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Chemistry, 2013 EC, natural science, entrance exam

Grade 12 · Chemistry · 2013 E.C.

MARKING KEY — CONFIDENTIAL

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

1. Significant figures are figures with (1)

A. measured values with the highest precision.

B. measured values with the highest accuracy.

C. measured values with the highest uncertainty.

D. ✓ **exactly known digits with the last digit uncertain.**

Answer: D

A measured value can never be perfectly exact. Significant figures are all the digits you are sure about, plus one final digit that is estimated. That last digit carries the uncertainty of the measurement.

For example, if a burette reads 24.35 mL, the digits 2, 4 and 3 are certain and the 5 is the estimated one. All four are significant figures.

Options A, B and C talk about precision, accuracy and uncertainty. Those words describe the quality of a measurement, not what significant figures are.

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

2. The branch of chemistry that is involved in separation, identifying and determining the relative amounts of components in a sample of material is known as (1)

A. Biochemistry.

B. Physical chemistry.

C. ✓ **Analytical chemistry.**

D. Inorganic chemistry.

Answer: C

The question describes a branch of chemistry that separates a sample into its parts, identifies each part, and measures how much of each is present. That is exactly what analytical chemistry does. An analytical chemist may use instruments to find out what an unknown material contains and in what amounts.

Physical chemistry is a tempting wrong choice, but it studies energy changes, reaction rates and the theories behind chemical behaviour. It does not focus on separating and measuring the components of samples.

Textbook: Chemistry Grade 9, Unit 1 Chemistry and its Importance, section 1.1 Definition and Scope of Chemistry (page 2).

3. For the determination of the density of a new ceramic, a student measured the mass of a piece on an analytical and obtained 3.8056 gram and its volume 2.5 mL by displacement of water in a graduated cylinder. The correct reported density of the ceramic should be (1)

A. 1.5222 g/mL
B. ✓ **1.5 g/mL**
C. 1.5224 g/mL
D. 3.5 g/mL

Answer: B
Divide mass by volume:

$$d = \frac{m}{V} = \frac{3.8056\ \text{g}}{2.5\ \text{mL}} = 1.52224\ \text{g/mL}$$

Now apply the rule for significant figures. In multiplication and division, the answer keeps as many significant figures as the least precise measurement. The mass (3.8056 g) has 5 significant figures, but the volume (2.5 mL) has only 2. So the reported density must have 2 significant figures.

Rounding 1.52224 to 2 significant figures gives **1.5 g/mL**.

Options A and C keep digits that the rough volume reading cannot support, so they overstate the precision of the result.

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

4. The scientific method is (1)

A. a collection of scientific guesses and hypotheses by seeking patterns in the observation.
B. ✓ **a method of arriving at an organized body of knowledge based on reproducible experiments and observation.**
C. the sum total of unique guidelines for the practice of science in the world.
D. the result of fortunate, accidental discovery in the development of science.

Answer: B
The scientific method is the organized way scientists build reliable knowledge. It moves from observation and questions to a hypothesis, then to experiments that test the hypothesis, and finally to analysis and conclusions. The key idea is that the experiments must be reproducible: anyone who repeats them should get the same result.

Option A stops at guessing, option C describes rules rather than a method, and option D describes lucky accidents. None of these is the method itself.

Textbook: Chemistry Grade 9, Unit 2 Measurements and Scientific Methods, section 2.2 Chemistry as Experimental Science (page 37).

5. One of the following is NOT a cause of uncertainty in measurement? (1)

A. ✓ **The type of material measured**
B. The person doing the experiment
C. The measuring device
D. The environment where the measurement is made

Answer: A
Uncertainty enters a measurement through three main doors: the measuring device (a worn ruler or a badly calibrated balance), the person doing the measuring (reading errors, reaction time, parallax), and the environment (temperature changes, vibration, air currents).

