1. The name 2-ethyl-3-chlorohexane does not follow IUPAC conventions. What is the systematic name of this organic compound?

A. 3-chloro-2-ethylhexane B. 4-chloro-3-methylheptane

C. 4-chloro-5-ethylhexane D. 5-methyl-4-chloroheptane

E. 2-methyl-3-chlorohexane

2. Which alkene exists as *cis*-*trans* isomers?

A.  B. 

C.  D. 

E. 

3. When reacted with dilute H2SO4, which alkene gives a tertiary alcohol as the major product and a primary alcohol as the minor product?

A.  B. 

C.  D. 

E. 

4. Choose the molecule which has a total of 10 valence electrons on its atoms.

1. Cl2 B. PH3 C. OF2 D. HCl E. HCN

5. Which type of compound may react by substitution, elimination or oxidation?

A. alkanes B. alcohols C. alkenes D. haloalkanes E . carboxylic acids

6. Which compound can be distinguished from the others using water and red litmus paper?

A. CH3CH = CHCH3 B. CH3CH2CH2OH C. CH3CH2CO2H

D. CH3CH2CH2Cl E. CH3CH2NH2

7. Which haloalkane gives a single alkene product when heated with KOH(alc)?

A.  B.  C. 

D.  E. 

1. Which of the following would be the best solvent for dissolving icosane (C20H42)?
2. water B. methanol C. ethanol D. hexane E. molten sodium chloride
3. PO43- reacts with water to accept a proton. Which product of this reaction would be described as the conjugate acid?

A. OH- B. HPO42- C. H3O+ D. H2PO4- E. H3PO4

10. When concentrated sulfuric acid reacts with sodium iodide, the products include sulfur, iodine, hydrogen sulfide and sulfur dioxide. Which statement is correct?

1. Hydrogen sulfide is the product of reduction of sulfuric acid.
2. Iodide ion is a stronger oxidising agent than the sulfate ion.
3. Sulfur atoms from sulfuric acid are both oxidised and reduced.
4. Sulfur atoms from sulfuric acid are oxidised to make sulfur dioxide.
5. Iodine is the product of a reduction reaction.
6. Redox reactions are common in Group 17 chemistry. Which statement is correct?
7. Br– ions will reduce Cl2 but not I2.
8. Cl2 will oxidise Br– ions but not I– ions.
9. F2 is the weakest oxidising agent out of F2, Cl2, Br2, I2.
10. I– ion is the weakest reducing agent out of F–, Cl–, Br– and I– ions.
11. Br2 will oxidise I– ions and Cl– ions.
12. Solutions containing hypochlorite ions, ClO-, are used as household bleaches and disinfectants. These solutions decompose on heating as shown:

3ClO– ClO3– + 2Cl–

Which line in the table shows the oxidation state of chlorine in each of these three ions?

|  |  |  |  |
| --- | --- | --- | --- |
|  | ClO– | ClO3-– | Cl– |
| A  B  C  D  E | +1  -1  +1  +1  -1 | +3  +3  +5  +5  +5 | -1  +1  -1  +1  -1 |

1. Which element (if any) is reduced in the reaction for which the equation is shown?

3 Cu(*s*) + 8 HNO3(*aq*) 2 NO(*g*) + 3 Cu(NO3)2(*aq*) + 4 H2O(*l*)

1. Cu B. H C. N D. O E. None

14. When K2MnO4 is dissolved in water, the reaction occurs according to the equation given below:

***a*** MnO42- + ***b*** H2O ***c*** MnO4– + ***d*** MnO2 + ***e*** OH–

What are the values of ***a*** and ***c*** in the balanced equation?

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E |
| ***a***  ***c*** | 2  1 | 3  2 | 4  3 | 5  4 | 6  5 |

15. A cotton ball burns more brightly in a jar of 80% O2 than in the air, which is 20% O2. Which is the best explanation for this observation?

A. The cotton collides mores frequently with the O2 inside the jar.

B. The excited state of O2 is formed more efficiently inside the jar

C. The temperature is higher inside the jar.

D. The jar acts as a catalyst for the reaction.

E. The activation energy for the reaction is higher in the jar with 80% O2.

16. The following equation shows the formation of magnesium oxide from magnesium metal.

2Mg(s) + O2 (g) → 2MgO(s) ∆r*HO*  = −1204 kJ mol-1

Which statement is correct for this reaction?

* 1. 602 kJ of energy are absorbed for every mol of magnesium oxide formed.
  2. 602 kJ of energy are absorbed for every mol of oxygen gas reacted
  3. 602 kJ of energy are released for every mol of oxygen gas reacted.
  4. 1204 kJ of energy are released for every two mol of magnesium oxide formed.
  5. 1204 kJ of energy are released for every mol of magnesium reacted.

