This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners’ meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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1 (a) uranium / plutonium / thorium [1]

(b) graphite / carbon [1]

(c) platinum / titanium / mercury / gold
   NOT: carbon / graphite [1]

(d) helium [1]

(e) nitrogen / phosphorus [1]

(f) argon
   ACCEPT: any ion 2 + 8 + 8 e.g. K⁺ etc. [1]

(g) tellurium
   ACCEPT: correct symbol [1]

[Total: 7]

2 (a) Any three of:
   iron is harder
   iron has higher density
   ACCEPT: heavier or potassium lighter
   iron has higher mp or bp
   iron has higher tensile strength or stronger
   iron has magnetic properties
   NOTE: has to be comparison, e.g. iron is hard (0) but iron is harder (1)
   NOT: appearance e.g. shiny
   ACCEPT: comparative statements relating to potassium [3]

(b) potassium hydrogen (1) and potassium hydroxide (1)
   zinc hydrogen (1) and zinc oxide (1)
   copper no reaction (1) [5]

[Total: 8]
### Question 3

(a) (i) fractional distillation
   (liquid) air

(ii) cracking / heat in presence of catalyst
   of alkane / petroleum
   to give an alkene and hydrogen
   OR: electrolysis
   named electrolyte
   hydrogen at cathode
   OR: from methane
   react water / steam
   heat catalyst
   only ACCEPT: water with methane or electrolysis

(b) (i) the pair with both graphs correct is C
   NOTE: mark (b)(ii) independent of (b)(i)

   (ii) high pressure favours side with lower volume / fewer moles
   this is RHS / product / ammonia
   %NH₃ / yield increases as pressure increases
   the forward reaction is exothermic
   exothermic reactions favoured by low temperatures
   %NH₃ / yield decreases as temperature increases
   ACCEPT: reverse arguments

   (iii) increases reaction rate
   ACCEPT: reduces activation energy
   OR: decreases the amount of energy particles need to react
   OR: economic rate at lower temperature so higher yield

[Total: 14]

### Question 4

(a) (i) (mass at t =0) – (mass at t = 5)
   NOTE: must have mass at t = 5 not final mass

   (ii) fastest at origin
   slowing down between origin and flat section gradient = 0
   where gradient = 0
   three of above in approximately the correct positions

   (iii) 3 correct comments about gradient = 2
   2 correct comments about gradient = 1
   1 correct comment about gradient = 0

   (b) start at origin and smaller gradient
   same final mass just approximate rather than exact

[Total: 14]
(c)  
(i)  smaller surface area
lower collision rate

(ii)  molecules have more energy
      collide more frequently / more molecules have enough energy to react

(d)  number of moles of HCl in 40 cm$^3$ of hydrochloric acid,
      concentration 2.0 mol / dm$^3$ = 0.04 × 2.0 = 0.08
      maximum number of moles of CO$_2$ formed = 0.04
      mass of one mole of CO$_2$ = 44 g
      maximum mass of CO$_2$ lost = 0.04 × 44 = 1.76 g

[Total: 15]

5  
(a)  
(i)  have same molecular formula / both are C$_2$H$_{12}$
      they have different structural formulae / different structures

(ii)  CH$_3$-CH$_2$-CH=CH-CH$_3$ / any other correct isomer

(b)  
(i)  CH$_2$-(Br)-CH$_2$Br
      NOT:  C$_2$H$_4$Br$_2$
      dibromoethane
      NOTE:  numbers not required but if given must be 1, 2

(ii)  CH$_3$-CH$_2$-CH$_3$
      NOT:  C$_3$H$_8$
      propane

(iii)  CH$_3$-CH$_2$-CH$_2$-OH / CH$_3$-CH$_2$-CH(OH)-CH$_3$
       butanol
       numbers not required but if given must be correct and match formula

(c)  
(i)  CH$_3$-CH=CH-CH$_2$-CH$_3$
     CH$_3$-CH=CH-CH$_3$

(ii)  pink / purple
     colourless
     NOT:  clear

(d)  -CH$_2$-CH(CN)-CH$_2$-CH(CN)-
correct repeat unit CH$_2$-CH(CN)
      COND:  at least 2 units in diagram
      continuation

[Total: 16]

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6 (a) (i) (attractive force between) positive ions and (negative) electrons opposite charges attract ONLY \[1\]
electrostatic attraction ONLY \[1\]

(ii) lattice / rows / layers of lead ions / cations / positive ions NOT: atoms / protons / nuclei can slide past each other / the bonds are non-directional \[1\]

(b) (i) anhydrous cobalt chloride becomes hydrated ACCEPT: hydrous \[1\]

(ii) carbon dioxide is acidic sodium hydroxide and calcium oxide are bases / alkalis \[1\]

(iii) Any two of:
water, calcium carbonate and sodium carbonate ACCEPT: sodium bicarbonate \[2\]

(c) number of moles of CO\(_2\) formed = \(\frac{2.112}{44} = 0.048\) \[1\]
number of moles of H\(_2\)O formed = \(\frac{0.432}{18} = 0.024\) \[1\]

\[x = 2 \text{ and } y = 1\] NOT: ecf from this line

formula is 2PbCO\(_3\).Pb(OH)\(_2\) / Pb(OH)\(_2\). 2PbCO\(_3\) \[1\]

[Total: 12]

7 (a) (i) hydrogen (atoms) replaced by (atoms) of a different element e.g. chlorine NOT: substitute \[1\]

(ii) light required \[1\]

(b) exothermic reaction gives out energy endothermic reaction absorbs takes in energy \[1\]

(c) bonds broken energy
C-H +412
Cl-Cl +242
total energy +654 \[1\]

bonds formed energy
C-Cl' -338
H-Cl' -431
total energy -769
energy change -115 negative sign indicates exothermic \[1\]

[Total: 8]