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Chemistry, 2014 EC, natural science, entrance exam

Grade 12 · Chemistry · 2014 E.C.

MARKING KEY — CONFIDENTIAL

Time allowed: 120 minutes | **Questions:** 30 | **Total marks:** 30

1. What is the purpose of synthetic Cryolite in the extraction of aluminum by the Hall' s process? (1)

A. ✓ **Cryolite reduces the melting point of alumina**

B. Cryolite increases the purity of the extraction of aluminum.

C. Cryolite is used as a catalyst in the extraction of aluminum.

D. Cryolite increases the melting point of alumina

Answer: A

Pure aluminum oxide (alumina, Al2O3) melts at about 2045 degrees Celsius. Keeping the cell that hot would use far too much energy. Cryolite (Na3AlF6) dissolves the alumina and brings the working temperature down to about 1000 degrees Celsius. The molten mixture also conducts electricity well, which the electrolysis needs.

Cryolite is not a catalyst and it does not purify the metal, so options B and C are wrong. Option D says the opposite of what cryolite does.

Textbook: Chemistry Grade 10, Unit 5 Metals and Nonmetals, section 5.2.3 Production of Aluminum, Iron and Copper (page 207).

2. Which of the following is a chemical property of aluminum? (1)

A. Aluminum is a grey metal in color.

B. ✓ **Aluminum liberates hydrogen gas from dilute acids like HCl and H2SO4**

C. Aluminum has a lower density than any other commercial metal.

D. Aluminum is a good conductor of heat and electricity.

Answer: B

A chemical property describes how a substance changes into a new substance during a reaction. When aluminum reacts with dilute HCl or H2SO4, it forms a salt and gives off hydrogen gas. A new substance forms, so this is a chemical property.

Color (A), density (C) and conduction of heat and electricity (D) can all be observed without changing the aluminum into anything new. They are physical properties.

Textbook: Chemistry Grade 10, Unit 5 Metals and Nonmetals, section 5.2.1 Properties and Extraction of Metals (page 203).

3. How is tanning carried out? In tanning the hides or skins are (1)

A. soaked in lime and water for several days.

B. soaked in water for several days.

C. treated with dilute hydrochloric acid to remove the line.

D. ✓ **treated with chromium salts.**

Answer: D

Tanning turns the protein of a raw hide into stable, durable leather. In mineral tanning, the most common modern method, the skin is placed in solutions of chromium salts such as chromium sulphate. Chrome tanning is fast and gives stretchable leather.

Option A describes liming, a preparatory step that loosens hair before tanning. Soaking in water (B) only cleans the hide, and dilute acid (C) is used for deliming. None of these is the tanning step itself.

Textbook: Chemistry Grade 12, Unit 3 Industrial Chemistry, section 3.4.6 Tannery (page 187).

4. How can a project of establishing an industry that consumes coal affect the environment? (1)

A. ✓ **Rise in global temperature**

B. Increment in concentration of nitric oxide

C. By changing the PH of water

D. Production of high level of lead in the atmosphere

Answer: A

An industry that burns coal releases large amounts of carbon dioxide. CO2 is a greenhouse gas: it traps heat in the atmosphere, so the global temperature rises. This is the main environmental effect of coal use.

Coal contains almost no lead, so option D is wrong. Coal burning can release some nitrogen and sulphur oxides, but the rise in global temperature from CO2 is the effect the question points to.

Textbook: Chemistry Grade 12, Unit 5 Introduction to Environmental Chemistry, section 5.3 Global Warming and Climate Change (page 265).

5. Which of the following is a fundamental quantity SI unit? (1)

A. Force

B. Speed

C. ✓ **Length**

D. Pressure

Answer: C

The SI system has seven base (fundamental) quantities: length, mass, time, electric current, temperature, amount of substance and luminous intensity. Length, measured in metres, is one of them.

Force, speed and pressure are derived quantities. Their units are built from the base units: speed is m/s, force is kg m/s squared (the newton), and pressure is force per area (the pascal).

Textbook: Chemistry Grade 9, Unit 2 Measurements and Scientific Methods, section 2.1 Measurements and Units in Chemistry (page 20).