17. Which of the following is NOT good practice when doing an acid-base titration?

1. Rinsing the burette with the base to be delivered from the burette.
2. Removing the funnel (if used) from the burette before taking the initial reading.
3. Rinsing the conical flask with the acid to be titrated.
4. Using as little indicator as possible.
5. Avoiding removing the flask from under the burette while doing the titration.

18. Which describes the arrangement of atoms in the sulfite ion (SO32-) and the O-S-O bond angle?

1. trigonal pyramid, 109o  B. tetrahedral, 109o C. bent, 120o

D. trigonal planar, 120o E. trigonal planar, 109o

1. Which describes the energy change when 5 g of KOH and 60 g of NaCl are mixed and then dissolved in 10 L of water. *M*(KOH) = 56.1 g mol-1 *M*(NaCl) = 58.4 g mol-1

KOH(*s*) K+(*aq*) + OH–(*aq*) Δ*H* = -57.6 kJ mol-1

NaCl(*s*) Na+(*aq*) + Cl-(*aq*) Δ*H* = 3.9 kJ mol-1

1. 9.14 kJ released B. 9.10 kJ absorbed C. 1.13 kJ released
2. 0.76 kJ released E. 0.76 kJ absorbed

20. Use the given bond dissociation enthalpies, *E*, to calculate Δ*Ho* for the reaction of methane and ethyne to form propene?

CH4(*g*) + HC≡CH(*g*) CH3CH=CH2(*g*)

|  |  |  |  |
| --- | --- | --- | --- |
| **Bond** | ***E/*kJ mol-1** | **Bond** | ***E/*kJ mol-1** |
| C-H | 415 | C=C | 611 |
| C-C | 345 | C≡C | 837 |

1. -119 kJ mol-1 B. +119 kJ mol-1 C. -196 kJ mol-1

D. +196 kJ mol-1  E. -296 kJ mol-1

1. Which compound contains both covalent and ionic bonds?
2. sodium carbonate, Na2CO3 B. magnesium bromide, MgBr2

C. dichloromethane, CH2Cl2 D. ethanoic acid, CH3COOH

E. boron trihydride, BH3

22. N2 + 3H2 ⇌ 2NH3 *K*c = 4 x 10-3 at 300 oC

Consider a system where [N2] = 0.10 mol L-1, [H2] = 1.0 mol L-1 and [NH3] = 0.02 mol L-1.

Which of the following is true? (*Qc =* Ionic product)

1. *Qc > Kc* so the forward direction is favoured.
2. *Qc > Kc* so the reverse direction is favoured.
3. *Qc < Kc* so the forward direction is favoured.
4. *Qc = Kc* so neither direction is favoured.
5. *Qc < Kc* so the reverse direction is favoured.

23. Which molecule has the greatest polarity?

1. fluorine B. chlorine C. hydrogen fluoride

D. hydrogen chloride E. tetrafluoromethane

1. Which solution would you expect to react the fastest with magnesium metal?
2. a mixture of 20 mL 0.1 mol L-1 NaOH and 20 mL 0.1 mol L-1 HCl
3. a mixture of 20 mL 0.05 mol L-1 NaOH and 30 mL 0.05 mol L-1 HCl
4. a mixture of 20 mL 0.05 mol L-1 NaOH and 15 mL 0.1 mol L-1 HCl
5. a solution of 0.005 mol L-1 HCl
6. pure water
7. The reaction between excess calcium carbonate and hydrochloric acid can be followed by measuring the volume of carbon dioxide produced with time. The results of one such reaction are shown below. How does the rate of this reaction change with time and what is the reason for this change?

A black line with a curved curve

Description automatically generated with medium confidence

1. The rate increases with time because the calcium carbonate particles get smaller.
2. The rate increases with time because the acid becomes more dilute.
3. The rate increases with time as heat is released.
4. The rate decreases with time because the calcium carbonate particles get smaller.
5. The rate decreases with time because the acid becomes more dilute.
6. 30 mL of 0.1 mol L-1 HCl is mixed with 30 mL of 0.05 mol L-1 NaOH. What is the pH of the mixture?

A 1.0 B 1.6 C 3.2 D 7.0 E 12.4

1. Rank the following in order of conductivity:
2. 1 mol L-1 ethanoic acid in water
3. 1 mol L-1 NaCl in water
4. 1 mol L-1 ethanol in water
5. 2 > 1 = 3 B. 1 > 2 = 3 C. 2 > 1 > 3 D. 3 > 2 > 1 E. 1 = 2 > 3
6. A mixture of ethanoic acid and water is at equilibrium. The equilibrium constant *K*a for this system is 4.76 × 10-5.

CH3CO2H + H2O CH3CO2- + H3O+

What is decreased if solid CH3CO2Na is added to the mixture?

