxygen D) Neon

1. Write the chemical formula for each of the following substances.

1. Octasulphur \_\_\_\_\_\_\_\_\_\_\_\_\_ 3. Carbon tetrachloride \_\_\_\_\_\_\_\_\_\_\_\_

2. Dinitrogen trioxide \_\_\_\_\_\_\_\_\_ 4. Diphosphorus pentoxide \_\_\_\_\_\_\_\_\_

1. Which of the following elements will combine with two atoms of hydrogen to form a molecule similar to that of water, H2O?
2. F B) S C) N D) Ne

1. According to the octet rule, how many hydrogen atoms will combine with a nitrogen atom?
2. 4 B) 3 C) 2 D) 1
3. Based on their position in the Periodic Table, which two of the following elements can form three chemical bonds?

1. Sodium 2. Calcium 3. Aluminum

4. Chlorine 5. Phosphorus 6. Helium

1. 1 and 5 B) 2 and 4 C) 3 and 6 D) 3 and 5
2. These elements combine to form compounds : Na, Ca, S, N, Al and Br.

Which of the chemical formulas below respect the octet rule?

1. NaBr, Ca2S, Na2S B) N2S3, SBr, AlS C) NaBr, Al2S3, NBr3  D) AlS, Na2N, CaS

1. Which of the following best describes an ionic bond?
2. It is formed when one or more electrons transfer from a non-metal to a metal.
3. It is formed following the transfer of one or more electrons between two non-metals.
4. It is formed when one or more electrons transfer from a metal to a non-metal.
5. It is formed following the transfer of one or more electrons between two metals.

1. Which of the following four statements relating to a covalent bond is **false**?
2. The electrons are shared between the partners in the bond.
3. The formation of ions results in this type of bonding.
4. The octet rule is obeyed by the partners in the bond if they are non-metals.
5. This type of bond can be formed between a non-metal and hydrogen.

1. Which of the following substances contains a triple covalent bond?
2. F2 B) N2 C) P4 D) S8

**Polyatomic Bonding**

• A polyatomic ion is a group of two or more chemically bonded atoms that has become electrically charged by losing or gaining one or more electrons (p. 44).

**Some polyatomic ions (radicals)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ammonium: | NH4+ | sulphite: | SO3- | peroxide: | O22- |
| hydroxide: | OH- | sulphate: | SO42- | phosphite | PO33- |
| nitrite: | NO2- | bisulphate: | HSO4- | phosphate: | PO43- |
| nitrate: | NO3- | carbonate: | CO32- | chlorate: | ClO3- |
|  |  | bicarbonate: | HCO3- | perchlorate: | ClO4- |

1. What is the molecular formula of the compound formed of the following ions?

Mg2+ and NO3–

1. The molecular formula of magnesium borate is Mg3(BO3)2.

What is the charge of the borate radical, BO3 in this formula?

1. 3− B) 2− C) 2+ D) 3+

1. The thiosulfate ion, S2O32−, has been used in agriculture, in matches, and in compounds that treat allergies and develop film. Which of the following are correct S2O32− compounds?

|  |  |
| --- | --- |
| 1. Na2S2O3 | 3. Ba2S2O3 |
| 2. CaS2O3 | 4. Al3S2O3 |

1. 1 and 2 B) 1 and 4 C) 2 and 3 D) 3 and 4

1. Many common substances are chemicals that contain polyatomic ions. Indicate the formula of the ion and the charge of the underlined polyatomic radical in each of the four molecules below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | |  | | **Ion and Charge** | |
| Milk of magnesia | | Mg(OH)2 | | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | |
| Bleach | | NaClO | | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | |
| Water clarifier | | Al2(SO4)3 | | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | |
| Borax | | Na2B4O7 | | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | |

1. What is the molecular formula of the compound formed by each pair of the given substances below?

1) Barium (Ba) and nitrogen (N)

2) Magnesium (Mg) and oxygen (O)

3) Lithium (Li) and nitrate (NO3-1)

4) Aluminum (Al) and sulphate (SO4-2)

1. Pairs of elements that can react together are listed below.

For each pair of reactants, give the full molecular formula for the product.

|  |  |
| --- | --- |
| Reactants | Name |
| Calcium and hydroxide |  |
| Aluminum and sulphate |  |
| Potassium and phosphate |  |
| Sodium and acetate |  |

1. You are asked to help your laboratory technician clean up the lab. You must classify the solutions and place them on the correct shelves in the storage room.

a) Identify the solution(s) containing polyatomic ions.



|  |
| --- |
| b) The flask below requires a label with the name of the solution.  Respecting the rules of nomenclature, record the name of the solution. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |



1. Each statement below indicates the electric charge on the polyatomic ion (radical) in a given compound.

Which of the following statements is TRUE?

1. In the compound Ca(NO3)2, the electric charge on the NO3 ion is 2−.
2. In the compound Al2(CrO4)3, the electric charge on the CrO4 ion is 2−.
3. In the compound K2SO4, the electric charge on the SO4 ion is 1−.
4. In the compound NH4Cl, the electric charge on the NH4 ion is 1−.
5. What is the molecular formula of the compound formed by combining the phosphate ion, PO43−, with the magnesium ion?
6. MgPO4 B) Mg2(PO4)3 C) Mg3PO4 D) Mg3(PO4)2

1. The molecular formula for barium silicate is BaSiO3.

In this formula, what is the charge on the polyatomic ion (radical) silicate, SiO3?

1. 1+ B) 1- C) 2+ D) 2-

1. A solution containing arsenate ions, AsO43−(aq), is mixed with another solution containing barium ions, Ba2+(aq). An insoluble compound is formed from the reaction of these two ions.

What is the molecular formula of this compound?

1. Ba(AsO4)2 B) Ba(AsO4)3 C) Ba2(AsO4)3 D) Ba3(AsO4)2
2. The law requires that chemical containers that have been refilled must be properly identified. A new lab technician labelled some containers incorrectly. Five container labels are shown.