The type of material being measured is not one of these causes. A given balance reads gold with the same uncertainty as it reads salt; what matters is the instrument, the person and the surroundings, not what the sample is made of.

Textbook: Chemistry Grade 9, Unit 2 Measurements and Scientific Methods, section 2.1.4 Uncertainty in Measurements (page 28).

6. Which of the following is true about isotopes? Isotopes of an element have (1)

A. the same number of electrons and neutrons.

B. ✓ **different number of neutrons and the same number protons.**

C. different physical and chemical properties.

D. the same atomic mass but different atomic numbers.

> **Answer:** B
>
> Isotopes are atoms of the same element. They must have the same number of protons, because the proton number is what defines the element. What differs is the number of neutrons, so their mass numbers differ.
>
> For example, carbon-12 and carbon-14 both have 6 protons, but they have 6 and 8 neutrons.
>
> Option D reverses the facts: isotopes have the same atomic number but different masses. Option C is wrong because isotopes share the same chemical properties; only some physical properties (like mass) differ slightly.
>
> **Textbook:** Chemistry Grade 9, Unit 3 Structure of the Atom, section 3.5 Composition of an Atom and the Isotopes (page 87).

7. Which statement correctly describes Heisenberg's uncertainty principle? (1)

A. If we measure the momentum of a particle precisely then its position will be correspondingly precise.

B. A particle with a mass moving at a given speed can be described by the wave characteristics of material particles.

C. A small particle like the electron can behave both as a particle and a wave.

D. ✓ **Both the location and the momentum of a subatomic particle like the electron cannot be precisely known.**

> **Answer:** D
>
> Heisenberg's uncertainty principle says that for a very small particle such as an electron, we cannot know both its exact position and its exact momentum at the same time. The more precisely we measure one, the less precisely we can know the other.
>
> Option A states the opposite of the principle. Options B and C describe de Broglie's idea of wave-particle duality, which is a different concept.
>
> **Textbook:** Chemistry Grade 11, Unit 1 Atomic Structure and Periodic Properties of the Elements, section 1.6.1 The Heisenberg's Principle (page 35).

8. Which of the following statement is correct about energy changes when an electron changes its energy level? (1)

A. When an electron jumps from a lower energy level to a higher level, the photon emitted is equal to the difference between the two energy levels.

B. When an electron falls from a higher energy level to a lower energy level, the energy is equal to the difference between the two energy levels is observed.

C. ✓ **When an electron jumps from a lower energy to a higher energy level, the energy is equal to the difference between the two energy levels is absorbed.**

D. When an electron falls from a higher energy level to a lower energy level, the energy is higher than the difference between the two energy levels is emitted.

> **Answer:** C
>
> An electron can only move between fixed energy levels. To climb from a lower level to a higher one, it must absorb energy exactly equal to the gap between the two levels. When it falls back from a higher level to a lower one, it emits that same amount of energy as a photon:
>
> $$\Delta E = E_{\text{higher}} - E_{\text{lower}} = h\nu$$
>
> Option C states this correctly for absorption. Option A is wrong because a photon is emitted when the electron falls, not when it jumps up. Option D is wrong because the emitted energy equals the gap; it is never more than the gap.
>
> **Textbook:** Chemistry Grade 11, Unit 1 Atomic Structure and Periodic Properties of the Elements, section 1.5.4 The Bohr Model of the Hydrogen Atom (page 25).

9. The sanitizer in wide use for protection against Covid-19 is labeled 83% alcohol. How can one scientifically check the concentration? This can be done by (1)

A. forming a hypothesis.

B. collection of data.

C. ✓ **experimentation.**

D. making observation.

> **Answer:** C
>
> The label makes a claim: the sanitizer is 83% alcohol. In the language of the scientific method, that claim is a hypothesis. A hypothesis is checked by conducting an experiment. Here that means actually measuring the alcohol content, for example by measuring the density of the liquid and comparing it with known values.
>
> Making an observation and forming a hypothesis come before checking; they cannot confirm anything. Data collection happens inside the experiment, but the step that scientifically tests the claim is the experiment itself.
>
> **Textbook:** Chemistry Grade 9, Unit 2 Measurements and Scientific Methods, section 2.2 Chemistry as Experimental Science (page 39).