6. What is enthalpy change? It is (1)

A. ✓ **the amount of heat given out or absorbed in a reaction at constantpressure.**

B. the amount of heat given out in a reaction.

C. the amount of heat absorbed in a reaction.

D. the amount of heat given out or absorbed in a reaction at constantpressure and volume.

Answer: A

The enthalpy change, ΔH, is the heat given out or absorbed by a reaction at constant pressure. Most reactions in the laboratory happen in open containers, where the pressure stays at atmospheric pressure, so the heat exchanged equals the enthalpy change.

Options B and C each cover only one direction of heat flow, but ΔH can be negative (heat released) or positive (heat absorbed). Option D adds constant volume, which is wrong: heat at constant volume is the internal energy change, not the enthalpy change.

7. What is oxidation? Oxidation is (1)

A. ✓ **the loss Of electrons by a species, accompanied by an increase inoxidation number.**

B. the addition of hydrogen to a substance and the removal of oxygen froma substance.

C. the reduction of the oxidation state of the oxidizing agent.

D. the addition of electron (s) to the oxidizing agent.

Answer: A

Oxidation is the loss of electrons by an atom, ion or molecule. When a species loses electrons, its oxidation number increases. For example, in $Zn \rightarrow Zn^{2+} + 2e^{-}$, zinc is oxidized and its oxidation number rises from 0 to +2.

Option B is backwards: adding hydrogen or removing oxygen is reduction. Options C and D describe what happens to the oxidizing agent, which is reduced, not oxidized.

Textbook: Chemistry Grade 12, Unit 2 Electrochemistry, section 2.1.1 Oxidation (page 57).

8. What is meant by preferential discharge, if a number in a solution? It means that last at given electrode. (1)

A. ✓ **least energy will be liberated first a given electrode.**

B. least energy will be liberated last at a given electrode.

C. highest energy will be liberated first at a given electrode.

D. highest energy will be liberated fist at

Answer: A

When several ions are present in a solution, they cannot all be discharged at once. The ion that needs the least energy to lose its charge is set free first at the electrode. This choice among the ions is called preferential discharge.

The main deciding factor is the position of the ion in the electrochemical series: an ion lower in the series is discharged before the ions above it. Concentration and the nature of the electrode can also change the order.

Textbook: Chemistry Grade 12, Unit 2 Electrochemistry, section 2.2.2 Preferential Discharge (page 70).

9. Faraday' s Second Law states: (1)

A. ✓ **passing the same quantity of electricity through solutions ofdifferent electrolytes produces masses of substances that are directlyproportional to their equivalent masses.**

B. passing the same quantity of electricity through solutions ofdifferent electrolytes produces masses of substances that are directlyproportional to their molecular masses.

C. the amount of substance consumed or produced at an electrode isinversely proportional to the quantity of electricity passing throughthe solution.

D. the amount of a substance consumed or produced at an electrode isdirectly proportional to the quantity of electricity passing through thesolution.

Answer: A

Faraday's second law compares different electrolytes. It states that when the same quantity of electricity passes through solutions of different electrolytes, the masses of the substances liberated are directly proportional to their equivalent masses.

Option D is Faraday's first law, which is about one electrolyte: mass is proportional to the quantity of electricity passed. Option B wrongly uses molecular mass instead of equivalent mass, and option C says inversely proportional, which is false.

Textbook: Chemistry Grade 12, Unit 2 Electrochemistry, section 2.3.2 Faraday's Second Law of Electrolysis (page 84).

10. Which of the following is true about Zn - Cu voltaic cell? (1)

A. ✓ **After the cell runs for several hours, the Zn electrode weights less.**

B. The anode half - cell consists of Cu electrode dipped into a Cu^(2+) solution.

C. As the cell operates, electrons are continuously generated at thecathode and consumed at the anode.

D. The electrons flow from right to left through the external circuit.

Answer: A

In the Zn-Cu (Daniell) cell, zinc is the anode. It is oxidized: $Zn \rightarrow Zn^{2+} + 2e^{-}$. Zinc atoms leave the electrode and enter the solution as ions, so the zinc electrode slowly loses mass while the cell runs. Option A is true.