Which labels have an **incorrect** molecular formula? Use the following table to help you.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Names, formulae and charges of various radicals** | | | | | | |
| **Charge 1-** | | **Charge 2-** | | | **Charge 3-** | |
| Nitrate, NO3 | | Dichromate, Cr2O7 | | | Phosphate, PO4 | |
| Nitrite, NO2 | | Carbonate, CO3 | | |  | |
| Permanganate, MnO4 | | Sulfate, SO4 | | |  | |
|  |  | |  |  | |  |
| Labels | | | | | | |
| 1. HSO4 | 2. Pb(NO3)2 | | 3. CuSO4 | 4. K2Cl | | 5. K2Cr2O7 |

1. 1 and 2 B) 1 and 4 C) 2 and 3 D) 4 and 5

1. Below is a list of four ions, from which various molecules can be formed.

Ba2+ Cl− Al3+ SO42−

Which group of molecular formulas consists of all correct possibilities?

1. BaCl, BaSO4, AlCl, AlSO4 C) BaCl2, Ba(SO4)2, AlCl3, Al(SO4)3
2. BaCl2, BaSO4, AlCl3, Al2(SO4)3 D) Ba2Cl, BaSO4, Al3Cl, Al3(SO4)2
3. Use the ions listed below to write formulas for three possible compounds:



1. Which of the elements has an ionic charge of +2 in the following compounds?

**NaCl, CaO, Al2O3, Mg3P2, and RaTe**

1. Te, O and Al B) CI, P and S C) Ca, Mg and Ra D) Na, S and Ra

1. Among the following chemical formulas, which contains two radicals (complex ions)?
2. H2SO4 B) NH4OH C) NaNO3 D) CaCO3
3. Among the following chemical formulas, which contains a radical (complexion) with a charge of ‑3 ?
4. (NH4)2SO4 B) NaNO3 C) Ca3(PO4)2 D) MgCO3
5. Which of the following is the correct formula for the compound of the aluminum cation and the anion, Cr2O72-  ?
6. AlCr2O7 B) Al3(Cr2O7)2 C) Al2Cr2O7 D) Al2(Cr2O7)3
7. Write the chemical formula for the compound formed between the anion PO43- and each of the following cations :
8. Sodium

B) Calcium

C) Aluminum

D) Ammonium

1. The reaction below represents the neutralization of the base Ca(OH)2 with the acid H3PO4.



|  |
| --- |
| Using the rules of nomenclature, name the reactants and write the molecular formula for the products. |
|  |

1. The formula of aluminum oxalate is Al2(C2O4)3.

In this formula, what is the charge of the radical oxalate, C2O4?

1. 1- B) 2- C) 3- D) 6-
2. Complete the following table:

|  |  |
| --- | --- |
| **Molecular Formula** | Name of the Compound |
| NO3 |  |
| MgCl2 |  |
|  | Aluminium Oxide |
|  | Calcium Phosphate |

1. Many common household products are chemicals that contain polyatomic ions. The table below represents various polyatomic ions found in household products.

**Complete the shaded areas of the table, Household Products.**

Household Products

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Household**  **Product** | **Use** | **Chemical Formula** | **Positive Ion and Charge** | **Negative Ion and Charge** |
| Calcium iodate | Antiseptic | Ca(IO3)2 |  |  |
| Ammonium chloride | Expectorant in cough syrup |  |  |  |
| Magnesium carbonate | Antacid |  |  |  |
| Aluminum sulfate | Deodorant | Al2(SO4)3 |  |  |

**Magnetism**

• Magnetism describes all the phenomena caused by magnets (p. 163).

• A magnet is an object that can attract other objects containing iron, cobalt or nickel (p. 163).

• All magnets have a north-seeking and a south-seeking pole. The north pole of a magnet is the end that naturally seeks the Earth’s magnetic pole near the geographic North Pole. The other end of the magnet is its south pole (pp. 165–166).

• A magnetic field is the area of space in which the magnetic force of a magnet can act on another magnet (p. 166).

• A ferromagnetic substance is a substance with the ability to acquire magnetic properties (p. 167).

• Magnetic remanence describes the ability of a material to acquire and conserve magnetic properties (p. 167).

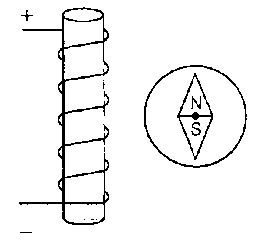
**ELECTROMAGNETISM**

• Electromagnetism describes all the phenomena resulting from the interaction between electricity and magnetism (p. 167).

• A solenoid is a cylindrical coil of live wire (p. 169).

• To transform a solenoid into an electromagnet, a ferromagnetic substance is inserted inside the solenoid, creating a core (p. 170).

1. Which pictures below have the correct compass direction?



1. 2. 3. 4.



1. 1 and 2 B) 1 and 3 C) 2 and 4 D) only 3
2. Four circular pieces of metal were brought close to one another during a laboratory experiment. Only one of these pieces of metal is a magnet.

The following table shows whether or not these pieces of metal attracted one another.

|  |  |  |
| --- | --- | --- |
| Combination | Attraction | |
| Yes | No |
| Piece 1 with piece 2 |  | ✓ |
| Piece 1 with piece 3 |  | ✓ |
| Piece 1 with piece 4 |  | ✓ |
| Piece 2 with piece 3 | ✓ |  |
| Piece 2 with piece 4 | ✓ |  |
| Piece 3 with piece 4 |  | ✓ |

Which piece of metal is a magnet?

1. Piece 1 B) Piece 2 C) Piece 3 D) Piece 4
2. Four objects W, X, Y and Z were brought close together two at a time. One of these objects is magnetic, one is nonmagnetic and two are ferromagnetic. The results were as follows:

|  |  |
| --- | --- |
| OBJECTS | RESULT |
| W and X | The objects attracted each other. |
| X and Y | The objects attracted each other. |
| W and Y | Nothing happened. |
| X and Z | Nothing happened. |

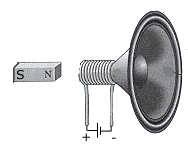
Which of these objects is nonmagnetic?