10. The correct electronic configuration for chromium (Cr, Z=24) is (1)

A. 1s^(2)2s^(2)2p^(6)3s^(2)3p^(6)3d^(4)4d^(2)

B. ✓ **1s^(2)2s^(2)2p^(6)s^(2)3p^(6)4s^(1)3d^(5)**

C. 1s^(2)2s^(2)3s^(2)3p^(6)4s^(1)d^(6)

D. 1s^(2)2s^(2) 2p^(6)3s^(2)3p^(6)4s^(2)3d^(4)

> **Answer:** B
>
> Chromium has 24 electrons. Filling the orbitals in the normal order would give ...$3p^6\ 4s^2\ 3d^4$. But a half-filled d subshell (d^5) is extra stable, so one electron moves from 4s into 3d. The real configuration is:
>
> $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$
>
> This matches option B (the option's print drops the 3 in front of $3s^2$, but it is the intended answer). Option D shows the naive filling $4s^2\ 3d^4$, which ignores the special stability of the half-filled d subshell. Chromium and copper are the two common exceptions you should memorize.
>
> **Textbook:** Chemistry Grade 11, Unit 1 Atomic Structure and Periodic Properties of the Elements, section 1.7 Electronic Configurations and Orbital Diagrams (page 41).

11. According to Hund's rule equal energy (degenerate) orbitals are filled with (1)

A. two electrons of opposite spins placed in the first orbitals.

B. ✓ **maximum number of unpaired electrons with parallel spins.**

C. two electrons of parallel spins placed in the first orbital.

D. maximum number of unpaired electrons with opposite spins.

> **Answer:** B
>
> Hund's rule applies to orbitals of equal energy, such as the three 2p orbitals. Electrons enter these orbitals one at a time, each in its own orbital and all spinning the same way, before any orbital receives a second electron. This gives the maximum number of unpaired electrons with parallel spins.
>
> Electrons repel each other, so spreading out into separate orbitals keeps the atom at lower energy. Options A and C describe pairing up first, which is the opposite of the rule, and option D has the spins wrong: the unpaired electrons keep parallel spins, not opposite ones.
>
> **Textbook:** Chemistry Grade 11, Unit 1 Atomic Structure and Periodic Properties of the Elements, section 1.7 Electronic Configurations and Orbital Diagrams (page 41).

12. In the modern periodic table (1)

A. ✓ **non-metals are placed on the right hand side of the periodic table.**

B. elements with similar properties are placed in the same period.

C. metals are placed on the right hand side of the periodic table.

D. transition and inner transition elements are placed in the middle of the periodic table.

> **Answer:** A
>
> In the modern periodic table, metals sit on the left and in the centre, while non-metals occupy the right hand side (with a staircase of metalloids between them). So option A is correct.
>
> Option B confuses periods with groups: elements with similar properties fall in the same group (vertical column), not the same period. Option C swaps the sides. Option D is only half right: transition elements are in the middle, but the inner transition elements (lanthanides and actinides) are placed in two separate rows at the bottom of the table.
>
> **Textbook:** Chemistry Grade 9, Unit 4 Periodic Classification of Elements, section 4.3 The Modern Periodic Table (page 120).