Option B is wrong because the copper half-cell is the cathode, not the anode. Option C reverses the flow: electrons are produced at the anode and used up at the cathode. Option D depends on how the diagram is drawn, so it cannot be a general truth.

Textbook: Chemistry Grade 12, Unit 2 Electrochemistry, section 2.5 Voltaic Cells (page 92).

11. Which of the following postulates of Dalton' s atomic theory was modified by the modern atomic theory? (1)

A. ✓ **Atoms are indivisible and indestructible.**

B. Atoms are the smallest particles of all elements.

C. Compounds are formed when atoms of more than one element combine.

D. Atoms are neither created nor destroyed in chemical reactions.

Answer: A

Dalton said the atom is indivisible and indestructible. Modern atomic theory changed this postulate: the atom is made of smaller particles, the protons, neutrons and electrons, and it can even be split in nuclear reactions.

The ideas in options B, C and D still hold in ordinary chemistry. The atom is still the smallest particle of an element that takes part in a chemical reaction, atoms still combine to form compounds, and atoms are not created or destroyed in chemical reactions.

Textbook: Chemistry Grade 11, Unit 1 Atomic Structure and Periodic Properties of the Elements, section 1.2 Dalton's Atomic Theory and the Modern Atomic Theory (page 3).

12. Which of the following includes all of the known atomic models? (1)

A. Bohr Model, the Quantum Mechanical Model, Thomson Model, Rutherford Model

B. Bohr Model, Quantum Mechanical Model, Dalton's Atomic Model, Valence Bond Model

C. Bohr Model, Thomson Model, Rutherford Model, Dalton's Atomic Model, de Broglie Model

D. ✓ **Bohr Model, the Quantum Mechanical Model, Rutherford Model, Thomson Model, Dalton's Atomic Model**

Answer: D

The atomic models studied in school chemistry, in historical order, are: Dalton's solid sphere model, Thomson's plum pudding model, Rutherford's nuclear model, the Bohr model and the quantum mechanical model. Only option D lists all five.

Option A misses Dalton's model. Option B includes the valence bond model, which explains chemical bonding, not the structure of the atom. Option C swaps the quantum mechanical model for a 'de Broglie model'; de Broglie proposed the wave nature of particles, not an atomic model.

Textbook: Chemistry Grade 9, Unit 3 Structure of the Atom, section 3.3 Atomic Theory (page 66).

13. What does Mendeleev' s Periodic Law state? Properties of elements are periodic functions of their (1)

A. ✓ **atomic masses**

B. atomic radius

C. atomic numbers

D. electron configurations

Answer: A

Mendeleev arranged the elements in order of increasing atomic mass. He saw that similar properties returned at regular intervals. His periodic law says the properties of elements are periodic functions of their atomic masses.

Option C describes the modern periodic law, which uses atomic numbers. That change came later, after Moseley's work. The question asks about Mendeleev's law, so atomic masses is the answer.

Textbook: Chemistry Grade 9, Unit 4 Periodic Classification of Elements, section 4.2 Mendleev's Classification of the Elements (page 116).

14. Which of the following statements is correct regrading alkenes and alkynes? (1)

A. Alkenes are soluble in polar solvents, while alkymes are not solublein polar solvents.

B. Alkenes and alkynes are soluble in polar solvents.

C. ✓ **The molecule of alkenes and alkynes are held together by weakinter-molecular force.**

D. Alkynes have longer bond length and less surface area than alkenes.

Answer: C

Alkenes and alkynes are hydrocarbons, so their molecules are nonpolar. Nonpolar molecules attract one another only by weak van der Waals forces. This is why the small members are gases and why their melting and boiling points are low. Option C is correct.

Options A and B fail because nonpolar molecules do not dissolve well in polar solvents like water. Option D fails because a triple bond is shorter than a double bond, not longer.

Textbook: Chemistry Grade 10, Unit 6 Hydrocarbons and their Natural Sources, section 6.3 Unsaturated Hydrocarbons: Alkenes, Alkynes and Aromatic Hydrocarbons (page 266).

15. Which functional group containing compound is named using the suffix "-ol"? (1)

A. Aryl

B. Carboxyl

C. Phenyl

D. ✓ **Hydroxyl**

Answer: D

The suffix '-ol' names alcohols. An alcohol contains the hydroxyl group, OH, attached to a carbon atom. For example, CH3CH2OH is ethanol and CH3OH is methanol.

