

2025 Chemistry Prediction Paper 2

The questions in this pack cover the **major** topics that are **predicted** to come up in Chemistry Paper 2. These questions are all from Edexcel International GCSE papers, though questions are included from the old specification. The content has been checked to ensure it is still relevant.

Please bear in mind that your actual Paper 2 will also include easier content as well as the challenging questions included here.

Total marks available: 155

Recommended time: 180 minutes

Important: these questions do NOT cover everything that could be included in Paper 2! The checklist shows all content that can be included in Paper 2.

If you print these questions out double sided and double staple them on the left, they format will be exactly like an exam paper ☺

Qu	Content	Score
1	Chromatography	/ 7
2	Oxidation reactions, properties of ionic compounds	/ 7
3	Reactions of Alkali Metals	/ 6
4	Equilibrium	/ 8
5	Titrations methods and calculations	/ 15
6	Solubility	/ 7
7	Metals and alloys	/ 7
8	Polymerisation	/ 6
9	Reactions of carboxylic acids Esters	/ 11
10	Ethanol	/ 12
11	Electrolysis of aqueous solutions	/ 9
12	Making insoluble salts	/ 18
13	Properties of ionic compounds	/ 8
14	Calculating enthalpy, bond energies, energy level diagrams	/ 10
15	Empirical formulae, metal extraction	/ 9
16	Thermal decomposition	/ 9
17	Reacting masses, gas calculations	/ 6

