I(1):

1) Carbon has allotropes: diamond, graphite (graphene), fullerene, nanotube.

$\boxed{2)}$ Nitrogen has no allotropes.

3) Oxygen has allotropes oxygen and ozone.

4) Phosphorus has allotropes red phosphorus and white phosphorus.

I(2):

1) 1 mol of HCl can dissociate 1 mol of H^+ ions.

2) As HF is a weak acid, 1 mol of HF can dissociate less than 1 mol of H^+ ions.

3) As CH_3COOH is a weak acid, 1 mol of CH_3COOH can dissociate less than 1 mol of H^+ ions.

4) As H_2S is a weak acid, 1 mol of H_2S can dissociate less than 1 mol of H^+ ions.

As the pH value decreases with the concentration of H^+ ions, the answer is $\boxed{1)}$.

I(3):

1) C=O bonds in CO_2 are double bonds.

2) H_3PO_4 contains a P=O double bond.

$\boxed{3)}$ H_2O_2 contains 2 H-O bonds and 1 O-O bond, which are all single bonds.

4) N_2 contains 1 triple bond.

I(4):

The order of melting points of common metals:

$Cr > Pt > Ti > \underline{Fe} > Ni > Mn > Cu > Au > \underline{Ag} > Ca > \underline{Al} > Mg > Zn > Pb > \underline{Sn} > Li > Na > K > Hg$

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

Note: Things get very complicated if it comes to the comparison of melting points of transition metals. Here I assume MEXT expected us to memorise the general tendency of their melting points or the fact that iron has a very high melting point along common metals. In case it didn't, the question can also be solved by common sense: A simple furnace can be made using iron. On the other hand, it can melt almost most of the common metals. Therefore, we can deduce that iron should have a much higher melting point than other metals.

I(5):

1) Crystalline silicon has the same crystal structure as a diamond, where 1 atom is surrounded by 4 nearby atoms.

2) High purity crystalline silicon can be used as the semiconductor for solar cells.

3) Doping boron or phosphorus can increase the electrical conductivity of crystalline silicon.

$\boxed{4)}$ Crystalline silicon is black in colour, as is the colour of solar cells.

I(6):

1) $Ca(OH)_2 + 2NH_4Cl \rightarrow CaCl_2 + 2NH_3 + 2H_2O$ (double displacement)

$\boxed{2)}$ $MnO_2 + HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$ (Redox)

3) $2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$ (double displacement)

4) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ (displacement)

I(7):

Properties of ideal gas:

-It is a point mass.

-There are no intermolecular forces between ideal gas molecules.

-It is in the gas state regardless of the surrounding condition.

-It obeys the ideal gas law (and hence the 3 fundamental gas laws)

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

II:

100 mL of 1.0 mol/L $NaOH(aq)$ contains $100 \cdot \frac{1.0}{1000} = 0.1\ mol$ of $NaOH$.

Therefore, it contains $0.1 \cdot (23.0 + 16.0 + 1.0) = 4.0\ g$ of $NaOH$.

Consider the equation $2NaOH + H_2SO_4 \to Na_2SO_4 + 2H_2O$.

To neutralise 0.1 mol of $NaOH(aq)$, 0.05 mol of $H_2SO_4(aq)$ is required.

Therefore, the number of moles that $H_2SO_4(aq)$ reminded after the reaction is $100 \cdot \frac{0.01}{1000} - 0.05 = 0.05\ mol$.

As 1 mol of $H_2SO_4(aq)$ can dissociate 2 mol of H^+ ions (i.e. proton), the number of moles of proton after reaction is $0.05 \cdot 2 = 0.1\ mol$.

On the other hand, there are totally $100 + 100 = 200\ mL$ of solution.

Therefore, the concentration of proton is $\frac{0.1}{\frac{200}{1000}} = \boxed{0.50}\ mol/L$.

III:

In a fuel cell, H_2 and O_2 are added and H_2O is produced (as given by the overall equation). We can hence identify the oxidising agent O_2 and the reducing agent H_2.

Therefore, H_2 is oxidised with the half equation:

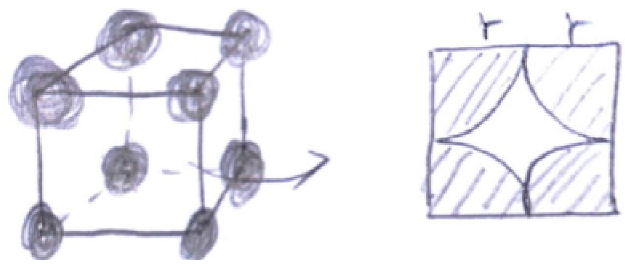
$\boxed{H_2} + 2\boxed{OH^-} \to 2\boxed{H_2O} + 2e^-$ (in alkaline (KOH electrolyte) environment)

And O_2 is reduced with the half equation:

$\boxed{O_2} + 2H_2O + 4e^- \to 4OH^-$

IV:

(1):



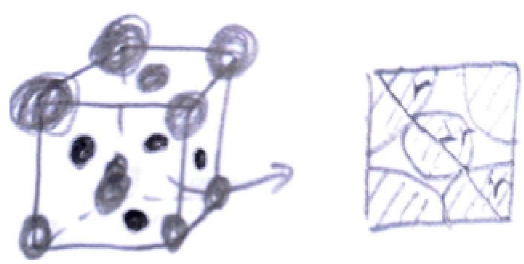
Referring to the graph, consider one face of the lattice, we have the length of edge of the cube is $\boxed{2.0}\,r$.