The carboxyl group (B) is named with the suffix '-oic acid', as in ethanoic acid. Aryl and phenyl (A and C) are not functional groups that give a suffix; they are names for aromatic ring groups attached to a molecule.

Textbook: Chemistry Grade 11, Unit 6 Some Important Oxygen-Containing Organic Compounds, section 6.2.2 Nomenclature of Alcohols (page 269).

16. What is a Lewis acid? It is (1)

A. ✓ **an electron pair acceptor**

B. a proton acceptor

C. a proton donor

D. an electron pair donor

Answer: A

In the Lewis concept, an acid is an electron pair acceptor and a base is an electron pair donor. For example, in the reaction of BF3 with NH3, the BF3 accepts the lone pair from nitrogen, so BF3 is the Lewis acid.

Options B and C belong to the Bronsted-Lowry concept, which defines acids as proton donors and bases as proton acceptors. Option D is the definition of a Lewis base, not a Lewis acid.

Textbook: Chemistry Grade 12, Unit 1 Acid-Base Equilibria, section 1.1.3 Lewis Concept of Acids and Bases (page 11).

17. Which Of the following statements is NOT correct about minerals and ores? (1)

A. All ores are minerals

B. ✓ **All minerals are ores**

C. Ores are usually used to extract metals economically

D. Minerals are the natural forms in which various metals exist.

Answer: B

Minerals are the natural compounds or elements of the earth's crust that contain metals. An ore is a mineral from which a metal can be extracted profitably. So every ore is a mineral, but many minerals are not rich enough or not cheap enough to serve as ores.

That makes statement B false, and the question asks for the statement that is NOT correct. Statements A, C and D all describe minerals and ores correctly.

Textbook: Chemistry Grade 10, Unit 5 Metals and Nonmetals, section 5.2.1 Properties and Extraction of Metals (page 204).

18. Which of the following is NOT a major step in metallurgical processes? (1)

A. Concentrating the ore

B. Mining the ore

C. Extracting the metal and refining

D. ✓ **Pretreatment**

Answer: D

Getting a metal from the ground follows major steps: mining the ore, concentrating the ore to remove the gangue, extracting the metal from the concentrated ore, and refining the metal to purify it. Options A, B and C name these steps.

Pretreatment is not counted as one of the major metallurgical steps, so option D is the answer.

Textbook: Chemistry Grade 10, Unit 5 Metals and Nonmetals, section 5.2.1 Properties and Extraction of Metals (page 205).

19. Which monomers are used for the synthesis of Teflon? (1)

A. Propylene

B. ✓ **Tetrafluoroethylene**

C. Isoprene

D. Styrene and Phenol

Answer: B

Teflon is polytetrafluoroethylene (PTFE). It is made by addition polymerization of one monomer, tetrafluoroethylene, $CF_2=CF_2$. Many of these units join to give the chain $(CF_2-CF_2)_n$, a polymer that resists heat and chemicals and feels slippery.

Propylene (A) gives polypropylene, isoprene (C) is the unit of natural rubber, and styrene (D) gives polystyrene. None of them makes Teflon.

Textbook: Chemistry Grade 12, Unit 4 Polymers, section 4.2 Polymerization Reactions (page 215).

20. What is the significance of electron probability distribution? It tells us about (1)

A. finding the electron in its orbit at a particular time.

B. ✓ **the uncertainty to assign fixed path for electrons.**

C. the probability of finding an electron is very far away from the nucleus.

D. finding the electron very close to the nucleus at all times.

Answer: B

Heisenberg showed that we cannot know both the position and the momentum of an electron exactly at the same time. So the quantum mechanical model does not give the electron a fixed path or orbit. Instead, the square of the wave function tells us the probability of finding the electron in a region of space.

The probability distribution is the way chemistry expresses this uncertainty, which is option B. Option A is wrong because electrons do not move in fixed orbits, and options C and D pick one location, while the distribution covers all space.

Textbook: Chemistry Grade 11, Unit 1 Atomic Structure and Periodic Properties of the Elements, section 1.6 The Quantum Mechanical Model of the Atom (page 34).