A. [OH-] B. [H3O+] C. [CH3CO2-] D. CH3CO2H E. *K*a

1. 2H2O(*l*)  H3O+(*aq*) + OH*−*(*aq*)

The equilibrium constant for the reaction above is 1.0 x 10-14 at 25 oC and 2.1 x 10-14 at 35 oC.

What can be concluded from this information?

1. [H3O+] decreases as the temperature is raised.
2. [H3O+] is greater than [OH*−*]
3. Water is a stronger electrolyte at 25 oC
4. The reaction is endothermic.
5. The reaction is exothermic.
6. In which set do all three species have the same number of electrons?
7. H+, Li+, Na+ B. C, N-, O2- C. N3*−, S2−,* Br*−*D. I, Xe, Cs E. Se2-, Br-, Rb+
8. 40 mg of a metal, M, requires 20 mL of 0.10 mol L-1 HCl for complete reaction.

Which element could be metal M?

1. Na B. Mg C. Al D. K E. Ca

32. Which reaction is not an acid-base reaction?

A. HCl + NH3 🡪 NH4+ + Cl-

B. HSO3– + CO32- ⇌ SO32- +HCO3-

C. 2H2O ⇌ H3O+ + OH-

D. 2CH3COOH + Mg 🡪 (CH3COO)2Mg + H2

E. CH3NH2 + HBr 🡪 CH3NH3Br

33. A group of students did a series of experiments to show how more reactive metals release less reactive metals from solutions of their salts. Their results are shown in the table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Solutions** | **Metal** | | | |
| **Ni** | **Ca** | **Cr** | **Ag** |
| AgNO3 | silver formed | silver formed | silver formed |  |
| CaCl2 | no reaction |  | no reaction | no reaction |
| NiCl2 |  | no data | nickel formed | no reaction |
| CrCl3 | no reaction | chromium formed |  | no data |

Putting the most reactive metal first, which is likely to be the correct order of reactivity?

A. Ca, Cr, Ni, Ag B. Ag, Ni, Cr, Ca C. Ca, Ni, Cr, Ag

D. Cr, Ca, Ni, Ag E. Ni, Ca, Ag, Cr

34. A solution of sulfuric acid, H2SO4, used in a car battery has a concentration of 4.0 mol L-1. What is the pH of the solution if it is assumed that the acid is fully dissociated to 2H+ and SO42- ?

A. – 0.9 B. – 0.6 C. 0.0 D. + 0.4 E. + 0.6

35. CaCO3(*s*) CaO(*s*) + CO2(*g*)

When heated, CaCO3(*s*) (*M=*100 g mol-1) decomposes as shown above. Heating a 20 g sample of impure CaCO3 gives 0.15 moles of CO2. What is the percentage purity of the CaCO3? Assume that none of the impurities produce CO2 on heating.

1. 15 B. 25 C. 50 D. 75 E. 90

36. 0.10 mol L-1 solutions of substances A, B and C have the pH shown below.

pH (A) = 5.6 pH (B) = 1.0 pH (C) = 9.3

Which of the following statements is correct?

1. [OH-] is highest in the solution of B
2. [H3O+] is highest in the solution of C
3. Substance B is a strong base.
4. The solution of C turns blue litmus red.
5. Substance A is a weak acid.

37. H2(*g*) + Cl2(*g*) 2HCl(*g*)

Hydrogen and chlorine react according to the equation above. What will be the result of the reaction of 2.0 moles of H2 and 1.5 moles of Cl2?

1. 1.5 mol of HCl and 0.5 mol of H2
2. 2.0 mol of HCl and 0.5 mol of Cl2
3. 3.0 mol of HCl and 0.5 mol of H2
4. 3.5 mol of HCl
5. 4.0 mol of HCl

38. The following shows a portion of an addition polymer, -CH2-CH2-CH2-CH2- .

The polymer has a relative molar mass of approximately 10,000 g mol-1.

Approximately how many monomer units are joined together in each polymer molecule?

1. 180 B. 360 C. 540 D. 620 E. 710

39. 1.000 g of a transition metal carbonate, MCO3, is heated to produce the metal oxide and 0.383 g of carbon dioxide (*M* = 44.01 g mol-1). What is the identity of the metal M?

A. Ti B. Mn C. Ni D. Cu E. Zn

40. The mass spectrum of a sample of lithium metal shows that it contains two isotopes, 6Li and 7Li. The isotopic abundances are shown in the table:

|  |  |
| --- | --- |
| Isotope | Isotopic abundance |
| 6Li  7Li | 7.42 %  92.58 % |

What is the relative atomic mass of this sample of lithium?

1. 6.07 B. 6.50 C. 6.87 D. 6.90 E. 6.93