CAMBRIDGE
INTERNATIONAL EXAMINATIONS

**JUNE 2003**

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 60

**SYLLABUS/COMPONENT: 9701/02**

**CHEMISTRY**
**Theory 1 (Structured Questions)**

**1 (a)** Atoms which have the same number of protons (or same element) but different numbers of neutrons (1) **[1]**

**(b) (i)** $^{35}Cl$ (1)

**(ii)** $H^{37}Cl$ (1) **[2]**

**(c)** H $Cl$ line at 36 has rel. abundance of 90 } (1)
38 30 }

These show $^{35}Cl$ and $^{37}Cl$ in ratio 3:1 (1)
[or use of 35 and 37] **[2]**

**(d)** Mean of the two isotopes $\frac{3 \times 35 + 1 \times 37}{4} = 35.5$ (1) **[1]**

**[Total: 6]**

**2 (a) (i)** That the volume of the gas molecules is negligible compared to the volume of gas (1)

**(ii)** That there are no intermolecular forces
OR collisions of the molecules are perfectly elastic
Particles are in constant motion, losing no energy on collision (1) any two **[2]**

**(b)** $6.02 \times 10^{23}$ (1) **[1]**

**(c) (i)** r = 0.192 nm (1) Assume most candidates will work in $dm^3$
$v = \frac{4}{3} \times 3.14 \times (1.92 \times 10^{-9})^3 = 2.96 \times 10^{-26}$ $dm^3$ ($2.96 \times 10^{-29}$ $m^3$) (1)

**(ii)** $2.96 \times 10^{-26} \times \frac{6.02 \times 10^{23}}{}$ (1) $= 1.78 \times 10^{-2}$ $dm^3$ ($1.78 \times 10^{-5}$ $m^3$) (1)

**(iii)** 24 $dm^3$ (0.024 $m^3$) (1)

**(iv)** $\frac{1.78 \times 10^{-2} \times 10^2}{24} = 0.074\%$ (1)

**(v)** Some statement which connects with **(a) (i)** above (1) **max [5]**

**(d)**
- hot metals will react with oxygen in air (or nitrogen)
- to form oxides/will burn out/to a powder
- argon will not react
- at high temperatures $O_2$ and $N_2$ in air will react to give $NO_x$

NOT expansion of gases on heating any two **[2]**

**[Total: 10]**

**3 (a)** $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (1) exothermic (1) **[2]**

**(b)** Pr. 5O atm upwards; Temp 400-600ºC; catalyst of iron
(1 each, conditions stated) **[3]**

**(c)** Too high a temp and equilibrium favours LHS, less ammonia at equilibrium (1)
Too low a temp, rate too slow/not enough molecules have $E_{act}$ (1) **[2]**

**(d) (i)** $K_p = \dfrac{PNH_3^2}{PN_2 \times PH_2^3}$ (1)

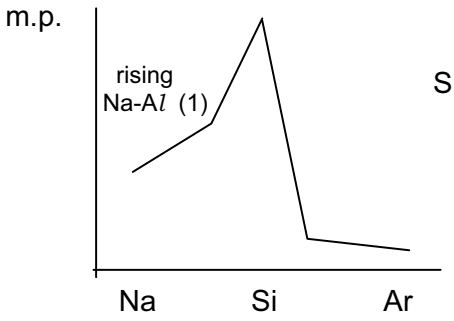
**(ii)** $K_p = \dfrac{37.2^2}{44.8 \times 105.6^3}$ (1)

$= 2.62 \times 10^{-5}$ atm$^{-2}$ (1) calculation and units **[3]**

**(e)** Excess (hence uncontrolled) nitrates leach out of fields into streams, seas (1)
Bacteria or algae grow fast/use oxygen/clog up water (1)
Balance destroyed/fish unable to live (1)
Process called eutrification (1) any 3 **[3]**

**[Total: 13]**

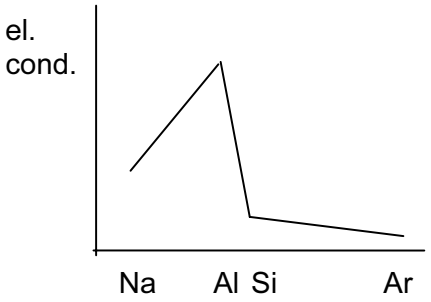
**4 (a) (i)**




Si to Ar (1)