21. Which Of the following is a property Of covalent compounds? Covalent compound (1)

A. has high melting and boiling points

B. is non-volatile

C. is crystalline solids at room temperature

D. ✓ **is generally insoluble in water**

> **Answer:** D
> Most covalent compounds are nonpolar or only slightly polar. Water is a highly polar solvent, so it cannot dissolve them. Covalent compounds generally dissolve in nonpolar solvents instead, following the rule that like dissolves like. Option D is the correct property.
>
> The other options describe ionic compounds. Covalent compounds usually have low melting and boiling points, are volatile, and many are gases or liquids at room temperature rather than crystalline solids.
>
> **Textbook:** Chemistry Grade 9, Unit 5 Chemical Bonding, section 5.3.5 General Properties of Covalent Compounds (page 169).

22. Which of the following is a covalent molecule? (1)

A. NaCl

B. ✓ **PCl3**

C. (CO3)^(2-)

D. [NH4]^(-)

> **Answer:** B
> PCl3 is formed from two nonmetals, phosphorus and chlorine, which share electrons. It is a neutral molecule held together by covalent bonds, so it is a covalent molecule.
>
> NaCl (A) is an ionic compound of a metal and a nonmetal. The carbonate ion (C) and the ammonium ion (D) do contain covalent bonds inside them, but each carries an overall charge, so they are polyatomic ions, not neutral molecules.
>
> **Textbook:** Chemistry Grade 11, Unit 2 Chemical Bonding, section 2.3 Covalent Bonds and Molecular Geometry (page 83).

23. Which Of the following carboxylic acids is a solid substance at room temperature? (1)

A. Octanoic acid

B. ✓ **Decanoic acid**

C. Heptanoic acid

D. Nonanoic acid

> **Answer:** B
> For straight-chain carboxylic acids, the melting point rises as the carbon chain gets longer. The acids with up to 9 carbon atoms are liquids at room temperature; the higher members are waxy solids.
>
> Heptanoic acid has 7 carbons, octanoic acid 8 and nonanoic acid 9, so all three are liquids. Decanoic acid has 10 carbons and melts at about 32 degrees Celsius, so it is the solid at room temperature.
>
> **Textbook:** Chemistry Grade 11, Unit 6 Some Important Oxygen-Containing Organic Compounds, section 6.4.2 Physical Properties of Carboxylic Acids (page 302).

24. What is the IUPAC name of an ester having the molecular formula C6H12O2 (1)

A. Methyl butyrate

B. Pentyl butyrate

C. ✓ **Ethyl butanoate**

D. Ethyl butyrate

> **Answer:** C
> An ester with the formula C6H12O2 that comes from butanoic acid (4 carbons) and ethanol (2 carbons) is CH3CH2CH2COOCH2CH3. In IUPAC naming, the alcohol part is named first as an alkyl group and the acid part ends in '-oate'. That gives ethyl butanoate.
>
> 'Ethyl butyrate' (D) is the common name of the same compound, so it is not the IUPAC name the question asks for. Methyl butyrate (A) is C5H10O2 and pentyl butyrate (B) is C9H18O2, so their formulas do not match.
>
> **Textbook:** Chemistry Grade 11, Unit 6 Some Important Oxygen-Containing Organic Compounds, section 6.5.2 Nomenclature (page 313).

25. What is the rate of dissolution? It is (1)

A. ✓ **the speed at which a solid substrate goes into solution.**

B. the rate at which a solid turns to liqui

C. the speed at which a solid sublimes.

D. the rate at which a solid dissociates.

> **Answer:** A
> Dissolution is the process of a solute dissolving in a solvent to form a solution. The rate of dissolution is the speed at which the solid solute goes into the solution. Stirring, heating and grinding the solid into smaller pieces all make it faster.
>
> Option B describes melting, option C describes sublimation and option D describes dissociation into ions. These are different processes, not the rate of dissolution.
>
> **Textbook:** Chemistry Grade 10, Unit 2 Solutions, section 2.2.5 The Rate of Dissolution (page 67).

