1.

Which statement(s) is (are) correct about a pure substance?

I. It is always an element
II. Its melting point is sharp
III. More than one pure substance is present in a heterogeneous mixture

A. I only

B. I and II only

C. II and III only

D. II only

2.

2.53 g of sodium sulfate is dissolved to form a 50.0 cm^3 aqueous solution. What is its concentration of sodium ions in $mol\ dm^{-3}$?

A. 0.356

B. 0.712

C. 0.425

D. 0.850

3.

Which statement(s) is (are) correct about real gases?

I. Gas particles are considered to have negligible volume
II. At low temperatures, intermolecular forces exist
III. At high pressure, real gases behave as ideal gases

A. I only

B. I and II only

C. II only

D. II and III only

4.

Given the chemical reaction below.

$$Cu\ (s) + 4HNO_3\ (aq) \rightarrow Cu(NO_3)_2\ (aq) + 2\ NO_2\ (g) + 2H_2O\ (l)$$

What is the volume of NO_2 (g) produced, in dm^3, when 100 g of an impure sample of copper (20.0 % of impurities present) is mixed with 2.00 dm^3 of a 3.00 $mol\ dm^{-3}$ nitric acid solution at 298 K and 100 kPa given a percentage yield of 95 %?

5.

Which combination is correct for $^{41}_{19}K^{+}$?

	Number of protons	Number of neutrons	Number of electrons
A.	19	22	18
B.	19	22	20
C.	22	41	20
D.	22	19	18

6.

Which energy transition in the hydrogen emission spectrum has the highest frequency?

A. $n = 3$ to $n = 1$

B. $n = 3$ to $n = 2$

C. $n = 4$ to $n = 3$

D. $n = 4$ to $n = 1$

7.

What is the correct order for increasing atomic radius?

A. $B < Be < Mg < Ca$

B. $B < Mg < Be < Ca$

C. $Ca < Mg < Be < B$

D. $Ca < Be < Mg < B$

8.

What is the name of $Al_2(SO_4)_3$?

A. Aluminium sulfate

B. Aluminium sulfide

C. Aluminium sulfite

D. Aluminium (III) sulfide

9.

Which molecule has the shortest carbon-to-carbon bond?

A. $CH_3CH_2CH_2CH_2CH_3$

B. $CH_2CHCH_2CH_2CH_3$

C. $CHCCH_2CH_2CH_3$

D. $CH_2CHCH_2CHCH_2$

10.

Which statements about silicon dioxide are correct?

I. It has a high melting point
II. Covalent bonds hold atoms together in a three-dimensional covalent network
III. Every silicon atom is bonded to two oxygen atoms in its structure

A. I and III only
B. I and II only
C. II and III only
D. I, II, and III

11.

BrF has a higher boiling point than BrCl.
Which row accurately represents the intermolecular differences between BrF and BrCl?

	Dipole-dipole attractions	London dispersion forces	Strongest intermolecular force
A.	Stronger in BrCl	Stronger in BrF	London
B.	Stronger in BrF	Stronger in BrCl	Dipole-dipole
C.	Stronger in BrCl	Stronger in BrF	Dipole-dipole
D.	Stronger in BrF	Stronger in BrCl	London

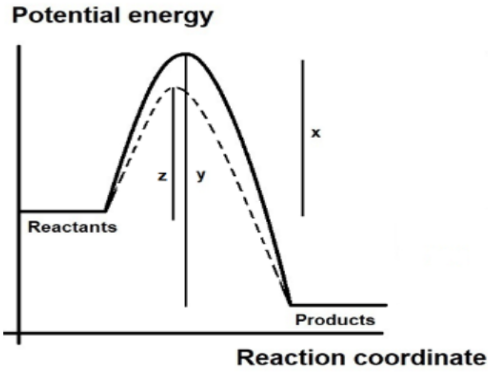
12.

Which combination is correct for Aluminium?

	Structure	Electrical conductivity in the solid state	Metallic character compared to that of sodium
A.	Lattice held by electrostatic attractions between cations and delocalized electrons	low	higher
B.	Lattice held by electrostatic attractions between cations and delocalized electrons	high	lower
C.	Lattice held by electrostatic attractions between oppositely charged ions	low	higher
D.	Lattice held by electrostatic attractions between oppositely charged ions	high	higher

13.

Which statement(s) is (are) correct about the energy profile given below?



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I. **z** is the enthalpy change for the catalyzed reaction
II. **x** corresponds to the activation energy of the catalyzed reaction
III. **y-x** is proportional to the energy released to the environment

14.

What is the enthalpy change in $kJ\ mol^{-1}$ for the chemical reaction below?

$$N_2\ (g) + 3H_2\ (g) \rightarrow 2\ NH_3(g)$$

Bond	**Bond Enthalpy** $(kJmol^{-1})$
$N \equiv N$	945
$H - H$	436
$N - H$	391

15.

Consider the chemical reaction given below.

$$P_4O_6\ (s) + 12\ HCl\ (aq) \rightarrow 4PH_3\ (g) + 6Cl_2O\ (g)$$

Which statements are correct for the rate of this chemical reaction?

I. The rate of consumption of P_4O_6 is greater than that of HCl
II. The production rate of Cl_2O is greater than the consumption rate of P_4O_6
III. The rate of this chemical reaction can be monitored by controlling the pH as time goes by

16.

Which statement about the role of nickel in the hydrogenation of ethene is correct?