The Periodic Table of the Elements

1	2	3	4	5	6	7	0
7 Li lithium 3	9 Be beryllium 4	11 Na sodium 11	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Al aluminium 13	24 Mg magnesium 12	27 Si silicon 14	28 P phosphorus 15	31 S sulfur 16	32 Cl chlorine 17	35.5 Ar argon 18	40 K potassium 19
39 Ca calcium 20	40 Sc scandium 21	45 Ti titanium 22	48 V vanadium 23	51 Cr chromium 24	52 Mn manganese 25	55 Fe iron 26	56 Ni nickel 28
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	101 Ru ruthenium 44	106 Pd palladium 46
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	190 Os osmium 76	195 Pt platinum 78
223 Fr francium 87	226 Ra radium 88	227 Ac* actinium 89	261 Rf rutherfordium 104	262 Db dubnium 105	266 Sg seaborgium 106	277 Hs hassium 108	288 Mt meitnerium 109
285 U uranium 92	286 Np neptunium 93	287 Pu plutonium 94	289 Am americium 95	291 Cm curium 96	294 Bk berkelium 97	296 Cf californium 98	297 Es einsteinium 99
337 Lr lawrencium 103	340 La lanthanum 104	341 Ce cerium 105	344 Pr praseodymium 106	348 Nd neodymium 107	351 Pm promethium 108	352 Sm samarium 109	355 Eu europium 110
401 Yb ytterbium 112	403 Lu lutetium 113	404 Hf hafnium 114	407 Ta tantalum 115	409 W tungsten 116	412 Re rhenium 117	415 Os osmium 118	416 Ir iridium 119
449 Fr francium 157	451 Ra radium 158	452 Ac actinium 159	455 Th thorium 160	457 Pa protactinium 161	459 U uranium 162	462 Np neptunium 163	464 Pu plutonium 164
501 U uranium 238	503 Np neptunium 237	504 Pu plutonium 244	506 Am americium 243	508 Cm curium 247	510 Bk berkelium 247	512 Cf californium 251	514 Es einsteinium 252
541 U uranium 288	543 Np neptunium 286	544 Pu plutonium 294	546 Am americium 291	548 Cm curium 295	550 Bk berkelium 299	552 Cf californium 307	554 Es einsteinium 315
581 U uranium 352	583 Np neptunium 354	584 Pu plutonium 360	586 Am americium 367	588 Cm curium 375	590 Bk berkelium 383	592 Cf californium 391	594 Es einsteinium 401
621 U uranium 426	623 Np neptunium 424	624 Pu plutonium 432	626 Am americium 439	628 Cm curium 447	630 Bk berkelium 455	632 Cf californium 463	634 Es einsteinium 473
661 U uranium 500	663 Np neptunium 502	664 Pu plutonium 510	666 Am americium 517	668 Cm curium 525	670 Bk berkelium 533	672 Cf californium 541	674 Es einsteinium 551
701 U uranium 574	703 Np neptunium 576	704 Pu plutonium 582	706 Am americium 589	708 Cm curium 597	710 Bk berkelium 605	712 Cf californium 613	714 Es einsteinium 623
741 U uranium 648	743 Np neptunium 650	744 Pu plutonium 658	746 Am americium 665	748 Cm curium 673	750 Bk berkelium 681	752 Cf californium 689	754 Es einsteinium 699
781 U uranium 722	783 Np neptunium 724	784 Pu plutonium 730	786 Am americium 737	788 Cm curium 745	790 Bk berkelium 753	792 Cf californium 761	794 Es einsteinium 771
821 U uranium 796	823 Np neptunium 798	824 Pu plutonium 806	826 Am americium 813	828 Cm curium 821	830 Bk berkelium 829	832 Cf californium 837	834 Es einsteinium 847
861 U uranium 870	863 Np neptunium 872	864 Pu plutonium 880	866 Am americium 887	868 Cm curium 895	870 Bk berkelium 903	872 Cf californium 911	874 Es einsteinium 921
901 U uranium 944	903 Np neptunium 946	904 Pu plutonium 954	906 Am americium 961	908 Cm curium 969	910 Bk berkelium 977	912 Cf californium 985	914 Es einsteinium 995
941 U uranium 1018	943 Np neptunium 1020	944 Pu plutonium 1026	946 Am americium 1033	948 Cm curium 1041	950 Bk berkelium 1049	952 Cf californium 1057	954 Es einsteinium 1067
981 U uranium 1092	983 Np neptunium 1094	984 Pu plutonium 1102	986 Am americium 1109	988 Cm curium 1117	990 Bk berkelium 1125	992 Cf californium 1133	994 Es einsteinium 1143
1021 U uranium 1166	1023 Np neptunium 1168	1024 Pu plutonium 1176	1026 Am americium 1183	1028 Cm curium 1191	1030 Bk berkelium 1209	1032 Cf californium 1217	1034 Es einsteinium 1227
1061 U uranium 1240	1063 Np neptunium 1242	1064 Pu plutonium 1250	1066 Am americium 1257	1068 Cm curium 1265	1070 Bk berkelium 1273	1072 Cf californium 1281	1074 Es einsteinium 1291
1101 U uranium 1314	1103 Np neptunium 1316	1104 Pu plutonium 1324	1106 Am americium 1331	1108 Cm curium 1339	1110 Bk berkelium 1347	1112 Cf californium 1355	1114 Es einsteinium 1365
1141 U uranium 1388	1143 Np neptunium 1390	1144 Pu plutonium 1398	1146 Am americium 1405	1148 Cm curium 1413	1150 Bk berkelium 1421	1152 Cf californium 1429	1154 Es einsteinium 1439
1181 U uranium 1462	1183 Np neptunium 1464	1184 Pu plutonium 1472	1186 Am americium 1479	1188 Cm curium 1487	1190 Bk berkelium 1495	1192 Cf californium 1503	1194 Es einsteinium 1513
1221 U uranium 1536	1223 Np neptunium 1538	1224 Pu plutonium 1546	1226 Am americium 1553	1228 Cm curium 1561	1230 Bk berkelium 1569	1232 Cf californium 1577	1234 Es einsteinium 1587
1261 U uranium 1610	1263 Np neptunium 1612	1264 Pu plutonium 1620	1266 Am americium 1627	1268 Cm curium 1635	1270 Bk berkelium 1643	1272 Cf californium 1651	1274 Es einsteinium 1661
1301 U uranium 1684	1303 Np neptunium 1686	1304 Pu plutonium 1694	1306 Am americium 1701	1308 Cm curium 1709	1310 Bk berkelium 1717	1312 Cf californium 1725	1314 Es einsteinium 1735
1341 U uranium 1758	1343 Np neptunium 1760	1344 Pu plutonium 1768	1346 Am americium 1775	1348 Cm curium 1783	1350 Bk berkelium 1791	1352 Cf californium 1799	1354 Es einsteinium 1809
1381 U uranium 1832	1383 Np neptunium 1834	1384 Pu plutonium 1842	1386 Am americium 1849	1388 Cm curium 1857	1390 Bk berkelium 1865	1392 Cf californium 1873	1394 Es einsteinium 1883
1421 U uranium 1906	1423 Np neptunium 1908	1424 Pu plutonium 1916	1426 Am americium 1923	1428 Cm curium 1931	1430 Bk berkelium 1939	1432 Cf californium 1947	1434 Es einsteinium 1957
1461 U uranium 1980	1463 Np neptunium 1982	1464 Pu plutonium 1990	1466 Am americium 1997	1468 Cm curium 2005	1470 Bk berkelium 2013	1472 Cf californium 2021	1474 Es einsteinium 2031
1501 U uranium 2054	1503 Np neptunium 2056	1504 Pu plutonium 2064	1506 Am americium 2071	1508 Cm curium 2079	1510 Bk berkelium 2087	1512 Cf californium 2095	1514 Es einsteinium 2105
1541 U uranium 2128	1543 Np neptunium 2130	1544 Pu plutonium 2138	1546 Am americium 2145	1548 Cm curium 2153	1550 Bk berkelium 2161	1552 Cf californium 2169	1554 Es einsteinium 2179
1581 U uranium 2202	1583 Np neptunium 2204	1584 Pu plutonium 2212	1586 Am americium 2219	1588 Cm curium 2227	1590 Bk berkelium 2235	1592 Cf californium 2243	1594 Es einsteinium 2253
1621 U uranium 2276	1623 Np neptunium 2278	1624 Pu plutonium 2286	1626 Am americium 2293	1628 Cm curium 2301	1630 Bk berkelium 2309	1632 Cf californium 2317	1634 Es einsteinium 2327
1661 U uranium 2350	1663 Np neptunium 2352	1664 Pu plutonium 2360	1666 Am americium 2367	1668 Cm curium 2375	1670 Bk berkelium 2383	1672 Cf californium 2391	1674 Es einsteinium 2401
1701 U uranium 2424	1703 Np neptunium 2426	1704 Pu plutonium 2434	1706 Am americium 2441	1708 Cm curium 2449	1710 Bk berkelium 2457	1712 Cf californium 2465	1714 Es einsteinium 2475
1741 U uranium 2498	1743 Np neptunium 2500	1744 Pu plutonium 2508	1746 Am americium 2515	1748 Cm curium 2523	1750 Bk berkelium 2531	1752 Cf californium 2539	1754 Es einsteinium 2549
1781 U uranium 2572	1783 Np neptunium 2574	1784 Pu plutonium 2582	1786 Am americium 2589	1788 Cm curium 2597	1790 Bk berkelium 2605	1792 Cf californium 2613	1794 Es einsteinium 2623
1821 U uranium 2646	1823 Np neptunium 2648	1824 Pu plutonium 2656	1826 Am americium 2663	1828 Cm curium 2671	1830 Bk berkelium 2679	1832 Cf californium 2687	1834 Es einsteinium 2697
1861 U uranium 2720	1863 Np neptunium 2722	1864 Pu plutonium 2730	1866 Am americium 2737	1868 Cm curium 2745	1870 Bk berkelium 2753	1872 Cf californium 2761	1874 Es einsteinium 2771
1901 U uranium 2794	1903 Np neptunium 2796	1904 Pu plutonium 2804	1906 Am americium 2811	1908 Cm curium 2819	1910 Bk berkelium 2827	1912 Cf californium 2835	1914 Es einsteinium 2845
1941 U uranium 2868	1943 Np neptunium 2870	1944 Pu plutonium 2878	1946 Am americium 2885	1948 Cm curium 2893	1950 Bk berkelium 2901	1952 Cf californium 2909	1954 Es einsteinium 2919
1981 U uranium 2942	1983 Np neptunium 2944	1984 Pu plutonium 2952	1986 Am americium 2959	1988 Cm curium 2967	1990 Bk berkelium 2975	1992 Cf californium 2983	1994 Es einsteinium 2993
2021 U uranium 3016	2023 Np neptunium 3018	2024 Pu plutonium 3026	2026 Am americium 3033	2028 Cm curium 3041	2030 Bk berkelium 3049	2032 Cf californium 3057	2034 Es einsteinium 3067
2061 U uranium 3090	2063 Np neptunium 3092	2064 Pu plutonium 3100	2066 Am americium 3107	2068 Cm curium 3115	2070 Bk berkelium 3123	2072 Cf californium 3131	2074 Es einsteinium 3141
2101 U uranium 3164	2103 Np neptunium 3166	2104 Pu plutonium 3174	2106 Am americium 3181	2108 Cm curium 3189	2110 Bk berkelium 3197	2112 Cf californium 3205	2114 Es einsteinium 3215
2141 U uranium 3238	2143 Np neptunium 3240	2144 Pu plutonium 3248	2146 Am americium 3255	2148 Cm curium 3263	2150 Bk berkelium 3271	2152 Cf californium 3279	2154 Es einsteinium 3289
2181 U uranium 3312	2183 Np neptunium 3314	2184 Pu plutonium 3322	2186 Am americium 3329	2188 Cm curium 3337	2190 Bk berkelium 3345	2192 Cf californium 3353	2194 Es einsteinium 3363
2221 U uranium 3386	2223 Np neptunium 3388	2224 Pu plutonium 3396	2226 Am americium 3403	2228 Cm curium 3411	2230 Bk berkelium 3419	2232 Cf californium 3427	2234 Es einsteinium 3437
2261 U uranium 3460	2263 Np neptunium 3462	2264 Pu plutonium 3470	2266 Am americium 3477	2268 Cm curium 3485	2270 Bk berkelium 3493	2272 Cf californium 3501	2274 Es einsteinium 3511
2301 U uranium 3534	2303 Np neptunium 3536	2304 Pu plutonium 3544	2306 Am americium 3551	2308 Cm curium 3559	2310 Bk berkelium 3567	2312 Cf californium 3575	2314 Es einsteinium 3585
2341 U uranium 3608	2343 Np neptunium 3610	234					