13. Covalent compounds are liquids or gases at room temperature and have low melting and boiling points. Which of the following state. ments explains these properties of covalent compounds? (1)

A. The intermolecular forces of attraction in covalent compounds are strong.

B. The unit of particles in covalent compounds are ions.

C. There are no forces of attraction between the molecules in covalent compounds.

D. ✓ **Covalent compounds exist as separate molecules.**

> **Answer:** D
>
> Covalent compounds exist as separate, individual molecules. The atoms inside each molecule are held by strong covalent bonds, but the forces between one molecule and the next are weak. Melting or boiling only has to overcome these weak intermolecular forces, so little heat is needed and the melting and boiling points are low.
>
> Option A says the intermolecular forces are strong, which would give high melting points, the opposite of what we observe. Option C goes too far: weak forces do exist between the molecules; if there were truly none, covalent substances could never condense into liquids at all. Option B describes ionic compounds.
>
> **Textbook:** Chemistry Grade 11, Unit 2 Chemical Bonding, section 2.3 Covalent Bonds and Molecular Geometry (page 83).

14. Both carbonyl sulphide, COS(SCO), S = C = O and carbon dioxide (CO_2)O = C = O are linear molecules. COS is polar whereas CO_2 is non-polar. this is because (1)

A. ✓ **CO_2 has a net dipole moment of zero.**

B. the C = O bonds in both COS and CO_2 are polar.

C. regions of high negative charge is distributed equally around the central atom is COS.

D. Sulphur is more electronegative than oxygen.

> **Answer:** A
>
> Both molecules are linear, so polarity depends on whether the bond dipoles cancel. In O=C=O the two bond dipoles are identical in size and point in exactly opposite directions, so they cancel and the net dipole moment of CO2 is zero. That is why CO2 is non-polar.
>
> In S=C=O the two ends are different: oxygen pulls electrons more strongly than sulphur, so the C=O and C=S dipoles are unequal and do not cancel. The molecule keeps a net dipole and is polar.
>
> Option B is true but does not explain the difference, since it applies to both molecules. Option D is false: sulphur is less electronegative than oxygen, not more.
>
> **Textbook:** Chemistry Grade 11, Unit 2 Chemical Bonding, section 2.3.1 Molecular Geometry (page 100).

15. Which of the following statements is true about the formation of CH_4 according to valence bond theory? (1)

A. The 2 s and two 2p orbitals in carbon hybridize to form three sp^(2)

B. ✓ **The 2s and three 2p orbitals in carbon hybridize to form four sp^3**

C. The 2s and one 2p orbitals in carbon hybridize to form two SP orbitals.

D. Carbon can form two hybrid orbitals as it has got only two halffilled orbitals.

> **Answer:** B
>
> Carbon's ground state ($1s^2$ $2s^2$ $2p^2$) has only two unpaired electrons, yet CH4 has four identical C to H bonds. Valence bond theory explains this in two steps. First, one 2s electron is promoted to the empty 2p orbital, giving four unpaired electrons. Then the one 2s and the three 2p orbitals mix to form four equal sp^3 hybrid orbitals.
>
> Each sp^3 orbital overlaps with the 1s orbital of a hydrogen atom, producing four identical bonds arranged tetrahedrally at 109.5 degrees.
>
> Option A (sp^2) would give only three bonds, as in ethene, and option C (sp) gives two, as in ethyne. Option D ignores the promotion step.
>
> **Textbook:** Chemistry Grade 11, Unit 2 Chemical Bonding, section 2.5.1 Valence Bond (VB) Theory (page 115).

16. Phosphorus (Z = 15) has the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^3$, what kind of hybridization does phosphorus undergo in the formation of phosphorus pentachloride (PCl_5) (1)

A. sp^3

B. ✓ **sp^3 d**

C. sp^2

D. sp

> **Answer:** B
>
> In PCl5 the central phosphorus atom forms five bonds, so it needs five equivalent orbitals. To get them, one 3s electron is promoted into an empty 3d orbital, and then one 3s, three 3p and one 3d orbital mix to form five sp^3d hybrid orbitals.
>
> Each of the five hybrid orbitals overlaps with a chlorine orbital, giving the trigonal bipyramidal shape of PCl5.
>
> A quick rule: count the electron pairs around the central atom. Five pairs means sp^3d. Option A (sp^3) would give only four orbitals, enough for PCl3 but not PCl5.
>
> **Textbook:** Chemistry Grade 11, Unit 2 Chemical Bonding, section 2.5.1 Valence Bond (VB) Theory (page 115).

