I(1):

The atomic with outermost shell furthest away from the nucleus and the smallest number of protons has the smallest first ionisation energy.

As Na and Mg are belongs to period 2 and Na has smaller number of protons than Mg, $\boxed{Na}$ has the smallest first ionisation energy.

I(2):

By common sense, for the same size, Au is much heavier than the other three options. Hence, $\boxed{Au}$ should has the hughest density.

Note: It is very difficult to compare their densities theoretically as there are many factors (mainly the crystal structure, ionic radius and the atomic mass) determining their densities.

I(3):

1) Linear.

2) Tetrahedral.

$\boxed{3)}$ Planar.

4) Tetrahedral.

I(4):

The boiling points of substances are determined by the strengths of their intermolecular forces.

As H_2O contains hydrogen bonds, it has very high boiling point.

For options (2) to (4), as H_2S has the smallest molecular size, it has the weakest intermolecular force. Therefore, $\boxed{H_2S}$ has the lowest boiling point.

I(5):

1) True.

2) True, as no additional H^+ or OH^- ions are dissociated from $NaCl$.

3) True. $NaCl$ has the simple cubic crystalline structure, where the coordinate number (i.e. the number of neighbour atoms/ions) is 6.

$\boxed{4)}$ The refractive index depends only on the crystalline structure of each unit cell. The crystallographic directions affect only the arrangement of unit cells but no the unit cells themselves.

I(6):

1) Oxidation number changed from 0 to -1, which is reduced.

2) Oxidation number changed from $+4$ to 0, which is reduced.

$\boxed{3)}$ Oxidation number changed from -2 to $+6$, which is oxidised.

4) oxidation number changed from $+7$ to $+2$, which is reduced.

I(7):

The increase in boiling point of water is directly proportional to the number of moles of molecules or ions added.

1) Number of moles of molecules$=\frac{10}{6\cdot12+12+6\cdot16}=\frac{10}{180}$ $mol.$

2) Number of moles of ions$=2\cdot\frac{10}{23+35.5}=\frac{10}{29.25}$ mol

3) Number of moles of ions$=2\cdot\frac{10}{23+32+4\cdot16}=\frac{10}{59.5}$ mol

$\boxed{4)}$ Number of moles of ions$=3\cdot\frac{10}{24.3+35.5}=\frac{10}{19.93}$ mol

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II:

The equation of oxidation of methane is $CH_4+2O_2\rightarrow CO_2+2H_2O$.

To oxidise 1 mol of methane, 2 mol, i.e. $2\cdot22.4=\boxed{44.8}$ L of O_2 is required.

On the other hand, the thermochemical equation of formation of CH_4 is

$C(graphite)+2H_2(g)\rightarrow CH_4(g)$.

Energy absorbed for bond breaking$=717+2\cdot432=1581$ kJ mol^{-1}.

Energy released for bond forming$=4\cdot414=1656$ kJ mol^{-1}.

Therefore, heat released during the formation of $CH_4=1656-1581=\boxed{75}$ kJ mol^{-1}.

III:

The reaction of metallic calcium with water produces $\boxed{Ca(OH)_2}$ and H_2 (Ca displaced H^+ in water). Moreover, bubbling CO_2 into $Ca(OH)_2$ gives $\boxed{CaCO_3}$ and H_2O (neutralisation).

Oxidation of Ca produces $\boxed{CaO}$, where adding it into water produce $Ca(OH)_2$ and H_2.

Reacting with HCl, $Ca(OH)_2$ and $CaCO_3$ are neutralised to $\boxed{CaCl_2}$. The electrolysis of it can produce Ca metal.

IV:

The reaction is given by

$CH_3COOH + CH_3CH_2OH \iff CH_3COOCH_2CH_3 + H_2O.$

(1): As 0.75 mol of H_2O is formed, 0.75 mol of reactants are consumed and 0.75 mol of products are formed.

Therefore, at the equilibrium state, $1.0 - 0.75 = 0.25$ mol of products are remained.