1. Chromatography can be used to separate the substances in a mixture.
- (a) Diagram 1 shows the apparatus used to separate the different dyes in a food colouring.

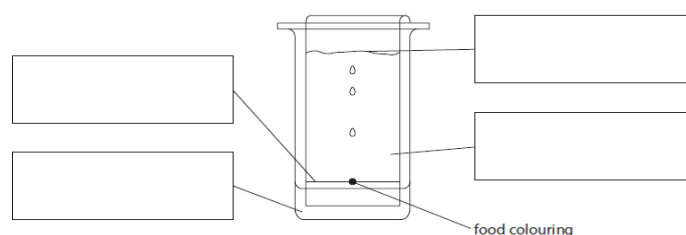


Diagram 1

The box lists some terms used in chromatography.

baseline	chromatography paper
solvent	solvent front

Use the terms from the box to label diagram 1. (3)

- (b) Diagram 2 shows a chromatogram produced using four different food colourings, P, Q, R and S.

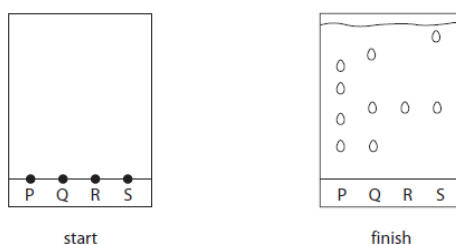


Diagram 2

- (i) Which food colouring contains only one dye? (1)

- ☐ A P
☐ B Q
☐ C R
☐ D S

- (ii) Which food colourings have one dye in common? (1)

- ☐ A P, Q and R
☐ B P, R and S
☐ C Q, R and S
☐ D P, Q, R and S

- (iii) Explain which food colouring contains the largest number of dyes. (2)

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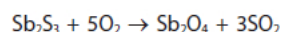
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(Total for question = 7 marks)

2. Antimony, Sb, is an element in Group 5 of the Periodic Table.
The mineral, stibnite, contains antimony sulfide, Sb_2S_3
Antimony can be obtained from stibnite in a two-stage process.

Stage 1 stibnite is roasted in air



Stage 2 the oxide produced is heated with carbon to form antimony and carbon dioxide

- (a) (i) State why the sulfur in stage 1 is said to be oxidised. (1)

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.....