17. One of the following reactions illustrates the formation of coordinate covalent bond? (1)

A. NaOH + HCl → NaCl + H_(2)O

B. Be + 2F2 → BeF_2

C. ✓ **NH_3 + HCl -+NH_4 + Cl^(-)**

D. CaCO_3 + HCl + CaCl_(2) + H_(2)O + CO_2

Answer: C

In a normal covalent bond, each atom contributes one electron to the shared pair. In a coordinate (dative) covalent bond, both shared electrons come from the same atom.

When NH3 reacts with HCl, the nitrogen atom uses its lone pair to bond with the H^+ from HCl, forming $NH4^+$. Both electrons of that new N to H bond are supplied by nitrogen alone, so it is a coordinate covalent bond.

Option B (Be + F2) is ordinary bond formation from the elements, and options A and D are acid-base and carbonate reactions in which no atom donates a complete lone pair to an empty orbital.

Textbook: Chemistry Grade 11, Unit 2 Chemical Bonding, section 2.3 Covalent Bonds and Molecular Geometry (page 90).

18. Hydrogen bonding occurs in compounds that contain H — N, H — O and H-F bonds. These bonds are stronger than the ordinary dipole-dipole interaction because (1)

A. ✓ **the partially positive H of one molecule is attracted to the partially negative lone pairs on the N, O or F another molecule.**

B. the H — N, and H — F bonds are less polar than ordinary covalent bonds.

C. the small sizes of N, O and F makes these atoms so electropositive that their covalently bonded H is highly negative.

D. the H — N, H — O and H — F bonds are non-polar and thus do not interact with neighboring molecules.

Answer: A

Nitrogen, oxygen and fluorine are small and strongly electronegative. When hydrogen bonds to one of them, the bonding electrons are pulled away from hydrogen, leaving it with a large partial positive charge on a very small atom.

This exposed, partially positive hydrogen is then strongly attracted to a lone pair on the N, O or F atom of a neighbouring molecule. Because the charges involved are larger and the atoms can approach very closely, this attraction (a hydrogen bond) is stronger than an ordinary dipole-dipole force.

Option C reverses the words: N, O and F are electronegative, and the hydrogen becomes positive, not negative. Options B and D wrongly call these very polar bonds less polar or non-polar.

Textbook: Chemistry Grade 11, Unit 2 Chemical Bonding, section 2.3.2 Intermolecular Forces in Covalent Compounds (page 107).

19. Which of the following is an example of exception to the octet rule? (1)

A. NH_3

B. CCl_4

C. H_(2)O

D. ✓ **PCl_(5)**

Answer: D

The octet rule says atoms tend to end up with eight electrons in their outer shell. In PCl5 the phosphorus atom forms five bonds, which places ten electrons around it. This is an expanded octet, possible because phosphorus (period 3) has empty 3d orbitals it can use. So PCl5 breaks the octet rule.

Check the others: in NH3 nitrogen has three bonds plus a lone pair (8 electrons), in CCl4 carbon has four bonds (8 electrons), and in H2O oxygen has two bonds plus two lone pairs (8 electrons). All three obey the rule.

Textbook: Chemistry Grade 11, Unit 2 Chemical Bonding, section 2.3 Covalent Bonds and Molecular Geometry (page 83).