26. Which one of the following is correctly stated regarding solubility as an equilibrium process? (1)

A. Saturated solution is a solution in which more of the solute can bedissolve

B. Unsaturated solution is a solutionto a given dissolved substance.

C. Supersaturated solution is more stable than saturated solution.

D. ✓ **Supersaturated solution is a solution that contains more than the equilibrium amount of dissolved solute.**

> **Answer:** D
> A saturated solution is at equilibrium: it holds the maximum amount of dissolved solute at that temperature, and dissolving happens at the same rate as crystallizing. A supersaturated solution holds more than this equilibrium amount, so option D is correct.
>
> Option A is wrong because a saturated solution cannot dissolve more solute. Option C is wrong because a supersaturated solution is unstable: a seed crystal or a small shake makes the extra solute crystallize out at once.
>
> **Textbook:** Chemistry Grade 10, Unit 2 Solutions, section 2.3.1 Unsaturated, Saturated, and Supersaturated Solutions (page 74).

27. Which of the following assumptions of the kinetic molecular theory of gases explains the high compressibility of gases? (1)

A. There is no force of attraction between gas molecules.

B. ✓ **The actual volume of gas molecules in negligible.**

C. Different particles have different speeds.

D. Particles are always in random motion.

> **Answer:** B
> The kinetic molecular theory assumes that gas particles are very far apart, so the volume of the particles themselves is negligible compared with the volume of the gas. Most of a gas is empty space. When pressure is applied, the particles are simply pushed closer together, which is why gases compress so easily.
>
> Option A, the absence of attractive forces, explains why gases expand to fill any container, not why they can be squeezed. Options C and D describe motion and speed, which do not explain compressibility.
>
> **Textbook:** Chemistry Grade 11, Unit 3 Physical States of Matter, section 3.3.1 The Kinetic Molecular Theory of Gases (page 152).

28. Consider a bottle containing water, water vapor and air in equilibrium. If the temperature decreases slightly, the amount of water vapors; (1)

A. will increase and the vapor pressure will decrease.

B. and vapor pressure will increase.

C. ✓ **and vapor pressure will decrease.**

D. will decrease and the vapor pressure will increase.

> **Answer:** C
> In the closed bottle, liquid water and its vapor are in equilibrium, and the vapor pressure depends only on temperature. When the temperature drops, molecules evaporate more slowly, and for a while condensation is faster than evaporation.
>
> So some vapor returns to the liquid: the amount of water vapor decreases, and the new equilibrium vapor pressure is lower. Both quantities fall together, which is option C.
>
> **Textbook:** Chemistry Grade 11, Unit 3 Physical States of Matter, section 3.4.1 Energy Changes in Liquids (page 174).

29. Why do water droplets collect on the outside of a glass of water on a hot day? (1)

A. Water from the glass starts to vaporize.

B. There is heat exchange between the water in the glass and the surrounding.

C. There will be a sublimation of water vapor on the outside of a glass.

D. ✓ **There will be a condensation of water vapor on the glass.**

> **Answer:** D
> On a hot day the air holds a lot of water vapor. The glass of water is colder than the air, so it cools the thin layer of air touching it. Water vapor in that layer loses energy, turns back into liquid, and collects as droplets on the outside of the glass. This change from vapor to liquid is condensation.
>
> Options A and B do not explain where the droplets come from, and option C is wrong because sublimation is a change between solid and gas, not gas to liquid.
>
> **Textbook:** Chemistry Grade 11, Unit 3 Physical States of Matter, section 3.4 The Liquid State (page 173).

30. What are hydrocarbons? Compounds that contain (1)

A. ✓ **hydrogen and carbon only.**

B. hydrogen and carbon with no benzene rings.

C. benzene and its derivatives only.

D. benzene rings only

> **Answer:** A
> Hydrocarbons are compounds that contain only carbon and hydrogen atoms. The family includes alkanes, alkenes, alkynes and the aromatic compounds such as benzene.
>
> Option B wrongly leaves out the aromatic hydrocarbons, which have benzene rings. Options C and D are too narrow the other way: benzene and its derivatives are only one part of the hydrocarbon family.
>
> **Textbook:** Chemistry Grade 10, Unit 6 Hydrocarbons and their Natural Sources, section 6.1 Introduction (page 238).

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