- (ii) Complete the equation for the reaction in stage 2. (1)



- (b) Bismuth is another element in Group 5 of the Periodic Table.
Bismuth forms an oxide, Bi_2O_3 , which has a giant ionic structure.

- (i) Give the formula of the bismuth ion in bismuth oxide. (1)

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- (ii) Explain why bismuth oxide has a high melting point. (2)

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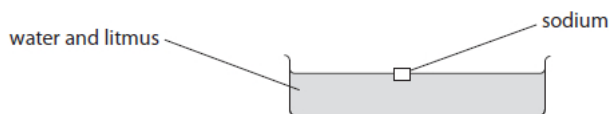
- (iii) Bismuth oxide reacts with dilute hydrochloric acid to form bismuth chloride.

- Write a chemical equation for this reaction. (2)

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(Total for question = 7 marks)

3. A teacher investigates the reaction between sodium and water.
The teacher fills a trough with water.
She adds a few drops of litmus solution to the water, and then adds a piece of sodium.



- (a) The sodium floats on the water. It reacts with the water and produces bubbles of hydrogen gas.

(i) State two other observations that are made during the reaction. (2)

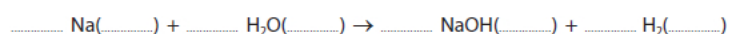
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(ii) Balance the equation for the reaction between sodium and water.
Include the state symbols. (2)



- (b) Lithium and potassium react in a similar way to sodium when added to water.

(i) State why they have a similar reaction in terms of the electronic configurations of their atoms. (1)

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(ii) Place the elements lithium, potassium and sodium in order of reactivity. (1)

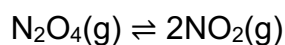
most reactive

.....

least reactive

(Total for question = 6 marks)

4. Dinitrogen tetraoxide, N_2O_4 , is a colourless gas.
Nitrogen dioxide, NO_2 , is a brown gas.
The two gases can exist together in dynamic equilibrium according to the equation



- (a) Explain what is meant by the term dynamic equilibrium. (2)

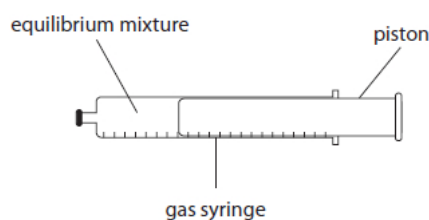
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- (b) Some N_2O_4 and some NO_2 are put into a sealed gas syringe and allowed to form an equilibrium mixture.



This equilibrium mixture is brown.

- (i) The pressure of the gas in the syringe is increased by pushing in the piston. The mixture is then allowed to reach a new equilibrium at the same temperature as before.

Explain why the new equilibrium mixture contains less NO_2 than the original equilibrium mixture. (2)

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(ii) A student suggests that the new equilibrium mixture would be lighter in colour than the original equilibrium mixture, as there is now less NO_2 present. Suggest why the new equilibrium mixture is actually darker than the original.

(1)

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(c) Carbon monoxide, CO , and oxides of nitrogen are produced in a car engine when petrol is burned.

These oxides can be partly removed by using a catalytic converter fitted to the car's exhaust system.

(i) State how oxides of nitrogen are produced in the car engine. (1)

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(ii) Give a disadvantage of allowing oxides of nitrogen to escape into the atmosphere. (1)

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(iii) Write a chemical equation for the reaction between nitrogen monoxide, NO , and carbon monoxide to form carbon dioxide and nitrogen. (1)

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(Total for question = 8 marks)

5. When a bottle of wine is left open for several days, some of the ethanol in the wine turns to ethanoic acid, CH_3COOH

(a) A scientist uses a titration method to investigate how much ethanoic acid is formed if a bottle of white wine is left open for one week.
She uses this method.

- fill a burette with the white wine and record the reading
- add 25.0 cm^3 of sodium hydroxide solution to a conical flask
- add a few drops of phenolphthalein indicator to the flask
- swirl the flask continuously while adding wine from the burette
- add the wine drop by drop near the end point
- record the reading at the end point

(i) Name the piece of apparatus that would be most suitable for measuring the 25.0 cm^3 of sodium hydroxide solution. (1)

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(ii) Suggest why red wine would not be suitable to use for this investigation. (1)

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(iii) State why she swirls the flask continuously. (1)

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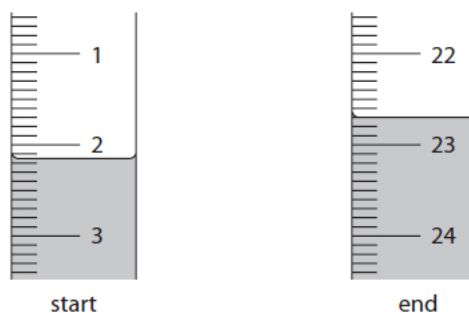
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(iv) State why she adds the wine drop by drop near the end point. (1)

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- (b) The diagram shows the burette readings at the start and end of one of the titrations.



Use the readings to complete the table.
Give your values to the nearest 0.05 cm³.

(3)

burette reading at end	
burette reading at start	
volume of wine added in cm ³	

- (c) The scientist repeats the titration four more times.
The table shows her results for these four titrations.

titration number	1	2	3	4
volume of wine added in cm ³	20.40	20.10	20.35	20.45
concordant results				

Concordant results are those within 0.20 cm³ of each other.

- (i) Add ticks (✓) to the table to show the concordant results.