1. W B) X C) Y D) Z
2. You have two ten-cent coins, one from 1965 and the other from 1994. To determine whether these coins are magnetic, ferromagnetic or non-magnetic, you conduct tests and note your observations.

|  |  |  |
| --- | --- | --- |
| **Step** | **Test** | **Observation** |
| 1 | Bring a magnet near the 1965 coin. | No reaction |
| 2 | Bring a magnet near the 1994 coin. | Attraction |
| 3 | Bring each coin near an iron nail. | No reaction |

Given the observations, what can you say about these coins?

1. The 1965 coin is non-magnetic and the 1994 coin is magnetic.
2. The 1965 coin is non-magnetic and the 1994 coin is ferromagnetic.
3. The 1965 coin is magnetic and the 1994 coin is ferromagnetic.
4. The 1965 coin is ferromagnetic and the 1994 coin is magnetic.
5. A speaker is made of a moveable solenoid and a fixed magnet. By rapidly changing the direction of the electrical current in the solenoid, the membrane of the speaker vibrates and produces sound. The diagram below shows the polarity of the magnet adjacent to the solenoid.



1. Draw the magnetic field lines between the magnet and the solenoids and indicate the location of the North and South poles of the solenoid. *Show the direction of the field lines in your drawing.*
2. In the case shown above, describe whether the **solenoid** and the **magnet** will attract or repel.
3. Choose which picture is correct? (The arrows indicate the direction of conventional current. This is the opposite of electron flow)



1. The following diagram shows a magnet, an electromagnet and a small car containing iron.



What happens when an electric current flows through the electromagnet?

1. The magnet and the car are both attracted to the electromagnet.
2. The magnet and the car are both repelled by the electromagnet.
3. The magnet is attracted to the electromagnet and the car is repelled by the electromagnet.
4. The magnet is repelled by the electromagnet and the car is attracted to the electromagnet.

1. Refer to the illustration of the compass and electromagnet in Figure 1 below.



a) Pole A is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pole B is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Terminal 1 is \_\_\_\_\_\_\_\_\_\_\_\_

Terminal 2 is \_\_\_\_\_\_\_\_\_\_\_\_

|  |
| --- |
| b) List two ways in which the strength of an electromagnet can be increased. |
|  |

1. A student is testing the strength of the magnetic field of four different solenoids.

|  |
| --- |
| Which of the solenoids described below will produce the strongest magnetic field? |

1. A solenoid with an iron core, 25 turns of wire, and with 4 amperes of current running through it.
2. A solenoid with an iron core, 25 turns of wire, and with 8 amperes of current running through it.
3. A solenoid with an iron core, 50 turns of wire, with 12 amperes of current running through it.
4. A solenoid with an iron core, 50 turns of wire, with 4 amperes of current running through it.
5. Which one of the following electromagnets will produce the strongest magnetic field?

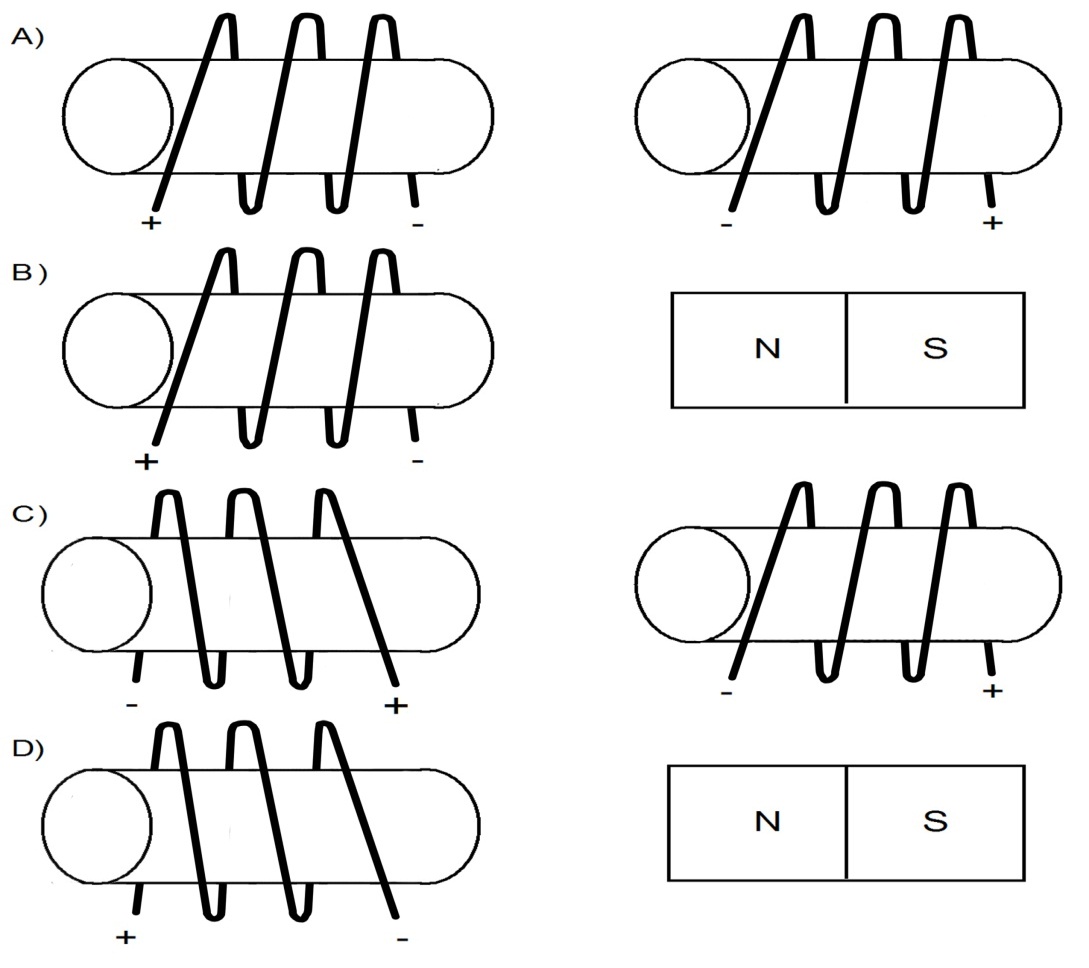
A) Copper Core B) Iron Core



C) Copper Core D) Iron Core



1. Which of the situations illustrated below would represent a force of attraction?



**Electricity**

WHAT IS ELECTRICITY?