20. When the boiling point of hydrides of group VIA elements, H_2O, H_2S , H_2Se and H_2Te are arranged in the order of increasing boiling point. The trend is $H_2Te < H_2Se < H_2S < H_2O$, water having the highest boiling point, this is due to (1)

A. the small size of O compared to the other group VIA elements.

B. the basic different structures of each hydride.

C. increasing boiling points with increasing molecular mass.

D. ✓ **hydrogen bonding present in H_(2)O molecules.**

> **Answer:** D
>
> Going down the group from H2S to H2Se to H2Te, boiling points rise steadily because bigger molecules have stronger dispersion forces. By that trend alone, water should boil lowest of all. Instead it boils highest.
>
> The reason is hydrogen bonding. Oxygen is small and highly electronegative, so each O to H bond leaves the hydrogen strongly positive, and water molecules link to each other through strong hydrogen bonds. Breaking this network takes far more energy than separating H2S, H2Se or H2Te molecules, which cannot hydrogen bond effectively.
>
> Option C describes the normal trend but cannot explain why the lightest hydride boils highest; only hydrogen bonding does.
>
> **Textbook:** Chemistry Grade 11, Unit 2 Chemical Bonding, section 2.3.2 Intermolecular Forces in Covalent Compounds (page 107).

21. Given the following catalyzed reactions (1)

I. $2CO_2$(s) → $2SO_3$ (g); V_2O_5(s) as a catalyst

II. OCl^-(aq) + I^-(aq) → OI^-(aq) + Cl^-(aq); OH^-(aq) as inhibitor

III. CO(s) + H_2(g) → CH_4(g) + H_2O(g);

IV. CO(s) + H_2(g) → HCHO(g); Cu(s) as a catalyst

Which reactions is examples for homogeneous catalysis?

A. I and II

B. ✓ **II**

C. II and III

D. IV

> **Answer:** B
>
> Catalysis is homogeneous when the catalyst (or inhibitor) is in the same physical state as the reacting substances, and heterogeneous when the states differ.
>
> - Reaction I: solid V2O5 acting on gases. Different states, so heterogeneous.
> - Reaction II: OCl^-, I^- and the OH^- inhibitor are all in aqueous solution. Same state throughout, so this is the homogeneous example.
> - Reaction III: no catalyst is given at all.
> - Reaction IV: solid Cu acting on gases. Heterogeneous.
>
> Only reaction II qualifies, so the answer is B. An inhibitor is simply a negative catalyst, so the same phase test applies to it.
>
> **Textbook:** Chemistry Grade 11, Unit 4 Chemical Kinetics, section 4.3 Factors Affecting the Rate of a Chemical Reaction (page 207).

22. Which statement is true about catalyst? (1)

A. A catalyst slows down or speeds up a reaction, itself being consumed.

B. A positive catalyst decreases the rate of a reaction by increasing the activation energy.

C. A negative catalyst increases the rate of a reaction by decreasing the value of activation energy.

D. ✓ The role of a catalyst is to increase or decrease the rate of a reaction by lowering or increasing the activation energy.

> **Answer:** D
>
> A catalyst changes the rate of a reaction by changing the activation energy, and it is recovered unchanged at the end. A positive catalyst speeds the reaction up by offering a path with lower activation energy. A negative catalyst (inhibitor) slows the reaction down by raising the activation energy. Option D captures both directions correctly.
>
> Option A fails because a catalyst is not consumed. Options B and C each swap the definitions: a positive catalyst never decreases the rate, and a negative catalyst never increases it.
>
> **Textbook:** Chemistry Grade 11, Unit 4 Chemical Kinetics, section 4.3 Factors Affecting the Rate of a Chemical Reaction (page 207).

23. According to the transition state theory (1)

A. the collision between two reacting species results in the formation of an activated complex, which has less energy than both reactants and products.