(1)

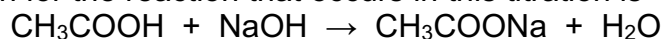
- (ii) Use your ticked results to calculate the mean (average) volume of wine added.

(2)

mean volume of wine added = cm³

- (d) Another scientist repeats the titration with a different bottle of white wine that has been left open for a week.

The equation for the reaction that occurs in this titration is



The mean volume of wine added is 19.50 cm^3 .

- (i) The concentration of the sodium hydroxide solution is 0.0500 mol/dm^3 .

Calculate the amount, in moles, of NaOH in 25.0 cm^3 of sodium hydroxide solution. (2)

amount of NaOH = mol

- (ii) Deduce the amount, in moles, of CH_3COOH in 19.50 cm^3 of the wine. (1)

amount of CH_3COOH = mol

- (iii) Calculate the concentration, in mol/dm^3 , of CH_3COOH in the wine. (2)

concentration of CH_3COOH = mol/dm^3

(Total for question = 15 marks)

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6. This is a method used to measure the solubility of a solid in water:

- add an excess of solid to some water in a boiling tube and stir
- measure the temperature of the saturated solution formed
- weigh an empty evaporating basin
- pour some of the saturated solution into the evaporating basin
- weigh the basin and contents
- heat the evaporating basin to remove all of the water
- weigh the evaporating basin and remaining solid.

(a) The table shows the results of an experiment using this method.

mass of evaporating basin / g	89.6
mass of evaporating basin + saturated solution / g	115.8
mass of evaporating basin + solid / g	94.9

Calculate the mass of solid obtained and the mass of water removed. (2)

mass of solid = g

mass of water = g

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.
Calculate the solubility of the solid, in g per 100 g of water, at this temperature. (2)

solubility = g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this strong heating would affect the value of the calculated solubility of the solid. (3)

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(Total for question = 7 marks)

7. This question is about metals.

(a) Which statement describes metallic bonding? (1)

- ☐ A electrostatic attraction between oppositely charged ions
- ☐ B electrostatic attraction between the nuclei of two atoms and a pair of electrons shared between them
- ☐ C electrostatic attraction between positively charged particles and delocalised electrons
- ☐ D electrostatic attraction between atoms

(b) Aluminium is malleable and can be easily shaped to make saucepans used for cooking food.

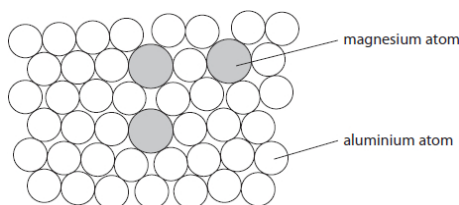
State two other properties of aluminium that make it suitable for saucepans used for cooking food. (2)

1

2

(c) Magnalium is an alloy of aluminium and magnesium.

The diagram shows how the atoms are arranged in this alloy.



(i) State what is meant by the term alloy. (1)

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(ii) Explain why magnalium is harder than aluminium. (3)

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(Total for question = 7 marks)

8. Polymers can be classified as addition polymers or condensation polymers.

(a) An addition polymer can be formed from the monomer $\text{CH}_2 = \text{CHCl}$

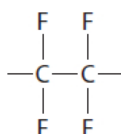
(i) Name this monomer. (1)

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(ii) Name the addition polymer formed from this monomer. (1)

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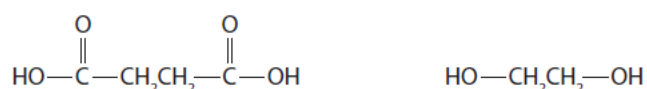
(b) The diagram shows the repeat unit of a different addition polymer.



Draw the displayed formula of the monomer used to make this polymer. (1)

(c) Polyesters are condensation polymers.

The structures of two monomers that are used to make a polyester are:



(i) Draw the structure of the repeat unit of the polyester formed from these two monomers. (2)

(ii) Identify the small molecule formed when these two monomers form the polyester. (1)

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(Total for question = 6 marks)

9. This question is about the reactions of carboxylic acids.

(a) Carboxylic acids react with solutions of metal carbonates.

(i) Complete the chemical equation for the reaction of ethanoic acid, CH_3COOH , with potassium carbonate solution. (2)



(ii) State what you would see in this reaction. (1)

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(b) The ester, ethyl ethanoate, can be prepared by reacting ethanol with ethanoic acid.

This is the method for the preparation.

- mix equal amounts of ethanoic acid and ethanol in a boiling tube
- add a few drops of concentrated sulfuric acid
- place the boiling tube in a hot water bath for several minutes

(i) State the role of concentrated sulfuric acid in this reaction. (1)

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(ii) Suggest why the mixture is heated in a water bath rather than directly with a Bunsen burner flame. (1)

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(iii) State how you would know that ethyl ethanoate has formed. (1)

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.....

(c) Another ester, methyl propanoate, can be prepared by reacting methanol with propanoic acid.

(i) Draw the displayed formulae of methanol, propanoic acid and the ester, methyl propanoate. (3)

methanol	propanoic acid
----------	----------------

methyl propanoate

(ii) Give the name of the other product of this reaction. (1)

.....

(d) Give one use of esters. (1)

.....

(Total for question = 11 marks)

10. Ethanol can be manufactured by fermentation or by the direct hydration of ethene.

(a) In Brazil, the main source of sugar for fermentation is sugar cane.

- sugar cane is added to water
- sugar cane contains sucrose ($C_{12}H_{22}O_{11}$) that dissolves in the water
- during the fermentation process the sucrose is broken down into glucose ($C_6H_{12}O_6$)
- this glucose is then converted into ethanol (C_2H_5OH) and carbon dioxide

(i) Name the substance that is added to the sucrose solution to allow fermentation to take place. (1)

.....

