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1 (a) (i) titanium / vanadium / zirconium / niobium  **max [2]**
(1 mark each)

*allow: symbols*

(ii) Na / Mg

(iii) sodium / Na

(iv) potassiu / K

(v) vanadium / V

(b) O$_2$

  correct balance

2 (a) (i) A: giant ionic

  B: simple atomic

  C: simple molecular

  D: metallic

(ii) B and C (both needed for mark)

(b) solid; molten;

3 (a) coolant / making ethanol / any other names large scale relevant reaction

  e.g. making sulfuric acid

(b) blue / anhydrous cobalt chloride (paper); turns pink;

  OR white / anhydrous copper sulfate; turns blue;

(c) (i) lighted splint;

  pops / explodes;

(ii) pH 12

(d) (i) 3 (CO$_2$); 4(H$_2$O);

(ii) combustion

(iii) 36 (mg)
4 (a) Any 2 of:
   - diffusion /
   - ink particles move /
   - water particles or molecules move /
   - movement of particles is random /

  [2]

(b) two or more substances (together) that can be separated by physical means

[1]

(c) (i) ethanol
   allow: carboxylic acids

   [1]

   (ii) oxidation state / third box down ticked

   [1]

   (iii) idea of small molecules / monomers joining / repeating units;
   long chains / large molecules formed;

   [2]

(d) (i) ring around COOH group

   [1]

   (ii) removal of oxygen / decrease in oxidation number / addition of electrons

   [1]

5 (a) filtration / centrifugation
allow: decanting

[1]

(b) C

[1]

(c) (i) solvent shown in bottom of beaker;
   spot on the base line vertically below the spots shown;
   chromatography paper labelled anywhere;

   [1]

   [1]

   [1]

   (ii) 4

   [1]

(d) (i) A

   [1]

   (ii) bromine water;
   decolourises / goes colourless;
   allow: potassium manganate (VII); decolourises;

   [2]

   (iii) substance containing carbon and hydrogen only

   [1]

   (iv) ethanoic acid

   [1]

   (v) alcohols / alkanols

   [1]
6 (a) conduct heat / conduct electricity / shiny / malleable / ductile max [2]

(b) 4 [1]

(c) 82 electrons
   82 protons
   126 neutrons [1]

(d) lead + oxygen → lead(II) oxide [1]

(e) (i) carbon [1]
    (ii) gas at room temperature / third box down ticked [1]

7 (a) (i) one of:
   BMF molecule and diamond a giant covalent structure /
   BMF has pentagonal (and hexagonal) structure diamond has bent hexagonal or tetrahedral structure /
   BMF each carbon joined to 3 others, diamond each carbon joined to four others /

   (ii) two of:
   graphite has (flat) hexagonal rings, diamond has bent hexagonal rings or tetrahedral /
   graphite has 3 bonds to each carbon, diamond has 4 /
   graphite is layered diamond is not /
   graphite has two types of bonding / forces or weak and strong bonds whereas diamond has only one type of bond / covalent bonds only [2]

(b) covalent [1]

(c) layers can slide over each other / forces weak between layers [1]

(d) cutting / drilling allow: jewellery [1]

(e) any 2 of:
   carbon dioxide is a greenhouse gas /
   absorbs infrared radiation /
   increases global warming /
   lead to climate change / [2]

(f) any two of:
   sulfur reacts with oxygen (when coal burnt) /
   forms sulfur dioxide /
   sulfur dioxide reacts with oxygen (to form sulfur trioxide) /
   sulfur dioxide or trioxide dissolve in rain (to form acid) / [2]
(g)  (i) waste gases from digestion in animals / second box down ticked [1]
      (ii) correct dot and cross diagram for methane [1]
      (iii) ethane / propane / butane etc [1]

8  (a) calcium oxide [1]

(b) thermal decomposition [1]

(c) carbon dioxide has been removed from the limestone / it comes from the limestone [1]

(d) neutralising acid soils / treating acidic lakes / flue gas desulfurisation etc [1]

(e) temperature of Bunsen / distance of Bunsen from the tube / amount or mass of carbonate used [1]

(f)  (i) calcium [1]
      (ii) 25 cm³ [1]
      (iii) calcium faster than strontium which is faster than barium / idea of trend down the group;
            correct trend i.e. less rapid reaction the further down the group; ORA [2]

(g) add acid to carbonate;
    bubble gas or carbon dioxide (evolved) through limewater / test gas or carbon dioxide with limewater;
    limewater goes milky or cloudy; [3]