B. ✓ in the activated complex, the original bonds are weakened and the new bonds are partially formed.

C. the activation energy is the energy that must be absorbed or released by reactants to reach the activated complex.

D. the standard reaction enthalpy (ΔH^(0)) depends on the magnitude of the activation energy (E_(a)).

> **Answer:** B
>
> Transition state theory says that when reactant molecules collide with enough energy, they first form a short-lived arrangement called the activated complex. In this complex the old bonds are stretched and weakened while the new bonds have started to form but are not yet complete. That is exactly what option B states.
>
> Option A is wrong because the activated complex sits at the top of the energy hill: its energy is higher than both reactants and products, not lower. Option C is wrong because activation energy must be absorbed to climb to the complex; it is never released on the way up. Option D is wrong because the reaction enthalpy depends only on the energy difference between reactants and products, not on the height of the activation barrier.

24. Which of the following is true about the rate constant? (1)

A. It expresses the relationship between the rate of a chemical reaction and the volume of reacting species.

B. ✓ The volume of a rate constant tells us how fast or slow a reaction is.

C. The value of a rate constant is independent of reaction conditions.

D. A small rate constant indicates a faster reaction and a larger rate constant indicates a slower reaction.

> **Answer:** B
>
> In the rate law, rate = $k[A]^m[B]^n$, the rate constant k links the rate to the concentrations of the reactants. Its value is a direct measure of how fast the reaction goes: for the same concentrations, a large k means a fast reaction and a small k means a slow one. Option B states this (the word printed as "volume" should read "value").
>
> Option C is false because k is not independent of conditions: raising the temperature increases k, and a catalyst changes it too. That is exactly why heated reactions run faster.
>
> Option D reverses the meaning of k, and option A connects the rate to volume instead of concentration.

25. The mathematical expression K = (-Ea / (2.3303R)) 1/T + log A derived from the Arrhenius equation is of important as it Shows (1)

A. reactions with lar rer activation energies have higher values of k and are therefore faster.

B. ✓ for a given value of activation energy of the rate constant increases as the tem erature increases.

C. reactions with lar yer activation energies, the value of the rate constant decreases as the temperature increases.

D. for a given value of activation energy, the value of the rate constant decreases as the timperature increases.

Answer: B

The logarithmic form of the Arrhenius equation is:

$$\log k = \log A - \frac{E_a}{2.303\,R} \cdot \frac{1}{T}$$

Keep the activation energy fixed and watch the temperature term. As T increases, 1/T gets smaller, so the amount subtracted from log A gets smaller, and log k (and therefore k) gets larger. In plain words: for a given activation energy, heating the reaction makes the rate constant bigger and the reaction faster. That is option B.

Option A has it backwards: a larger activation energy makes the subtracted term bigger, so k is smaller and the reaction is slower. Options C and D both claim k falls as temperature rises, which contradicts the equation.

26. From the magnitude of the contribution constant, K_{eq} one can deduce that (1)

A. small K_eq values indicate the reaction yields very high amounts of products near equilibrium.

B. ✓ large K_eq value in licates that the reaction reaches equilibrium with little reactants rer laining.

C. intermediate K_eq value indicates that the reaction does proceed in the forward direction.

D. K_eq will be larger when we have higher amounts or reactants over products.

Answer: B

The size of the equilibrium constant tells you how far a reaction goes before it settles at equilibrium. Since K_{eq} is the ratio of product concentrations to reactant concentrations, a large K_{eq} means the products dominate: the reaction has gone nearly to completion and little reactant remains. That is option B (the stem's "contribution constant" is a misprint of equilibrium constant).

Option A is the reverse: a small K_{eq} means mostly reactants and very little product. Option D is also backwards, because more product (not more reactant) makes the ratio larger.

Textbook: Chemistry Grade 11, Unit 5 Chemical Equilibrium.

27. The statement "If a system at equilibrium is subjected to a stress, the system will readjust itself to reduce the effects of the stress is known as (1)

A. Faradays law

B. Boyle's law

C. Avogadro's principle

D. ✓ Le-Chaterlier's principle

Answer: D

This is the definition of Le Chatelier's principle: when an equilibrium system is disturbed by a change in concentration, pressure or temperature, the system shifts in the direction that reduces the effect of that disturbance.