• Electricity describes all the phenomena caused by positive and negative charges (p. 140).

• Electrical charge is a property of protons and electrons. A proton carries a positive charge, while an electron carries a negative charge (p. 141).

• A negatively charged body contains more electrons than protons (p. 141).

• A positively charged body contains fewer electrons than protons (p. 141).

• The elementary charge is the charge carried by a single electron or proton. It has a value of 1.602 x 10–19 C (p. 141).

• The coulomb is the unit of measurement for electrical charge. One coulomb is equal to the charge of 6.25 x 1018 electrons or protons (p. 141).

• Charging an object consists in creating an imbalance in the electrical charge of that object (p. 142).

• A conductor is a substance that permits the free flow of electrical charges (p. 143).

• An insulator is a substance that impedes the free flow of electrical charges (p. 143).

• An electrical field is the area of space in which the electrical force of a charged body can act on another charged body (p. 144).

**STATIC ELECTRICITY**

• Static electricity describes all the phenomena related to electrical charges at rest (p. 145).

• An object can be charged in various ways: by friction, by conduction or by induction (p. 146).

• Coulomb’s law states that the magnitude of the force between two immobile and electrically charged particles is directly proportional to the product of their charges and inversely proportional to the square of the distance between them (p. 149).

**DYNAMIC ELECTRICITY**

• Dynamic electricity describes all the phenomena related to electrical charges in motion (p. 150).

• Electric current is the orderly flow of negative charges carried by electrons (p. 150).

• The conventional current direction is the direction in which a positive particle would flow in an electrical circuit. For this reason, the direction goes from the positive terminal of the power supply to its negative terminal (p. 150).

• Current intensity is the number of charges that flow past a given point in an electrical circuit every second (p. 151).

• The potential difference is the amount of energy transferred between two points in an electrical circuit (p. 152).

• Electrical resistance is the ability of a material to hinder the flow of electric current (p. 153).

• Ohm’s law states that, for a given resistance, the potential difference in an electrical circuit is directly proportional to the current intensity (p. 154).

• Electrical power is the amount of work an electrical device can perform per second (p. 155).

• An electrical circuit is a network in which electrical charges can flow continuously in a loop (p. 156).

• A series circuit is a circuit in which the elements are connected end to end (p. 158).

• A parallel circuit is a circuit that contains at least one branch (p. 158).

• Kirchhoff’s first law states that the intensity of a current that flows into an element or a node of an electrical circuit is always equal to the intensity of the current that flows out of the element or node (p. 159).

• Kirchhoff’s second law states that in an electrical circuit, the total energy acquired by the charges from the power supply is always equal to the total energy transferred by these charges, whatever pathway they may take in the circuit (p. 160).

• Equivalent resistance represents the amount of resistance needed in a single resistor to replace the entire collection of resistors in a circuit (p. 162).

1. The following electric circuit consists of two resistors *R*1 and *R*2 and a power source.



Using an ammeter, you measured the current intensity (*I*) through each resistor. Here are the results :

|  |  |
| --- | --- |
| **Resistor** | **Intensity (A)** |
| *R*1 | 0.75 |
| *R*2 | 0.75 |

Given this information, what is the current intensity provided by the power source *I*s?

1. Given the following electric circuit with four voltmeters.

Voltmeter V1 reads 2.0 V.

Voltmeter V2 reads 4.0 V.

Voltmeter V3 reads 7.0 V.



What is the reading on voltmeter V4?

1. 13.0 V B) 4.0 V C) 2.0 V D) 1.0 V
2. Three known resistances are connected in series to the terminals of a power source. The potential difference at the terminals of the 3.0 Ω resistance is 12 V.



What is the potential difference of the power source?

1. Three known resistances are connected in parallel to the terminals of a power source. The current passing through the 3.0 Ω resistance is 1.0 A.



What is the intensity of the current coming from the power source?

1. In the following electric circuit, one of the two resistances is 4.0 Ω. The other resistance, "*R*", is unknown. The voltage of the power source is 12 V and the electric current from the source is 4.5 A. What is the value of resistance "*R*"?



|  |  |
| --- | --- |
| 1. The circuit in the diagram at the right consists of 4 resistors whose values are 2 Ω, 4 Ω, 5 Ω and 7 Ω respectively.     What is the reading of the ammeter? |  |

1. Calculate the equivalent resistance that could replace three resistors in each of the circuits.

10.0

20.0

50.0

Circuit 1

Circuit 2

50.0

20.0

10.0

1. A student assembled the two circuits illustrated below. Each of these circuits consists of two identical light bulbs, a 1.5 V battery and a voltmeter.



What is the reading displayed on voltmeters V1 and V2?

1. V1 = 0.75 V and V2 = 0.75 V C) V1 = 1.5 V and V2 = 0.75 V
2. V1 = 0.75 V and V2 = 1.5 V D) V1 = 1.5 V and V2 = 1.5 V
3. The circuit illustrated below has a power supply fixed at 12 V.



What is the current intensity in resistor R3?

1. An electric circuit is illustrated below. The value of the resistance of the resistors is:

*R*1 = 50 Ω

*R*2 = 200 Ω



What is the value of the equivalent resistance of this circuit?

1. The circuit illustrated below consists of a power supply, three resistors (R1, R2 and R3), an ammeter (A) and a voltmeter (V).



What is the potential difference, or voltage, (*V*) at the terminals of the power supply?

1. The electric circuit shown below consists of an ammeter A, a power supply, and resistors R1 and R2 connected in parallel.



What is the current intensity (*I*) flowing through the ammeter?

1. The following diagram shows a parallel circuit consisting of three resistors.



What is the value of resistor *R*3?

1. The following circuit is connected to a source that can provide a current of 2 A when the potential difference (voltage) is 12 V.



What is the resistance of resistor *R*3?

1. The following circuit is connected to a source that can provide a current intensity of 18 A when the potential difference (voltage) is 36 V?



What is the current intensity *I*1 flowing through resistor *R*1?

1. In the electric circuit illustrated below, the current intensity (*I*) is 0.25 A.



What is the potential difference across the terminals of the power source, *V*s?

