1 Use your copy of the Periodic Table to answer these questions.

    (a) Choose an element from the Periodic Table to match each description.
         You may give either the name or the symbol.

        (i) It is the most reactive metal. .... [1]

       (ii) It is the only non-metal which is a liquid at r.t.p.. .... [1]

      (iii) An isotope of this element is used as a fuel in nuclear reactors. .... [1]

      (iv) This Group VII element is a solid at r.t.p.. .... [1]

       (v) This element is in Group V and Period 4. .... [1]

      (vi) This unreactive gas is used to fill lamps. .... [1]

    (b) Predict the formula of each of the following compounds.

        (i) germanium oxide ....

       (ii) tellurium bromide .... [2]

    (c) Give the formula of each of the following ions.

        (i) strontium ....

       (ii) fluoride .... [2]

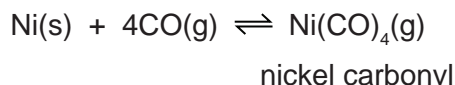   [Total: 10]

2 Nickel is a transition element.

(a) Predict **three** differences in the chemical properties of nickel and barium.

....

....

.... [3]

(b) Nickel ores are converted into nickel(II) oxide. This can be reduced to impure nickel by heating with carbon. The nickel is purified by the following reversible reaction.

$$Ni(s) \ + \ 4CO(g) \ \rightleftharpoons \ Ni(CO)_4(g)$$

nickel carbonyl

(i) Impure nickel is heated at 60 °C. The forward reaction occurs.

$$Ni(s) \ + \ 4CO(g) \ \rightarrow \ Ni(CO)_4(g)$$

impure
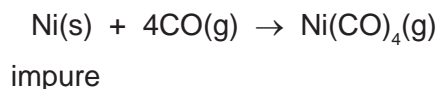
The nickel carbonyl, a gas, moves into a hotter chamber at 200 °C. The backward reaction occurs and the nickel carbonyl decomposes.

$$Ni(CO)_4(g) \ \rightarrow \ Ni(s) \ + \ 4CO(g)$$

pure
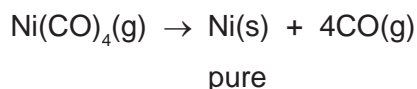
Is the forward reaction exothermic or endothermic? Give a reason for your answer.

....

....

.... [2]

(ii) Explain why the forward reaction is favoured by an increase in pressure.

....

.... [2]

(iii) Suggest what happens to the impurities.

.... [1]

(iv) Suggest another method of refining nickel. Give a brief description of the method which you have suggested. A labelled diagram is acceptable.

[4]

[Total: 12]

3   Choose an element which fitseachofthefollowingdescriptions.

   (i)   It is a yellow solid which burns to form an acidic oxide.

   .... [1]

   (ii)   This element is a black solid which, when heated, forms a purple vapour.

   .... [1]

   (iii)   Most of its soluble salts are blue.

   .... [1]

   (iv)   It has a basic oxide of the type MO which is used to treat acidic soils.

   .... [1]

   (v)   It is an unreactive gas used to fill balloons.

   .... [1]

[Total: 5]

4 Titanium is a transition element. It is isolated by the following reactions.

titanium ore → titanium(IV) oxide → titanium(IV) chloride → titanium

TiO_2 $TiCl_4$ Ti
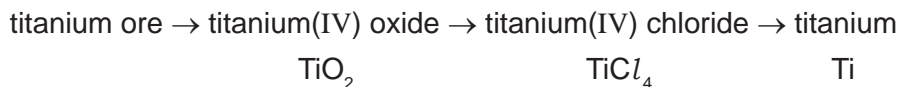
(a) Why is it usually necessary to include a number in the name of the compounds of transition elements?

.... [1]

(b) Titanium(IV) chloride is made by heating the oxide with coke and chlorine.

$$TiO_2 + 2Cl_2 \rightleftharpoons TiCl_4 + O_2$$

$$2C + O_2 \rightleftharpoons 2CO$$
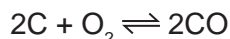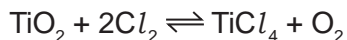
Explain why the presence of coke ensures the maximum yield of the metal chloride.

....

....

.... [2]

(c) Explain why the change, titanium(IV) chloride to titanium, is reduction.

....