(ii) Complete the equation for the conversion of sucrose into glucose. (1)

$C_{12}H_{22}O_{11} + H_2O \rightarrow$

(iii) Write a chemical equation for the conversion of glucose into ethanol and carbon dioxide. (1)

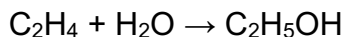
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(iv) Fermentation produces a solution that is a mixture of ethanol and water. Which of these is the most effective method of obtaining ethanol from this mixture? (1)

- ☐ A crystallisation
- ☐ B filtration
- ☐ C fractional distillation
- ☐ D simple distillation

(b) In the direct hydration method, ethene reacts with steam.

The equation for the reaction is



(i) Name the catalyst used in this reaction. (1)

.....

(ii) State the temperature and pressure used in this reaction. (2)

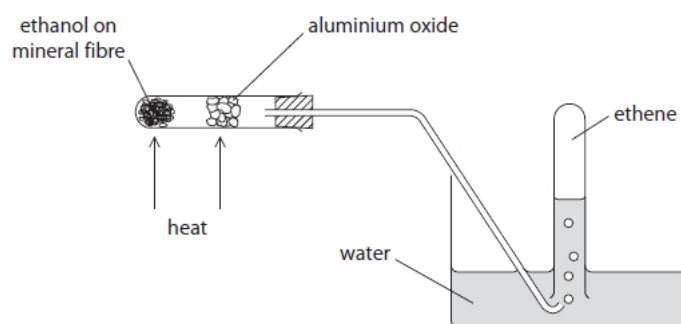
temperature

.....

pressure

.....

(c) This apparatus is used to convert ethanol into ethene.



(i) Name the type of reaction taking place. (1)

.....

(ii) State the function of the aluminium oxide in this reaction. (1)

.....

(d) Ethene belongs to a homologous series of unsaturated hydrocarbons called alkenes.

(i) State what is meant by the term unsaturated (1)

.....

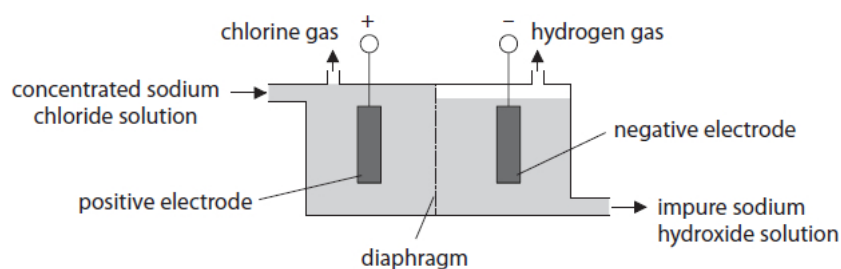
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(ii) State the colour change that is observed when bromine water is shaken with ethene in a test tube. (2)

from to

(Total for question = 12 marks)

11. The diagram shows the electrolysis of concentrated sodium chloride solution in a diaphragm cell.



- (a) (i) The ionic half-equation for the reaction at the positive electrode is



Use this equation to explain why oxidation occurs at the positive electrode.

(2)

.....

.....

.....

.....

- (ii) At the negative electrode, water molecules gain electrons to form hydroxide ions and hydrogen gas.

Complete the ionic half-equation for this reaction.

(2)



- (b) Chlorine reacts with sodium hydroxide to produce a mixture of water, sodium chloride and sodium chlorate(I), NaOCl.

Write a chemical equation for this reaction.

(1)

.....

(c) Chlorine is used in the manufacture of the addition polymer poly(chloroethene).

(i) Explain how an addition polymer is formed from its monomers. (2)

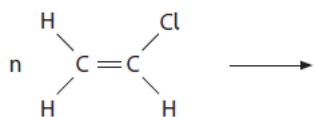
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(ii) Complete this equation by drawing the displayed formula of poly(chloroethene). (2)

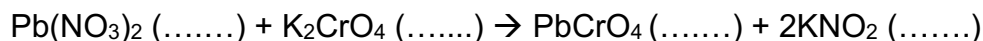


(Total for question = 9 marks)

12. A student investigates the reaction between lead(II) nitrate solution and potassium chromate solution.

(a) Lead(II) nitrate solution and potassium chromate solution react to form a yellow precipitate of lead(II) chromate and potassium nitrate solution.

(i) Complete the equation by adding the state symbols. (1)



(ii) Use information from the equation to determine the charge on the chromate ion. (1)

.....

(b) The student uses this method for her investigation.

- place 5.0 cm³ potassium chromate solution in a test tube standing in a test tube rack
- add 1.0 cm³ lead(II) nitrate solution to the test tube
allow the precipitate to settle and measure its height
- repeat the method using separate 5.0 cm³ samples of potassium chromate and adding different volumes of lead(II) nitrate solution