1. The following circuit consists of two resistors R1 and R2, two ammeters  and  and a power supply.



Ammeter A2 reads 5 A. What is the reading given by ammeter AT?

1. The following electric circuit consists of a power source, two identical resistors (*R*1 and *R*2) and four ammeters , , and.



Ammeter A1 reads 1.6 A and ammeter A3 reads 0.8 A.

What do ammeter A2 and ammeter A4 read?

1. Ammeter A1 reads 0.8 A and ammeter A4 reads 0.8 A.
2. Ammeter A1 reads 0.8 A and ammeter A4 reads 1.6 A.
3. Ammeter A1 reads 1.6 A and ammeter A4 reads 1.6 A
4. Ammeter A1 reads 1.6 A and ammeter A4 reads 2.4 A.
5. The following electric circuit consists of a 10-V power source, *V*s, three resistors (R1, R2 and R3) and a voltmeter . The resistance of R1 is 5 Ω, the resistance of R2 is 15 Ω and the resistance of R3 is 20 Ω.



What is the potential difference (voltage) given by voltmeter ?

1. The following electric circuit consists of a power source, two ammeters (and), two resistors (R1 and R2) and a voltmeter. Ammeter  reads 3 A and ammeter  reads 1 A.



What is the potential difference (voltage), *V*2, across the terminals of resistor R2?

1. The resistance of a resistor can be determined using the four coloured bands on the resistor as well as a colour code. The table below gives some the colour code for resistors.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Band colour | Black | Red | Yellow | Blue | Grey | Silver |
| Digit | 0 | 2 | 4 | 6 | 8 |  |
| Multiplier | 1 | 102 | 104 | 106 | 108 |  |
| Tolerance | ± 20% |  |  |  |  | ± 10% |

What would the colours on the resistor be if the resistance of the resistor was 4200 Ω ± 10%?

1. Silver, red , yellow, blue C) Yellow, red, black, silver
2. Silver, red, red ,yellow D) Yellow, red, red, silver
3. The circuit illustrated below consists of three resistors (R1, R2 and R3) and a power supply.



The equivalent resistance of this circuit is 10 Ω, what is the value of resistor 2, R2?

1. You must choose one of the sets of Christmas lights illustrated below.

Each set contains 8 bulbs.



|  |  |
| --- | --- |
| • | **In set A, the current in each bulb is 0.4 A.** |
| • | **In set B, the current in each bulb is 0.1 A.** |

Which set would require the least amount of current from the power supply? Why?

1. In the laboratory, you are given a power supply , conducting wires and the six resistors shown below.



The power supply produces a potential difference of 9 V. Using the power supply and two of the resistors above, you must build a series circuit with a current of 1.5 A flowing through the power supply. Draw your electric circuit with the resistors chosen.

1. A student assembled Circuit 1 and determined the values of the resistors.

Circuit 1



He then assembled Circuit 2, shown below, using elements from Circuit 1.

Circuit 2

A

R

1

R

2

120 V

What is the reading of ammeter A in circuit 2?

1. The following electric circuit consists of a power supply, an ammeter  and three resistors (R1, R2 and R3). The voltage across the power supply is 15 V, and the ammeter reads 0.15 A.

What is the value of R3?



1. The following electric circuit consists of a power supply, *V*T, an ammeter  and three identical resistors (R1, R2 and R3). The potential difference across the terminals of the power supply is 15 V.



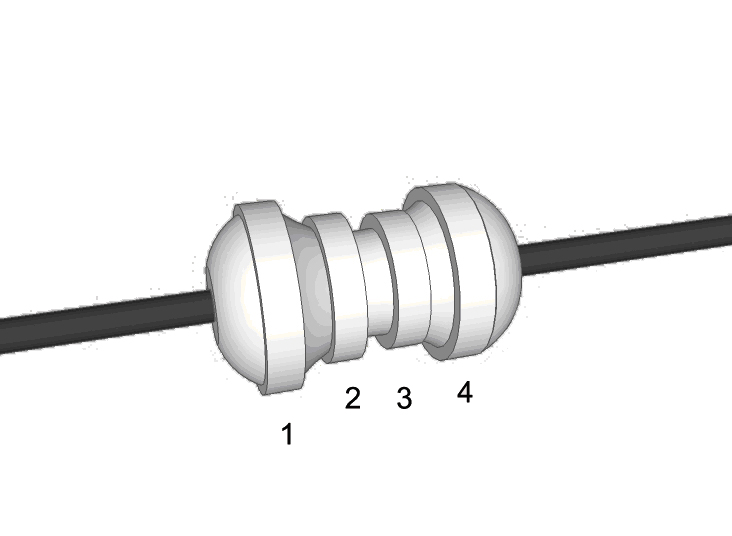
What is the current intensity reading, *I*, given by the ammeter?

1. A student is asked to create two circuits using the same three resistors. He sets up Circuit A so that all the resistors are in series. He then takes it apart and places these same resistors in parallel in Circuit B. (See diagrams below.)



|  |
| --- |
| Calculate the equivalent resistance (Req) of Circuit A and Circuit B. |

1. As the values of manufactured resistors are never perfectly precise, they are manufactured with a certain tolerance. Below is a diagram of a resistor.



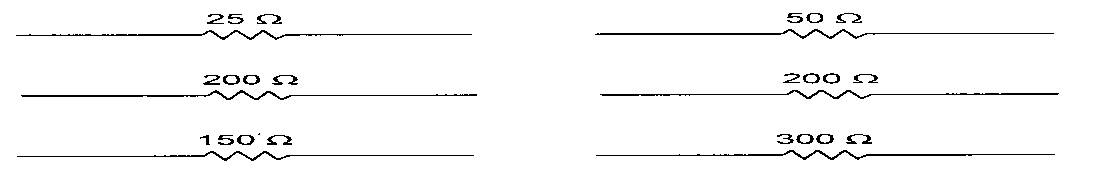
|  |
| --- |
| Determine, in order from left to right, the band colors of a resistor if it had a true resistance value of 340 Ω ± 5%. |

Resistor Colour Code Chart

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Colour** | Black | Brown | Red | Orange | Yellow | Green | Blue | Purple | Grey | White |
| **Digit** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Multiplier** | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 |

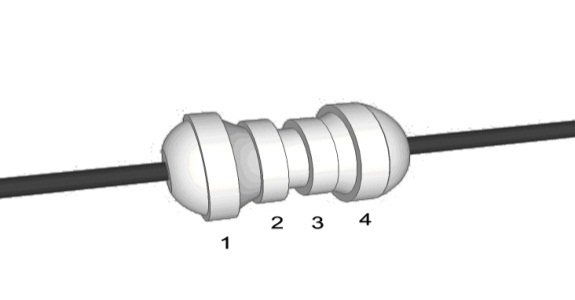
Tolerance: Gold ± 5%, Silver ± 10%, none ± 20%

1. In the laboratory, you are given a power supply (), conducting wires and the six resistors shown below.



Using the power supply and two of these resistors, you must build **two** circuits that each have an equivalent resistance of 100 Ω.