Let V be the volume of the mixture, we have $K_C = \frac{\frac{0.75}{V} \cdot \frac{0.75}{V}}{\frac{0.25}{V} \cdot \frac{0.25}{V}} = \boxed{9.0}$.

(2): Referring to the table:

Chemical	acetic acid	ethanol	ethylacetate	water
Initial amount	1.0 mol	1.0 mol	0 mol	4.0 mol
Equilibrium amount	$(1-x)$ mol	$(1-x)$ mol	x mol	$(4+x)$ mol

Therefore, considering the equilibrium constant, we have $\frac{x(4+x)}{(1-x)(1-x)} = 9$

$$4x + x^2 = 9 - 18x + 9x^2$$

$$8x^2 - 22x + 9 = 0$$

$$(4x-9)(2x-1)=0$$

$$x=\frac{1}{2} \text{ or } \frac{9}{4} \text{ (rejected as } x<1)$$

Therefore, the amount of ethylacetate produced= $\boxed{0.50}$ mol

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V:

(1): Adding H_2SO_4 into benzene will substitue the $-H$ branch by a $-SO_3H$ branch. Therefore, benzene sulforic acid $\boxed{(2)}$ is formed. Neutralising it with $NaOH$ gives $\boxed{(12)}$, which can undergo alkali fusion with $NaOH$ to give phenol $\boxed{(13)}$.

Adding HNO_3 into benzene with H_2SO_4 catalyst will substitue the $-H$ branch by a $-NO_2$ branch. Therefore, nitrobenzene $\boxed{(10)}$ is formed. It can be reduced using Sn as a reducing agent to give aniline $\boxed{(17)}$, which can undergo diazotisation at $> 5°C$ and hydrolysed to phenol.

On the other hand, adding C_2H_5Cl into benzene with $AlCl_3$ catalyst will give $\boxed{(4)}$ and HCl, which can undergo dehydrogenation and give $\boxed{(15)}$ which can undergo addition polymerisation to form a polymer. Besides, (4) and (15) themselves can be oxidised using $KMnO_4$ as an oxidising agent to form benzoic acid $\boxed{(14)}$ and formic acid.

Moreover, the oxidation of toluene can also give benzoic acid. With the free radical substitution of Cl_2, toluene becomes chloromethyl benzene $\boxed{(8)}$, where the $-Cl$ group can be substituted as $-OH$ with $NaOH$. Now, oxidising it using $KMnO_4$ directly or using $K_2Cr_2O_7$ follow by $KMnO_4$ can get benzaldehyde, where the latter will form benzaldehyde $\boxed{(11)}$ as an intermediate.

(2): Referring to the above, we have:

$\boxed{\text{(a): reduction (b): dehydrogenation (c): addition polymerisation (d): oxidation}}$

VI:

(1): The compound that dissolved in aqueous layer A is very soluble in water. Therefore, it is $\boxed{\text{alanine}}$.

The compound that dissolved in aqueous layer B can undergo neutralisation with HCl. Therefore, it is $\boxed{\text{aniline}}$.

The compound that dissolved in ether layer C cannot undergo neutralisation with $NaOH$. Therefore, it is $\boxed{\text{toluene}}$.

(2): $\boxed{\text{Phenol}}$ is precipitated after CO_2 is bubbled in as it is a weaker acid than H_2CO_3.

(3): The remained compound is $\boxed{\text{salicyclic acid}}$

VII:

(1): $NaOH$ is a strong alkali which can be used to undergo the decarboxylation. During the reaction, H_3CCOOH is decarboxylated to CH_4, which is $\boxed{\text{mathane}}$.

(2): The reaction is a double displacement, where Ca^{2+} and H^+ are interchanged.

Therefore, the reaction is $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$.

The organic compound formed is $\boxed{\text{acetylene}}$.

(3): At $160°C$, alcohols are dehydrated to alkene. Therefore, $\boxed{\text{ethene}}$ is formed.

Note: If the temperature is lower than $160°C$, ether will form instead. If the temperature is lower than $120°C$, no dehydration reaction can undergo.