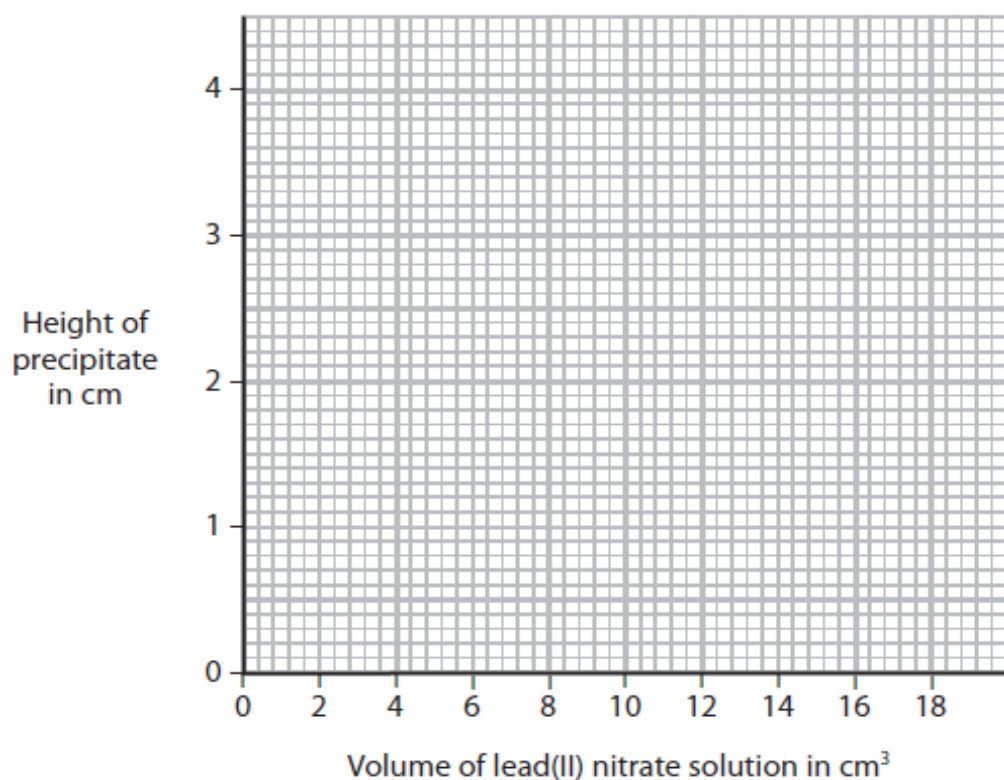
These are the student's results.

Volume of lead(II) nitrate solution in cm ³	Height of precipitate in cm
1.0	0.3
2.0	0.6
4.0	1.2
6.0	1.8
8.0	2.4
9.0	2.7
11.0	3.0
12.0	3.0
14.0	2.1
16.0	3.0
18.0	3.0

(i) Plot the student's results on the grid. (2)

(ii) Circle the anomalous result on the grid. (1)

(iii) Ignoring the anomalous result, draw a straight line of best fit through the first six points, and another straight line of best fit through the last five points. Make sure that the two lines cross. (2)



(iv) Use your graph to find the volume of lead(II) nitrate solution that reacts exactly with the 5.0 cm³ (1)

volume of lead(II) nitrate solution = cm³

(v) Suggest two possible reasons for the anomalous result. (2)

1

.....

2

.....

- (c) (i) Describe how to obtain a pure, dry sample of solid lead(II) chromate from the test tube at the end of the investigation. (3)

.....

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- (ii) Give a test to show that the potassium nitrate solution in the test tube contains potassium ions. (2)

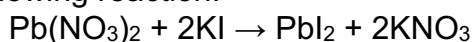
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- (d) The student does a similar experiment to produce a precipitate of lead iodide, PbI₂, using the following reaction.



He finds that 5.0 cm³ of 0.90 mol/dm³ KI solution reacts with 8.0 cm³ of Pb(NO₃)₂ solution.

Calculate the concentration, in mol/dm³, of the Pb(NO₃)₂ solution. (3)

concentration of Pb(NO₃)₂ solution = mol/dm³

(Total for question = 18 marks)

13. Lithium fluoride, LiF, and magnesium oxide, MgO, are ionic compounds.

(a) (i) Calculate the relative formula mass (M_r) of MgO. (1)

$M_r =$

(ii) Give the formulae of the two ions in LiF. (1)

..... and

(b) Explain why

- ionic compounds have high melting points
- the melting point of magnesium oxide is much higher than the melting point of lithium fluoride (4)

.....

.....

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(c) Explain why ionic compounds do not conduct electricity when solid, but do conduct electricity when molten or in aqueous solution. (2)

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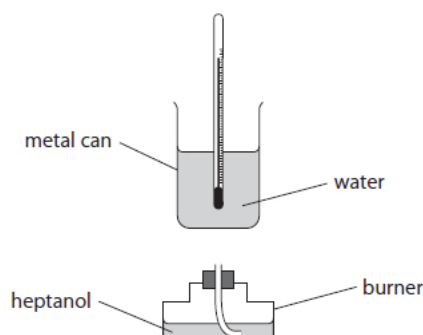
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(Total for question = 8 marks)

14. Heptanol and hydrogen are both used as fuels.

- (a) A student uses this apparatus to find the heat energy released from the combustion of heptanol.



He uses this formula

$$Q = m \times 4.18 \times \Delta T$$

[Q = heat energy released, m = mass of water in g, ΔT = change in temperature of water]

1.00 cm³ water has a mass of 1.00 g.

- (i) State the measurements that the student needs to record to find a value for the heat energy released. (2)

.....

.....

.....

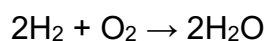
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- (ii) The student burns 0.75 g of heptanol and calculates Q to be 19 kJ. Use this information to calculate the molar enthalpy change, in kJ/mol, for the combustion of heptanol.

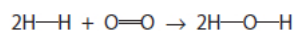
[M_r of heptanol = 114] (3)

molar enthalpy change = kJ/mol

(b) The equation for the combustion of hydrogen is



(i) This equation shows the reaction, including the covalent bonds in the molecules.



The table gives the average (mean) bond energies.