1. A diagram of a coded resistor, with each coloured band labelled as a number, is shown below. Resistor



Resistor Colour Code Chart

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Colour** | Black | Brown | Red | Orange | Yellow | Green | Blue | Purple | Grey | White |
| **Digit** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Multiplier** | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 |

Tolerance: Gold ± 5%, Silver ± 10%, none ± 20%

The resistance of this resistor is 34 Ω ± 5%.

|  |
| --- |
| What is the colour of the third band on the resistor? |

1. Black B) Brown C) Orange D) Red
2. The diagram below represents an electric circuit consisting of batteries and two identical light bulbs.



The potential difference across light bulb L2 is \_\_\_\_\_\_\_\_\_\_.

1. the same as that across the terminals of the batteries.
2. twice that across light bulb L1.
3. half that across light bulb L1.
4. the same as that across light bulb L1.
5. Refrigeration units can also have resistors as electrical components. What would be the value (resistance) of a resistor with a blue, green, red and no band for the tolerance?
6. Nicolas has decided to participate in the *Engineering Challenge.* This year he plans to build a racecar that can move around obstacles. He needs a resistor to slow down the motor. He asks the laboratory technician for a resistor offering a resistance between 8 Ω and 12 Ω. She offers him the four resistors below.

|  |
| --- |
| Which of the following resistors should Nicolas use? |



1. Refer to the illustration of Circuit A and Circuit below.



Which of the two circuits (Circuit A or Circuit B) has the greatest resistance?

Resistor Colour Chart

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Colour** | Black | Brown | Red | orange | Yellow | Green | Blue | Purple | Grey | White |
| **Digit** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Multiplier** | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 |

1. Kabira works for a security company. She has to go to a client’s house to add a new motion detector (*R*2) to a pre-existing electric circuit. The new motion detector has a resistance of 480 Ω (*R*2).

The motion detector that is already installed (*R*1), has a resistance of 2400 Ω (*R*1) and a current of 0.005 A (*I*1).



|  |
| --- |
| What is the current intensity (*I*2) travelling through the new motion detector (*R*2)? |

1. Your task is to analyze these choices and to: determine the amount of electrical energy that would be consumed by each lighting option if used for 5 hours

|  |
| --- |
| **Electrical Energy Facts** |
| Electrical energy can be expressed in kW•h  1 kW•h = 3 600 000 Joules  Electrical energy costs 13 ¢/kW•h |

|  |
| --- |
| **Lighting Option 1**  Three identical CFLs, each with a resistance of 9.0 × 102 ohms, are connected in parallel to a 120 V circuit.  VT = 120 V  RCFL = 9.0 × 102Ω |
|  |

|  |
| --- |
| **Lighting Option 2:**  Three identical LEDs, each with a voltage of 22 volts, are connected in series to a 120 V circuit. The electrician added a 2.4 × 102 ohm resistor in series to limit the current supplied to the LEDs.  R1 = 2.4 × 102 Ω  VLED = 22 V  VT = 120 V |

**Heat & Energy**

• Thermal energy is the energy contained in a substance, determined by the number of particles in the substance and their temperature (p. 73).

• Heat is the transfer of thermal energy between two environments with different temperatures. Heat always passes from the warmer to the cooler environment (p. 73).

• Temperature is a measure of the degree of agitation of the particles of a substance (p. 74).

• The specific heat capacity corresponds to the amount of thermal energy required to raise the temperature of one gram of a substance by one degree Celsius (p. 74).

* + - 1. Two (2) litres of water begins to boil after absorbing 670 400 J of heat energy.

|  |
| --- |
| Calculate the initial temperature of the water. |
|  |

* + - 1. Two students were performing an experiment on heat energy. They poured 125 g of water into a calorimeter. The temperature of the water was 22.0°C. The students then placed a small electric heating element into the water. The heating element transferred 7 120 J of energy to the water.

|  |
| --- |
| What was the final temperature of the water? |

A) 8.4°C B) 13.6°C C) 35.6°C D) 79.0°C

* + - 1. Amelia is preparing a pizza on an aluminum baking pan. She places the pizza in the oven. Ten minutes later she realizes that she forgot to add the cheese. She must take the pizza out of the oven to add the cheese.



The baking pan, which weighs 375 grams, was at room temperature (22°C) before it was placed in the oven. It absorbed 9450 J of energy during the ten minutes it was in the oven.

*The specific heat capacity of aluminum is 0.90 J/g°C.*

|  |
| --- |
| What is the temperature of the baking pan when it is removed from the oven? |
|  |

**Moles, stoichiometry, endothermic and exothermic reactions**

• Balancing a chemical equation consists in placing a coefficient before each reactant and product so that the number of atoms of each element on the reactant side is equal to the number of atoms of each element on the product side (p. 111).

• Stoichiometry is the study of the quantities of reactants required for chemical reactions to occur and of the quantities of products that are thus formed (p. 112).

• An endothermic reaction is a chemical change that absorbs energy (p. 114).

• An exothermic reaction is a chemical change that releases energy (p. 114).

• Oxidation is a chemical change involving oxygen or a substance with properties similar to those of oxygen (p. 120).

• Combustion is a form of oxidation that releases a large amount of energy (p. 122).