Therefore, the volume of the cube is $8r^3$.

On the other hand, each lattice contains $\frac{1}{8} \cdot 8 = 1$ atom. Therefore, the volume of the atom is $\frac{4}{3}\pi r^3$.

Given the above, the volume occupied by the atoms is $\frac{\frac{4}{3}\pi}{8} \approx \boxed{52\%}$.

(2):



Similarly, refer to the graph, consider one face, by Pythagoras' theorem, we have the length of edge of the cube is $\frac{4}{\sqrt{2}}r$, approximately $\boxed{2.8}\,r$. Therefore, the volume of the cube is $16\sqrt{2}r^3$.

On the other hand, each lattice contains $\frac{1}{8} \cdot 8 + \frac{1}{2} \cdot 6 = 4$ atoms. Therefore, the volume of the atoms is $4 \cdot \frac{4}{3}\pi r^3 = \frac{16}{3}\pi r^3$.

Given the above, the volume occupied by the atoms is $\frac{\frac{16}{3}\pi}{16\sqrt{2}} \approx \boxed{74\%}$.

V:

The trimerisation of acetylene gives benzene $\boxed{(17)}$. Moreover, the substitution reaction between acetylene and benzene gives styrene (ethenylbenzene) $\boxed{(9)}$.

The addition of acetic acid (CH_3COOH) to acetylene gives $H_2C = CHOOCCH_3$ $\boxed{(20)}$.

The addition of hydrogen chloride (HCl) to acetylene gives $H_2C = CHCl$ $\boxed{(19)}$.

The dimerisation of acetylene gives $H_2C = CH - C \Xi CH$ $\boxed{(11)}$. Moreover, the addition of HCl to it gives $H_2C = CHCCl = CH_2$ $\boxed{(18)}$ as the major product by Markovnikov's rule. Besides, the hydrogenation of it gives $H_2C = CH - CH = CH_2$ $\boxed{(24)}$.

The addition of hydrogen cyanide (HCN) to acetylene gives $H_2C = CHCN$ $\boxed{(13)}$.

The addition of water to acetylene gives $H_2C = CHOH$, which is very unstable and will turn to H_3CCHO $\boxed{(6)}$ immediately.

The hydrogenation of acetylene gives $H_2C = CH_2$ $\boxed{(12)}$, which gives ethanol after the addition reaction with water.

Note: Generally, the addition of HA to acetylene will give $H_2C = CA$.

IV:

(1): (The question is set incorrectly. The molecular weight should be 88 instead)

The molar ratio $C : H : O = \frac{68.18}{12.0} : \frac{13.64}{1.0} : \frac{18.18}{16.0} \approx 5 : 12 : 1$.

Therefore, the empirical formula of X is $C_5H_{12}O$.

Solving $n(5 \cdot 12.0 + 12 \cdot 1.0 + 16.0) = 88$, we have $n = 1$.

Therefore, the molecular formula of X is $C_5H_{12}O$ $\boxed{(c)}$.

(2): X is either an ether or an alcohol.

There's no reaction between ether and sodium.

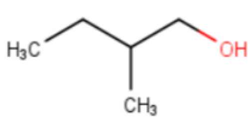
Moreover, the only reaction between alcohol and sodium is

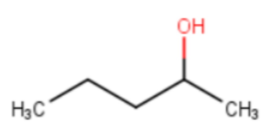
$ROH + Na -> RONa + \frac{1}{2}H_2$.

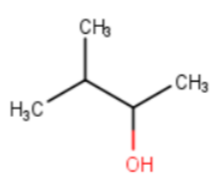
Therefore, the gas evolved is hydrogen $\boxed{(f)}$.

(3): By (2), we know X is an alcohol $\boxed{(c)}$.

(4): For the existence of chiral carbon, there must be a branch on X. Moreover, X must be asymmetric. Therefore, we have $\boxed{3}$ such isomers:

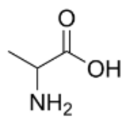




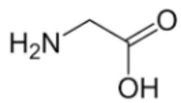


IIV:

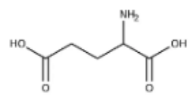
Alanine:



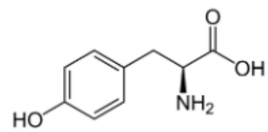
Glycine:



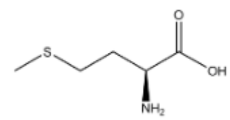
Glutamic acid:



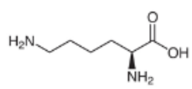
Tyrosine:



Methionine:



Lysine:



(1):

(a) True.

$\boxed{(b)}$ Optical isomers do not exist for glycine.

(c) All the 20 common amino acids are soluble in water although some aromatic amino acids are less soluble.

$\boxed{(d)}$ Glutamic acid contains two carboxylate groups.

(e) All amino acids show positive results with the ninhydrin test.

(2): Glycine $\boxed{(2)}$ has the smallest molecular weight among all amino acids.

(3): $\boxed{(5)}$

(4): The sodium salt of glutamic acid $\boxed{(3)}$ Is called MSG, which is generally used as synthetic seasoning.

(5): The xanthoproteic test (heat an amino acid with concentrated nitric acid, whose positive result is the amino acid becomes yellow) is used to test amino acid with benzene ring. Among them, only tyrosine $\boxed{(4)}$ can give positive results.