A. It acts as an oxidizing agent

B. It increases the activation energy

C. It increases the time taken for the chemical reaction to occur

D. It provides an alternative pathway for the chemical reaction to occur

17.

Consider the chemical reaction below.

$$PCl_3 + Cl_2 \rightleftharpoons PCl_5$$

Which statement about the equilibrium is correct?

A. The removal of chlorine increases the K_c magnitude

B. The removal of chlorine decreases the K_c magnitude

C. The removal of chlorine shifts the chemical reaction to the product side

D. The removal of chlorine shifts the chemical reaction to the reactant side

18.

Which ion is the conjugate acid of H_2CO_3?

A. HCO_3^-

B. CO_3^{2-}

C. CO_3^-

D. $H_3CO_3^+$

19.

Which statement(s) is (are) correct about the titration reaction that occurs when calcium hydroxide is titrated with nitric acid?

I. Calcium nitride is formed
II. The reaction is exothermic
III. Carbon dioxide is formed as the pH decreases

A. I only

B. I and II only

C. I, II and III

D. II only

20.

Which statement is correct?

A. Acid rain is caused by dissolved CO_2

B. Rainwater with pH = 5.9 corresponds to acid rain

C. Acid deposition can be minimized with a post-combustion method known as hydrodesulfurization of crude oil fractions

D. Negative effects of acid rain in lakes can be counteracted by " liming" lakes

21.

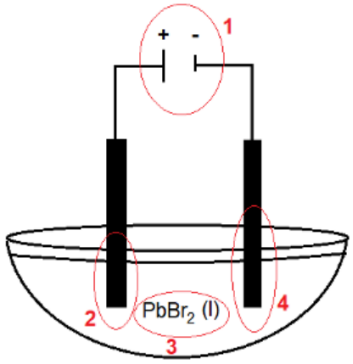
Which change(s) in carbon can be classified as an oxidation?

I. $C \rightarrow CO_2$
II. $C_2O_4^{2-} \rightarrow C_2O_2^{2-}$
III. $C_2H_4 \rightarrow C_2H_6$

A. I only
B. I and II only
C. I and III only
D. III only

22.

Which combination is correct for the electrolytic cell described below?



	1	2	3	4
A.	Battery	Reduction of cations	Salt bridge	Lead is formed
B.	Battery	Oxidation of anions	Electrolyte	Lead is formed
C.	Voltmeter	Reduction of cations	Electrolyte	Bromine is formed
D.	Voltmeter	Oxidation of anions	Salt bridge	Bromine is formed

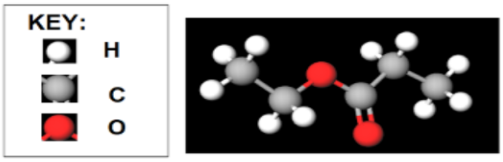
23.

Which combination is correct for the oxidation number of nitrogen in each of these species?

	N_2O	NO_2^-	$Mg(NO_3)_2$
A.	+1	+4	+3
B.	+1	+3	+5
C.	+2	+4	+5
D.	+2	+3	+3

24.

Given the molecule **X** below.



Which compound is an isomer of molecule **X**?

A. Pentanoic acid

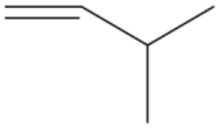
B. Ethyl ethanoate

C. Pentanal

D. $CH_3COCH(CH_3)CH_2CH_2OH$

25.

What is the IUPAC name of the structure below?



A. pent-1-ene

B. 2-methyl-but-1-ene

C. 3-methylbutene

D. 3-methyl- but-1-ene

26.

Which statement(s) is (are) correct about combustion reactions?

I. They require oxygen to occur
II. They are always exothermic
III. They always produce carbon dioxide

A. I only

B. I and II only

C. I, II and III

D. I and III only

27.

Which statement(s) is (are) correct about this chemical reaction?

$$Cl_2 \rightarrow 2\ Cl\cdot$$

I. It is a heterolytic fission
II. It can represent an initiation step
III. Radicals are consumed in this reaction

A. I only
B. I and II only
C. I and III only
D. II only

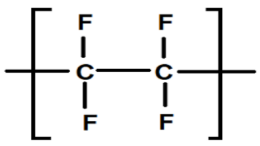
28.

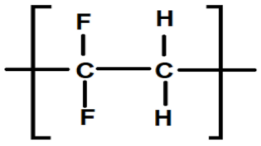
Which reactant yields 2-methylbutane after its hydrogenation?

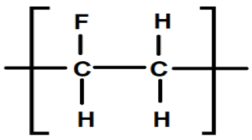
A. but-1-ene
B. but-2-ene
C. 2,3-dimethyl-but-2-ene
D. 2-methylbuta-1,3-diene

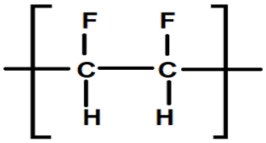
29.

Which is the repeating unit for the polymer formed with tetrafluoroethene as a starting material?

A.


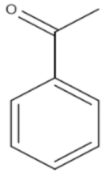
B.


C.


D.


30.

Which statement(s) about this molecule is(are) correct?



I. Its index of hydrogen deficiency is 5
II. Its ^1H NMR spectrum presents three signals
III. Its molecular ion peak corresponds to $m/z = 115$

A. I only
B. I and II only
C. I and III only
D. III only