Q1:

1) 3 outermost sheel electrons.

$\boxed{2)}$ 7 outermost shell electrons.

3) 2 outermost shell electrons.

4) 1 outermost shell electrons.

5) 6 outermost shell electrons.

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Q2:

As the trivalent cation (+3 ion) has 24 electrons, the atom has 27 electron.

For an atom, the number of electrons is equal to the number of protons. Therefore, the atom has 27 protons.

As the atom has 32 neutrons, the mass number is $32 + 27 = 59$.

Only the atom of $\boxed{(4)}$ has a mass number of 59. Hence, it is the answer.

**Alternative** The atomic number of the atom is 27, where the corresponding element symbol is $Co$. Therefore, the answer is $\boxed{(4)}$.

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Q3:

The numer of molecules is directly proportional to the number of moles. Now that the mass of gases are the same, the larger the molecular mass, the smaller the number of moles and hence the smaller number of molecules.

The molecular masses are:

1) 40

2) $2 \cdot 36 = 72$

$\boxed{3)}$ $12 + 16 = 28$

4) $3 \cdot 16 = 48$

5) $32 + 2 \cdot 16 = 64$

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Q4:

As $I_2$ is very volatile, it sublimes to gas easily and leave the impurities. Collect the sublimed gas can obtain a pure $I_2$.

$KNO_3$ is a solution, where the impurities are dissolved inside and cannot be separated by distillation. However, the impurities become solid in $KNO_3$ crystal and we can purify it by recrystallisation.

Given the above, the correct combination is $\boxed{(4)}$.

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Q5:

The mass fraction of $Na_2SO_4$ in the compound$=\frac{2\cdot 23+32+4\cdot 16}{18n+2\cdot 23+32+4\cdot 16} = \frac{71}{9n+71}$.

When heating the compound, the mass of the anhydrous compound obtained will be $\frac{71}{9n+71}$ times the mass of the compound. Therefore, we have

$0.322 \cdot \frac{71}{9n+71} = 0.142$, and $n = \boxed{10}$.

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Q6:

As the forward reaction is exothermic, by Le Chatelier's principle, the equilibrium position shifts to the left and more $NO_2$ will be produced when the temperature is increased, which will result in a darker colour $\boxed{(a)}$.

As the number of gas molecules at the reactant side is more than that at the product side, by Le Chaterlier's priciple, the equilibrium position shifts to the right when the pressure is increased. At first, the increase in pressure will decrease the concentration of chemicals, hence the colour is darken. However, after a sufficient duration, the increased $N_2O_4$ yield due to the shift will counter the effect and lighten the colour $\boxed{(c)}$.

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Q7:

1) Is linear but cotain $C \Xi C$ triple bond instead of double bond.

$\boxed{2)}$ Is linear and contain $C = O$ double bond.

3) Is bent and contain no double bonds.

4) Is planar and contain no double bonds.

5) Is tetrahedral although it contains $C = C$ double bond.

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Q8:

The formula mass of air$=2 \cdot 14 \cdot \frac{4}{1+4} + 2 \cdot 16 \cdot \frac{1}{1+4} = 28.8$.

By $pV = nRT$, we have $p = \frac{\rho}{m}RT$, or $\rho = \frac{mp}{RT}$. Therefore, under the same pres-

sure and temperature, the density of gas is directly proportional to its formula mass.

Comparing the formula masses:

1) $12 + 4 = 16 < 28.8$

$\boxed{2)}$ $3 \cdot 12 + 8 = 44 > 28.8$

3) $1 + 19 = 20 < 28.8$

4) $2 \cdot 14 = 28 < 28.8$

5) $14 + 3 = 17 < 28.8$

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Q9:

The oxidation number of $S$ atom in $H_2SO_4$ is $+6$ and that in $SO_2$ is $+4$.

Therefore, the chamge in oxidation number is $6 - 4 = \boxed{2}$.

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Q10:

The ions presending in the solution are $Cu^{2+}, SO_4^{2-}, H^+$ and $OH^-$. Among them, $Cu^{2+}$ has the highest oxidising power. The only reducing agent that can reduce $Cu^{2+}$ is the $Cu$ electrode.

Therefore, $Cu$ is oxidised to $Cu^{2+}$ at the anode (i.e. A) and $Cu^{2+}$ is reduced to $Cu$ at the cathode (i.e. B).

The changes at A and B will hence be a decrease and an increase in mass respectively $\boxed{(3)}$.