• Cellular respiration is a chemical change in which glucose and oxygen are used to generate energy. The reaction also produces carbon dioxide and water (p. 123).

• Photosynthesis is a chemical change that produces glucose and oxygen from solar energy, carbon dioxide and water (p. 124).

1. Nitrogen fixation is the chemical process that changes atmospheric nitrogen to ammonia. It can be described by the chemical equation:

N2 + 3H2 → 2 NH3 + heat

|  |
| --- |
| a) Is this chemical reaction endothermic or exothermic? |
| b) Is this chemical reaction a decomposition or a synthesis reaction? |

1. The combustion of ethane is a common method for cooking in rural areas.

The unbalanced equation is: C2H6 + O2 → CO2 + H2O

|  |
| --- |
| a) Determine the balanced chemical equation for the reaction. |
| b) How many moles of H2O will be produced if 4 moles of ethane (C2H6) are reacted. |

1. A lab technician needs to prepare 3.0 L of a potassium nitrate (KNO3) solution with a concentration of 0.15 mol/L.

|  |
| --- |
| Determine the mass of solute the lab technician needs to prepare. |
|  |

1. A camp opens every year with a simple fireworks demonstration. Black powder is used as the active ingredient. The balanced chemical equation for the reaction is:

2 [KNO3](http://en.wikipedia.org/wiki/Potassium_nitrate) + S + 3 [C](http://en.wikipedia.org/wiki/Carbon) → [K2S](http://en.wikipedia.org/wiki/Potassium_sulfide) + [N2](http://en.wikipedia.org/wiki/Nitrogen) + 3 [CO2](http://en.wikipedia.org/wiki/Carbon_dioxide)

|  |
| --- |
| If 20.0 g of carbon are used, what mass of K2S will be produced following the reaction? |

1. The lab technician prepared 2.0 L of concentrated sulphuric acid (H2SO4) stock solution by dissolving 1.765 Kg of H2SO4 in water. The chemistry teacher subsequently asked her to prepare sixty (60) 225 mL samples of 0.50 mol/L sulphuric acid solution.

|  |
| --- |
| Calculate the total volume of prepared concentrated stock solution that the lab technician  will use to prepare the samples. |

1. Methane (CH4) is a naturally occurring gas. When it is used as a biofuel, the following reaction takes place. Balanced equation: CH4 + 2  O2 → CO2 + 2 H2 O + energy

|  |  |
| --- | --- |
|  |  |
|  |  |

|  |
| --- |
| a) This type of reaction is:  A) Neutralization C) Synthesis  B) Oxidation D) Decomposition  b) Is this an endothermic or exothermic reaction? Justify your answer. |
|  |

1. Burning of fossil fuels such as gasoline (or octane, C8H18) produces carbon dioxide (CO2), a contributor to global warming. The balanced equation for the combustion of octane is:

2 C8H18 + 25 O2 → 16 CO2 + 18 H2O

Excessive logging in the rain forest also contributes to global warming. Carbon dioxide plays an important role in photosynthesis. In the presence of sunlight carbon dioxide reacts with water (H2O) to produce glucose (C6H12O6) and oxygen (O2). The balanced equation for photosynthesis is:

6 CO2 + 6 H2O → C6H12O6 + 6 O2

A small patch of trees in a rain forest is able to remove 56.7 kg of CO2 from the atmosphere in one day.

|  |
| --- |
| a) Determine the mass of octane (C8H18) that is responsible for producing 56.7 kg of CO2.  b) What mass of glucose will this small patch of trees produce? |

1. Mario is studying the energy changes of different chemical reactions.He mixes ethanoic acid (CH3COOH) with sodium carbonate (Na2CO3) in a reaction vessel. The balanced chemical equation for this reaction is shown below.

2 CH3COOH + Na2CO3 + energy → 2 CH3COONa + H2O + CO2

|  |
| --- |
| Which of the following statements correctly describes what Mario should observe and conclude  about the reaction? |

1. The temperature of the reaction vessel will increase and therefore the reaction is endothermic.
2. The temperature of the reaction vessel will increase and therefore the reaction is exothermic.
3. The temperature of the reaction vessel will decrease and therefore the reaction is endothermic.
4. The temperature of the reaction vessel will decrease and therefore the reaction is exothermic.
5. Sodium chloride (NaCl) is the most common ionic compound in sea water. A 100.0 mL sample of sea water contains 2.80 g of sodium chloride.

|  |
| --- |
| What is the molar concentration (in mol/L) of sodium chloride in the sample of sea water? |

1. 0.000479 mol/L B) 0.479 mol/L C) 28.0 mol/L D) 209 mol/L
2. Magnesium sulfate (MgSO4) is a chemical compound commonly called Epsom salt. It has been used for centuries to treat the following medical conditions:
   * Skin problems
   * Cardiac arrhythmias
   * Asthma

Your aunt Susan suffers from a skin problem. You offer to prepare a solution of magnesium sulfate (MgSO4 ) to ease her discomfort. To prepare the solution you must dissolve 35 g of MgSO4 in 2.6 liters of water.

|  |
| --- |
| What is the molar concentration of the solution? |

1. A welder has to cut a metal door with her acetylene (C2H2) torch. The following chemical equation represents the combustion of acetylene:

2 C2H2 + 5 O2 → 4 CO2 + 2 H2O

|  |
| --- |
| How many moles of CO2 will be released into the atmosphere if the welder uses 12 kg of  acetylene to cut the metal door? |

1. Whether you are working in a laboratory or in industry, it is important to understand that the position of the energy term in a chemical equation will tell you whether the reaction will be endothermic or exothermic.

|  |
| --- |
| Match the terms in the first column with the equations in the second column. |

|  |  |
| --- | --- |
| **Type of Reaction** | **Equations** |
| I. Endothermic reaction  II. Exothermic reaction | 1. 4 Fe(s) + 3 O2(g) → 2 Fe2O3(s) + 1648.4 kJ  2. NaCl(s) + 4.3 kJ → Na+(aq) + Cl−(aq)  3. CH3CH2OH(l) + 3 O2(g) → 2 CO2(g) + 3 H2O(g) + 1367 kJ  4. N2(g) + O2(g) + 104 kJ → 2 NO(g) |

1. I-1, I-3, II-2, II-4 B) I-1, I-4, II-2, II-3 C) I-2, I-3, II-1, II-4 D) I-2, I-4, II-1, II-3
2. You need 2.0 g of silver (Ag) for an experiment. However, you can only find silver nitrate (AgNO3(aq)) . You decide to extract the silver from the silver nitrate using copper (Cu), according to the following equation:

Cu(s) + 2 AgNO3(aq) → Cu(NO3)2(aq) + 2 Ag(s)

What mass of silver nitrate will you require in order to obtain the 2.0 g of silver that you need?