Bond	Average bond energy in kJ/mol
H—H	436
O=O	498
H—O	464

Use the values in the table to calculate the enthalpy change, ΔH , for the reaction.

Include the sign in your answer.

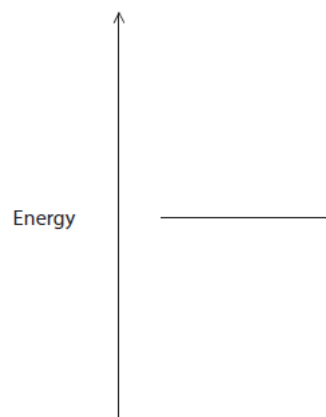
(3)

$\Delta H = \dots\dots\dots$ kJ

(ii) Complete the energy level diagram for the reaction between hydrogen and oxygen by showing the reactants and products.

Label the enthalpy change, ΔH , for the reaction.

(2)



(Total for question = 10 marks)

15. Copper pyrites is an ore of copper that contains copper, iron and sulfur.

(a) The percentage composition by mass of copper pyrites is

Cu 34.60% Fe 30.52% S 34.88%

Show, by calculation, that the empirical formula of copper pyrites is CuFeS_2 (3)

(b) Copper is obtained from copper pyrites in a two-stage process.

Stage 1

Copper pyrites is heated in air.



Stage 2

The copper(II) sulfide is separated and then heated in air. It reacts with oxygen to form copper and sulfur dioxide.

(i) State why the sulfur in the reaction in stage 1 is described as being oxidised. (1)

.....
.....

(ii) Write a chemical equation for the reaction that occurs in stage 2. (1)

.....

(c) Sulfur dioxide dissolves in water to form an acidic solution.

(i) Identify the ion that causes this solution to be acidic. (1)

.....

(ii) State how litmus paper can be used to show that the solution is acidic. (1)

.....

.....

(iii) Give two observations that are made when a piece of magnesium ribbon is added to the acidic solution. (2)

1

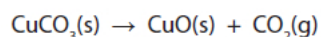
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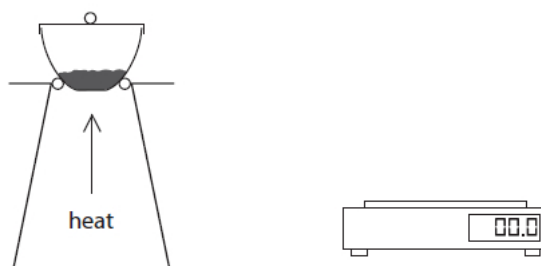
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(Total for question = 9 marks)

16. The equation for the thermal decomposition of copper(II) carbonate is



A student investigates the decomposition of copper(II) carbonate using this apparatus.



She uses this method.

- weigh the crucible, lid and copper(II) carbonate
- heat the crucible, lid and contents for 2 minutes
- allow to cool and then reweigh
- heat for a second period of 2 minutes
- allow to cool and then reweigh
- heat for a third period of 2 minutes
- allow to cool and then reweigh

The table shows the student's results.

Experiment	Mass of crucible, lid and contents in grams			
	before heating	after heating for 2 minutes	after heating for 4 minutes	after heating for 6 minutes
1	26.3	23.0	21.9	21.4
2	25.8	22.7	21.5	21.5
3	26.0	23.0	21.2	21.2
4	26.1	23.2	21.8	21.8

(a) Why does the mass decrease during heating? (1)

.....

.....

(b) State the colours of the solids in the reaction. (2)

$\text{CuCO}_3(\text{s})$

$\text{CuO}(\text{s})$

(c) (i) In which experiment might the decomposition not be complete? (1)

.....

(ii) Give a reason for your choice. (1)

.....

.....

(iii) Which statement could explain why the decomposition might not be complete? (1)

- ☐ A The student used a higher temperature than in the other experiments.
- ☐ B The student used less copper(II) carbonate than in the other experiments.
- ☐ C The student heated the crucible without a lid on.
- ☐ D The student used a spirit burner instead of a Bunsen burner.

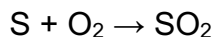
(d) In another experiment, the student calculates that she should obtain a mass of 3.7 g of CuO(s) after completely decomposing a sample of CuCO₃(s). She actually obtains a mass of 3.4 g of CuO(s). Calculate the percentage yield in her experiment. (2)

percentage yield = %

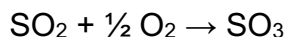
(Total for question = 8 marks)

17. Sulfuric acid can be manufactured from sulfur in a four-stage process.

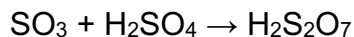
stage 1 sulfur is burned in air to form sulfur dioxide



stage 2 the sulfur dioxide is reacted with more oxygen to form sulfur trioxide



stage 3 the sulfur trioxide is absorbed in concentrated sulfuric acid to make oleum



stage 4 the oleum is carefully diluted with water to form sulfuric acid

(a) Write a chemical equation for the formation of sulfuric acid from oleum. (1)

.....

(b) A mass of 80 tonnes of sulfur is reacted with oxygen in stage 1.

Calculate the maximum mass, in tonnes, of sulfur trioxide that can be produced in stage 2.

[1 tonne = 1.0×10^6 g]

(3)

maximum mass = tonnes

(c) Calculate the minimum volume at rtp, in cubic decimetres (dm^3), of oxygen required to completely react with 64 tonnes of sulfur dioxide.

[1 mol of oxygen at rtp has a volume of 24 dm^3]

(2)

volume of oxygen = dm^3

(Total for question = 6 marks)

END OF QUESTIONS