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Q11:

$\boxed{(a)}$: $2Na + 2H_2O \rightarrow 2NaOH + H_2$

(b): No reaction.

$\boxed{(c)}$: $H^+$ ions are reduced to $H_2$ at the cathode and $OH^-$ ions are oxidised to $O_2$ at the anode.

(d): $MnO_2$ is reduced to $Mn^{2+}$ at the anode and $Cl^-$ ions are oxidised to $Cl_2$ at the cathode.

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Q12:

(a): $NaCl(aq)$ or $NaCl(l)$ does contain electricity. However, $NaCl(s)$ does not, as the ions are not mobilised (T).

(b): T, refer to (a).

(c): For concentrated $NaCl(aq)$, $Cl^-$ are oxidised to $Cl_2$ instead of $OH^-$ (T).* Therefore, the answer is $\boxed{(1)}$.

*: However, it is not the case of not sufficiently concentrated $NaOH(aq)$. The question didn't state very clearly.

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Q13:

(a): $Al_2O_3$ is amphoteric. $CaO$ and $Na_2O$ are basic.

(b): Both $HCl$, $HI$ and $H_2S$ are acidic.

(c): The hydrogen compounds of $C, N$ and $P$ are $CH_4$, $NH_3$ and $PH_3$ respectively.

Given the above, the correct combination is $\boxed{(4)}$.

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Q14:

The question is equivalent to the metal that cannot displace $Ag^+$ ion from its aqueous solution.

Therefore, we are going to spot the metal that has a lower reactivity than $Ag$.

Among the four options, $\boxed{Pt}$ has a lower reactivity than $Ag$.

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Q15:

(1): True for both $Al$ and $Zn$:

$2Al + 6HCl \rightarrow 2AlCl_3(aq) + 3H_2$

$Zn + 2HCl \rightarrow ZnCl_2(aq) + H_2$

(2): Not true for both $Al$ and $Zn$. Metals have no direct reaction with alkalis.

$\boxed{(3)}$: True for $Zn$ but not $Al$:

$Zn^{2+} + 2(OH)^- \rightarrow Zn(OH)_2$, $Zn(OH)_2 + 4NH_3 \rightarrow Zn(NH_3)_4(OH)_2(aq)$

(4): True for both $Al$ and $Zn$:

$Al^{3+} + 3OH^- \rightarrow Al(OH)_3$, $Al(OH)_3 + NaOH \rightarrow NaAl(OH)_4(aq)$

$Zn^{2+} + 2OH^- \rightarrow Zn(OH)_2$, $Zn(OH)_2 + 2NaOH \rightarrow Na_2Zn(OH)_4(aq)$

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Q16:

The answer is $\boxed{(6)}$, which is just some memorising tasks.

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Q17:

Compounds with hydrogen bonds are generally easily soluble in water:

(1): Both compounds can form hydrogen bond with water.

(2): Both compounds can form hydrogen bond with water.

(3): Phenol can form hydrogen bond with water.

$\boxed{(4)}$: Both compounds cannot form hydrogen bond with water.

(5): Formaldehyde can form hydrogen bond with water.

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Q18:

(a): But-1-ene + $Cl_2$ $\rightarrow$ 1,2-dichlorobutane, where the second carbon atom is a chiral carbon. Therefore, optical isomers are formed.

Methylpropene + $Cl_2$ $\rightarrow$ dicholoromethylpropane, where no chiral carbons exist. Therefore, no optical isomeres are formed.

(b): The first carbon's braches are the same (-H) for but-1-ene. Therefore, no cis-trans isomers exist.

cis-but-2-ene and trans-but-2-ene exist for but-2-ene.

The first carbon's braches are the same (-H) for methylpropene. Therefore, no

cis-trans isomers exist.

Given the above, the correct combination is $\boxed{(2)}$.

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Q19:

Oletic acid contains 1 $C = C$ double bond.

As the fat contains 3 oletic acids, it contains 3 $C = C$ double bond.

1 mol of $H_2$ is required to saturate 1 mol of $C = C$ double bond. Therefore, $3 \cdot 0.10 = 0.3\ mol$, i.e. $0.3 \cdot 22.4 = \boxed{6.72}\ L$ of $H_2$ is required.

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Q20:

The polymerisation is a condense polymerisation with a carboxylic acid and an amine.

It can be identify that the two monomers are $HOOC - (CH_2)_4 - COOH$ and $H2N - (CH_2)_6 - NH_2$.

Therefore, the answer is $\boxed{(3)}$.