**[2]**

**(ii)**

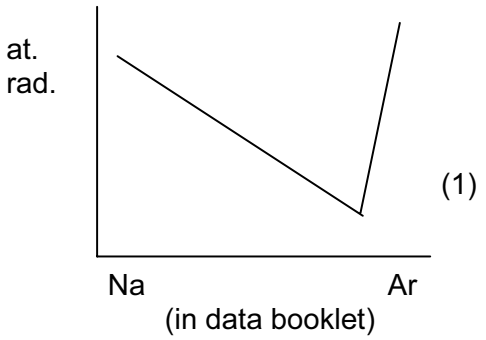



rising
Na-Al (1)

P – Ar (below Na) (1)

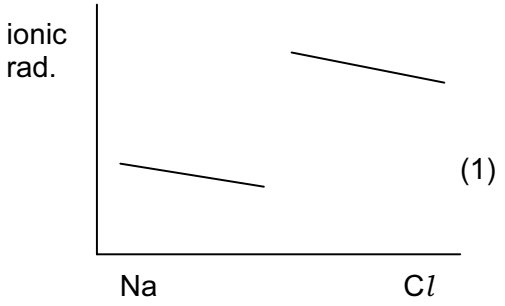
**[2]**

**(iii)**




(1) **[1]**

**(iv)**




(1) **[1]**

**[6]**

**(c) (i)** $Na_2O$ MgO $Al_2O_3$ $P_2O_5$ (or $P_4O_{10}$ or $P_2O_3$) $SO_2$ or $SO_3$ (1)

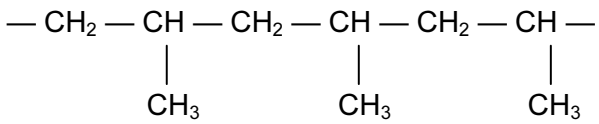
**(ii)** $Na_2O + H_2O \rightarrow 2NaOH$ (1)

**(iii)** $2NaOH + SO_2 \rightarrow Na_2SO_3 + H_2O$ (1) or $NaHSO_3$

<u>OR</u> $2NaOH + SO_3 \rightarrow Na_2SO_4 + H_2O$ (1) $NaHSO_4$ **[3]**

**[Total: 9]**

**5 (a)**




(1) **[1]**

**(b)** Alkane (1) **[1]**

**(c) (i)** Not biodegradable/does not decompose/unreactive
Not affected by enzymes
Not attacked by aqueous or polar reagents found in tissues
Insoluble/does not absorb water/cotton absorbs water
NOT is stronger than cotton
[equivalent worthy points; they may overlap - but allow - max 2] **[2]**

**(ii)** Alkanes react with oxygen (combustion)
Not possible in muscle (1)
also react with halogens/in U.V. light
muscle is internal and no halogens (1)
[ecf for alkene answers in **(b)**] **[2]**

**[Total: 6]**

**6 (a)**

$$\frac{66.7}{12} \qquad \frac{11.1}{1} \qquad \frac{22.2}{16}$$

= 5.5 = 11.1 = 1.3875

Divide by 1.3875

$C_4H_8O$ (1) 48 + 8 + 16 = 72 hence $C_4H_8O$ (1) **[2]**

**(b) (i)** orange ppt (1) red to yellow/crystals or solid

**(ii)** ketone (1)

**(iii)** $CH_3CH_2COCH_3$ or butanone (1) **[3]**

**(c) (i)** $NaBH_4$ allow $NaAlH_4$ (Li $Al H_4$) (1) $H_2$/Ni or Pt

**(ii)** secondary alcohol (1)

**(iii)** $CH_3CH_2CHOHCH_3$ (1)
[Allow ecf marks if **(b) (iii)** is butanal] **[3]**

**[Total: 8]**

**7 (a) (i)** e.g.
$CH_3CO_2C_3H_7$ $CH_3CO_2CH(CH_3)_2$ $CH_3CH_2CO_2C_2H_5$ $H\text{-}CO_2C_4H_9$
$C_3H_7CO_2CH_3$ + branches any three **[3]**

**(ii)** $RCO_2R'$ + NaOH → $RCO_2Na$ (1) + R'OH (1)
→ $RCO_2H$ + R'OH (1) only **[2]**

**(b) (i) and (ii)** * volatile, or liquids (1) immiscible, with water (1) smell (1) any two **[2]**

**(c) (i)** solvents, perfumes, flavourings, lotions, olive or palm oils any two

**and (ii)** To make soap, to make Terylene **[2]**
NOT polyesters

**[Maximum Total: 8]**