The other names do not fit: Faraday's laws concern electrolysis, Boyle's law relates gas pressure and volume, and Avogadro's principle relates gas volume to the number of molecules.

Textbook: Chemistry Grade 11, Unit 5 Chemical Equilibrium, section 5.2.6 Changing Equilibrium Conditions: Le-Chatelier's Principle (page 245).

28. The law of mass action states that (1)

A. ✓ the rate of a reaction is directly proportional to the product of the concentration of reactants raised to the power of their respective coefficients in the balanced equation.

B. the K_eq expression is the ratio of the concentrations reactants to the products raised to their coefficients.

C. a chemical equilibrium is attained only when the reaction is started with reactants.

D. for a reaction at equilibrium, the reaction quotient, Q is always less than the equilibrium constant, (K_eq)^(-)

Answer: A

The law of mass action, proposed by Guldberg and Waage, states that the rate of a reaction is directly proportional to the product of the concentrations of the reactants, each raised to the power of its coefficient in the balanced equation. For aA + bB, this means rate is proportional to $[A]^a[B]^b$. Applying this law to both the forward and reverse reactions at equilibrium is what gives the equilibrium constant expression.

Option B is upside down: K_{eq} is products over reactants, not reactants over products. Option C is false because equilibrium can be reached starting from either side, and option D is false because at equilibrium Q equals K_{eq}.

Textbook: Chemistry Grade 11, Unit 5 Chemical Equilibrium, section 5.2.4 Equilibrium Expression and Equilibrium Constant (page 229).

29. For the reaction between gaseous NO and O_2 to form NO_2(g), what will be the equilibrium constant expression. (1)

$2NO(g) + O_2(g \rightleftharpoons 2NO_2(g)$

A. ✓ Kc = [NO_(2)]^2 / [NO]^(2) [O_(2)]

B. Kp = [P NO_(2)]^(2) / [NO]^(2) [O_(2)]

C. Kp = [P NO_(2)] / (P NO)^(2) (P O_(2))

D. Kp = [P NO]^(2) (P O_(2)) / (P NO_(2))

Answer: A

The equilibrium constant expression puts the products on top and the reactants on the bottom, each raised to its coefficient in the balanced equation. For 2NO(g) + O2(g) ⇌ 2NO2(g):

$$K_c = \frac{[NO_2]^2}{[NO]^2[O_2]}$$

NO2 is squared because its coefficient is 2, NO is squared for the same reason, and O2 appears to the first power. Option A matches this exactly.

The other options mix up the K_p form: option C forgets the square on NO2, and option D turns the whole expression upside down.

Textbook: Chemistry Grade 11, Unit 5 Chemical Equilibrium, section 5.2.4 Equilibrium Expression and Equilibrium Constant (page 228).

30. In the production of NH3 by the Haber process according to the equation$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ ΔH = -92KJmol^{-1} What are the favorable conditions for the production of high yield of NH_3? (1)

A. Low pressure and low temperature

B. ✓ High pressure and low temperature

C. High pressure and high temperature

D. Low pressure and high temperature

Answer: B

Use Le Chatelier's principle on N2(g) + 3H2(g) ⇌ 2NH3(g), with delta H = -92 kJ/mol.

Pressure: the left side has 4 moles of gas and the right side has 2. Raising the pressure pushes the equilibrium toward the side with fewer gas molecules, which is the ammonia side. So high pressure raises the yield.

Temperature: the forward reaction is exothermic (it releases heat). Lowering the temperature removes heat, so the equilibrium shifts forward to replace it, again making more NH3.

So the best yield comes from high pressure and low temperature. In practice a moderate temperature and an iron catalyst are used, because a very cold mixture reacts too slowly, but the question asks only about yield.

Textbook: Chemistry Grade 11, Unit 5 Chemical Equilibrium, section 5.2.7 Equilibrium and Industry (page 253).

— END OF MARKING KEY —

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