**Answers**

**Simplified atomic model and Isotopes**

* + - 1. B
      2. B
      3. C
      4. C
      5. D
      6. C
      7. A
      8. B
      9. C
      10. C
      11. C
      12. 12, 13 and 14
      13. A
      14. 1b, 2a and 3c
      15. B
      16. C
      17. C
      18. C
      19. C
      20. D
      21. A

**Trends**

From left to right across the period, electronegativity increases.

C

D

D

B

B

B

D

A

B

C

A

C

D

C

**Radioactivity**

1. A
2. D
3. C
4. A
5. D
6. D
7. D
8. D
9. A
10. D
11. B
12. D
13. C
14. C
15. A

**Bonding**

1. C
2. P2O3
3. A) CaCl2 B) Ionic
4. D
5. AlF3
6. C
7. A
8. B
9. MgS
10. YZ2
11. A
12. Alkaline earth metal
13. D
14. K3X
15. C
16. CO
17. X3Y
18. A
19. C
20. C
21. B
22. MgCl2 magnesium chloride
23. D
24. Be and S
25. B
26. As2O3
27. D
28. A
29. Boron
30. C
31. C
32. A
33. B
34. B2O3
35. AlCl3 Aluminum chloride
36. A
37. D
38. 1- S8 2- N2O3 3- CCl4 4- P2O5
39. B
40. B
41. D
42. C
43. C
44. B
45. B

**Polyatomic bonding**

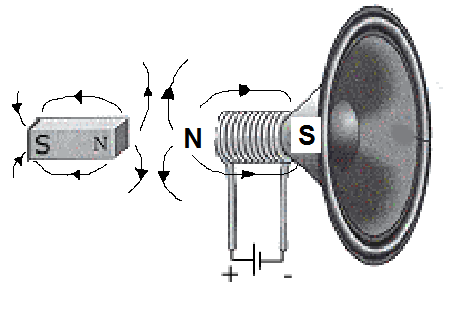
1. Mg(NO3)2
2. A
3. A
4. OH- ClO-1 SO4-2 B4O7-2
5. 1. Ba3N2 2. MgO 3. LiNO3 4. Al2(SO4)3
6. Ca(OH)2 Al2(SO4)3 K3PO4 NaCH3COO
7. A- H2SO4  & NaOH B- aluminum oxide
8. B
9. D
10. D
11. D
12. B
13. B
14. Al2(SO4)3, KNO3, Pb(MnO4)2, Al(NO3)3
15. C
16. B
17. C
18. D
19. A) Na3PO4 B) Ca3(PO4)2 C) AlPO4 D) (NH4)3PO4
20. H2O and Ca3(PO4)2 calcium hydroxide and hydrogen phosphate
21. B

|  |  |
| --- | --- |
|  | Nitrogen trioxide |
|  | Magnesium chloride |
| Al2O3 |  |
| Ca3(PO4)2 |  |

|  |  |  |
| --- | --- | --- |
| Chemical formula | Positive ion and charge | Negative ion and charge |
|  | Ca+2 | IO3-1 |
| NH4Cl |  | Cl-1 |
| MgCO3 | Mg+2 |  |
|  | Al+3 | SO4-2 |

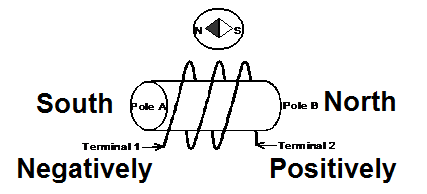
**Magnetism**

1. D
2. B
3. D
4. B
5. a-



b-They will repel each other

1. First one
2. D
3. a-



b-The intensity of the current can be increased

The core can be exchanged for a ferromagnetic substance

You can increase the number of coils around the core

1. C
2. D
3. B

**Electricity**

1. 1.5 A
2. D
3. 36 V
4. 3.0 A
5. 8.0 Ω
6. 0.5 A
7. Circuit 1 = 5.88 Ω and circuit 2 = 80.0 Ω
8. B
9. 2 A
10. 40 Ω
11. 120 V
12. 0.5 A
13. 2 Ω
14. 3 Ω
15. 3 A
16. 17.5 V
17. 15 A
18. B
19. 5 V
20. 6 V
21. D
22. 26.7 Ω
23. A- current constant throughout the circuit. [Set A IT = 0.4 A; Set B IT = (0.1 A X 8) = 0.8A]
24. A series circuit with two resistors. Possible resistor pairs: 5 and 1, 3 and 3 or 4 and 2
25. 0.67 A
26. 20 Ω
27. 2.5 A
28. A is 15 Ω B is 1.62 Ω
29. Orange – yellow – brown – gold
30. Parallel circuit with two resistors. Possible resistor combination: 200 and 200 or 150 and 300
31. A
32. D
33. 6 500 ± 20%
34. A
35. Circuit A is 32 Ω and circuit B is 10 Ω
36. 0.025 A
37. Option 1 is 864 000 J option 2 is 486 000 J

**Heat & Energy**

1. 20°C
2. C
3. 50. °C

**Moles, stoichiometry, endothermic and exothermic reactions**

1. a) exothermic reaction

b) synthesis reaction

1. a) 2C2H6 + 7O2 → 4CO2 + 6H2O

b) 12 moles of H2O

1. 45 g
2. 61.3 g of K2S
3. 0.75 L
4. a) B)

b) Exothermic reaction, because it releases energy (energy is one of the products)

7. a) 216 kg of C8H18

b) 38.7 kg of glucose

8 C

9. B

10. 0.11 mol/L

11. 922 mol

12. D

13. 3.15 g of AgNO3