.... [1]

(d) Complete the table which shows some of the properties of titanium and its uses.
The first line has been completed as an example.

property	related use
soluble in molten steel	making steel titanium alloys
....	making aircraft and space vehicles
resistant to corrosion, especially in sea water	....

[2]

(e) The titanium ore contains 36.8% iron, 31.6% titanium and the remainder is oxygen.

  (i) Determine the percentage of oxygen in this titanium compound.

  percentage of oxygen = ... %   [1]

  (ii) Calculate the number of moles of atoms for each element.
  The number of moles of Fe is shown as an example.
  number of moles of Fe = 36.8/56 = 0.66

  number of moles of Ti   = ...

  number of moles of O   = ... [1]

 (iii) What is the simplest ratio for the moles of atoms?

                    Fe   :   Ti

                    ....
                                                                                    [1]

 (iv) What is the formula of this titanium compound?

  .... [1]

[Total: 10]

5 Chromium is a transition element.

(a) Predict **two** differences in the physical properties of chromium and sodium.

....

.... [2]

(ii) Predict **two** differences in the chemical properties of chromium and sodium.

....

....

.... [2]

(b) Chromium is used to electroplate steel objects. The diagram shows how this could be done.
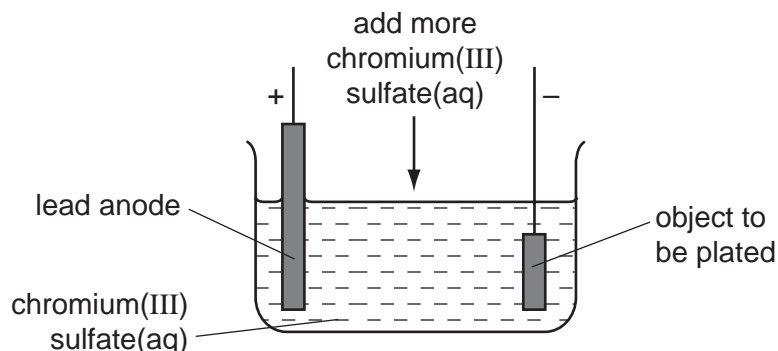
(i) Give **two** reasons why steel objects are plated with chromium.

....

.... [2]

(ii) The formula of the chromium(III) ion is Cr^{3+} and of the sulfate ion is SO_4^{2-}. Give the formula of chromium(III) sulfate.

.... [1]

(iii) Write the equation for the reaction at the negative electrode (cathode).

.... [2]

(iv) A colourless gas, which relights a glowing splint, is formed at the positive electrode (anode). Name this gas.

.... [1]

(v) During electrolysis, it is necessary to add more chromium(III) sulfate but during copper-plating using a copper anode, it is not necessary to add more copper(II) sulfate. Explain.

....

....

.... [2]

[Total: 12]

6   The first three elements in Group IV are carbon, silicon and germanium.
     The elements and their compounds have similar properties.

(a) The compound, silicon carbide, has a macromolecular structure similar to that of
         diamond.

    (i) A major use of silicon carbide is to reinforce aluminium alloys which are used in
         the construction of spacecraft. Suggest **three** of its physical properties.

    ....

    ....

    ....   [3]

    (ii) Complete the following description of the structure of silicon carbide.

    Each carbon atom is bonded to four .... atoms.

    Each silicon atom is bonded to .... carbon atoms.   [2]

(b) Germanium(IV) oxide, GeO_2, has the same macromolecular structure as silicon(IV)
         oxide. Draw the structural formula of germanium(IV) oxide.

[3]

(c) Germanium forms a series of hydrides comparable to the alkanes.

(i) Draw the structural formula of the hydride which contains four germanium atoms per molecule.

[1]

(ii) Predict the products of the complete combustion of this hydride.

.... [2]

[Total: 11]

7   For each of the following select an element from Period 4, potassium to krypton, that matches the description.

(a) It is a brown liquid at room temperature.   ....

(b) It forms a compound with hydrogen having the formula XH_4.   ....

(c) A metal that reacts violently with cold water.   ....

(d) It has a complete outer energy level.   ....

(e) It has oxidation states of 2 and 3 only.   ....

(f) It can form an ion of the type X .   ...

(g) One of its oxides is the catalyst in the Contact Process.   ....

[Total: 7]