<u>CAT 3 1999:</u> **Sample Answers**

1. a essential in the diet of humans (cannot be synthesized within the human body)

   not essential in the diet of humans (can be synthesized)

   b NH_4^+ , NO_3^-

   c any one of the acidic oxides of C, Si, N, P, S, Se or Cl.

   d to allow current in the form of ions to flow between the half cells.

   e a strong electrolyte e.g. NH_4NO_3, KNO_3 (It is important that the compound does not take part in, or alter, the cell reaction)

2. a False. When H_2O is present it is preferentially reduced to hydrogen.

   b False. Equal numbers of moles of the two metals are deposited but since the two metals have different RAMs the masses will be different.

   c True. An electron in the 4s subshell has a lower energy than one in the 3d subshell.

3. a 1= (+) and 2= (-).

   Electrolyte: Soluble strong electrolyte with Cu(II) as the cation eg $Cu(NO_3)_2$

   b i. $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

   ii. Q = 2.7 x 24 x 60 = 3888 C

   moles of electrons transferred = 3888/96500 = 4.029 x 10^{-2}

   moles of copper = (4.029 x 10^{-2})/2

   mass of copper = (4.029 x 10^{-2})/2 x 63.5 = 1.3 g

   c Fe would be corroded as it oxidized to Fe^{2+}

4. a i. $4\,{}^{1}_{1}H \longrightarrow {}^{4}_{2}He + 2\,{}^{0}_{1}e$

   ii. nuclear fusion

   iii. centre of a star

   iv. conversion of mass to energy or nuclear binding energy

   b i. chemical energy to thermal energy /heat / kinetic energy

   ii thermal energy to mechanical energy

   iii. mechanical energy to electrical energy

   c solar, wind, geothermal, tidal, hydroelectric.

5. a $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l \text{ or } g)$

$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l \text{ or } g)$

b number of mole of propane = 1000/44 =22.727 mol

energy released = 22.727 x 2220 = 50 500 kJ

c examples include: cost per unit mass, cost per unit energy, ease of storage and distribution, safety, greenhouse gas emission per unit of energy, combustibility.

6. a glucose and fructose

b i. Glycine and alanine

$H_2NCH(CH_3)COOH + H_2NCH_2COOH \rightarrow H_2NCH(CH_3)CONHCH_2COOH$

ii condensation

iii -CONH- group

7. a Polyunsaturated: made from fatty acids with more than one C=C double bond.

Monounsaturated: made from fatty acids with one C=C double bond.

Saturated: made from fatty acids with no C=C double bonds.

b i energy transferred by the current = q = VIt = 5.91 x 1.32 x 6.50 x 60 = 3042.5 J

calibration factor = q/ΔT,

hence ΔT = q/calibration factor = 3042.5/1135 = 2.86 ^{o}C

initial temperature = 22.36 - 2.68 = 19.68 ^{0}C

ii ΔT = 34.48 - 20.02 = 14.46 ^{o}C

energy released = cal. factor x ΔT = 1135 x 14.46 = 164112 J (for 0.500 g)

energy released per gram = 164112 / 0.500 = 32824 J g^{-1} = 32.8 kJ g^{-1}

iii Heat loss from calorimeter or variation in the composition of the oil from batch to batch.

iv Circle both $C_{17}H_{31}$ and $C_{17}H_{33}$

8. a 3.5 ± 0.5 minutes

b the reaction rate decreases with decreasing temperature.

c the enzyme, amylase, has been deactivated by the high temperature

d hydrolysis

e glucose or maltose

9. N, O, F and Ne continue from left to right following B and C

Cl is in the box directly above F

Ti: $1s^2 2s^2 3p^6 3s^2 3p^6 3d^2 4s^2$

Ti is placed in the lowest strip that is 10 boxes wide, second box from the left

lanthinides are the elements in the lowest strip of 14 boxes

actinides are the elements in the upper strip of 14 boxes

10. a i A stable isotope is one which has nuclei that do not undergo any form of radioactive decay.

ii Os

iii $m = M/N_A = (184.95/6.02 \times 10^{23}) = 3.07 \times 10^{-22}$ g

b i. Peak at 187 is 18.8 units high and represents 62.5% of the sample.

Hence the peak at 185 (184.95), which represents 37.5% of the sample, will have a height of (18.8/62.5) x 37.5 = 11.3

ii $A_r = [(184.95 \times 37.5) + (186.96 \times 0.6250)]/ 100 = 186.21$

11 a magnetism: if the metal is ferromagnetic it is a transition element

hardness: in general the transition metals are harder than the group 1 metals

melting point: a transition metal will more likely have a high melting point

emission spectrum; comparison with known spectra would allow identification

b i See a text book for examples, e.g. $FeCl_2$ and $FeCl_3$ MnO_2 and $KMnO_4$

ii See a text book for examples, e.g. $Mn(s) + O_2(g) \rightarrow MnO_2(s)$

c ion-dipole bonding