

Write your name here

Surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

--	--	--	--	--

Candidate Number

--	--	--	--	--

Chemistry

Advanced Subsidiary

Unit 2: Application of Core Principles of Chemistry

Friday 20 October 2017 – Morning

Time: 1 hour 30 minutes

Paper Reference

WCH02/01**Candidates must have: Scientific calculator**

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
– *you should take particular care on these questions with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- Show all your working in calculations and include units where appropriate.

Turn over ►

P50786A

©2017 Pearson Education Ltd.

6/5/5/1/4/



Pearson

SECTION A

Answer ALL the questions in this section. You should aim to spend no more than 20 minutes on this section. For each question, select one answer from A to D and put a cross in the box ☐. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☐.

1 Which compound is likely to show the **most** ionic character?

- ☐ A PH_3
☐ B BH_3
☐ C NaI
☐ D KCl

(Total for Question 1 = 1 mark)

2 Which species has a similar shape to that of an ammonia molecule?

- ☐ A BH_3
☐ B CH_3^+
☐ C CH_3^-
☐ D CO_3^{2-}

(Total for Question 2 = 1 mark)

3 Which compound contains a dative covalent bond?

- ☐ A NH_3
☐ B NCl_3
☐ C NH_4Cl
☐ D CH_3NH_2

(Total for Question 3 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

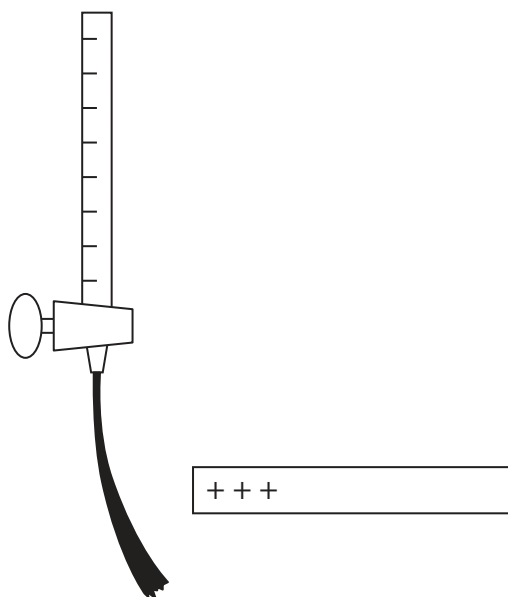
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



- 4 The diagram shows a liquid leaving a burette and passing a charged rod.



Which of the following liquids will be **most** attracted to the charged rod?

- ☐ A CCl_4
☐ B C_5H_{12}
☐ C CS_2
☐ D CHCl_3

(Total for Question 4 = 1 mark)

- 5 Which substance has more than one type of intermolecular force between its molecules in the liquid state?

- ☐ A Br_2
☐ B P_4
☐ C NH_3
☐ D CH_4

(Total for Question 5 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.



6 Which is a pure form of carbon that has **both** hexagonal and pentagonal rings in its structure?

- ☐ A Graphite
- ☐ B Diamond
- ☐ C Cyclohexane
- ☐ D Buckminsterfullerene

(Total for Question 6 = 1 mark)

7 Which species contains bond angles equal to 90° ?

- ☐ A BeCl_2
- ☐ B NH_4^+
- ☐ C SiCl_4
- ☐ D SF_6

(Total for Question 7 = 1 mark)

8 A white solid gives a lilac flame-test colour. It reacts with water, forming a strongly alkaline solution.

The solid could be

- ☐ A calcium oxide
- ☐ B potassium oxide
- ☐ C calcium chloride
- ☐ D potassium chloride

(Total for Question 8 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



9 As the atomic number of the Group 2 metals increases, the

- ☐ A first ionisation energy decreases.
- ☐ B atomic radius decreases.
- ☐ C electronegativity increases.
- ☐ D number of outer shell electrons increases.

(Total for Question 9 = 1 mark)

10 Which Group 2 hydroxide is the most soluble in water?

- ☐ A Barium hydroxide
- ☐ B Calcium hydroxide
- ☐ C Magnesium hydroxide
- ☐ D Strontium hydroxide

(Total for Question 10 = 1 mark)

11 What is the trend in bond energies for the sequence of molecules chlorine to bromine to iodine?

- ☐ A Decreases
- ☐ B Decreases to bromine then increases
- ☐ C Increases
- ☐ D Increases to bromine then decreases

(Total for Question 11 = 1 mark)

12 What is seen when concentrated sulfuric acid is added to solid sodium chloride at room temperature?

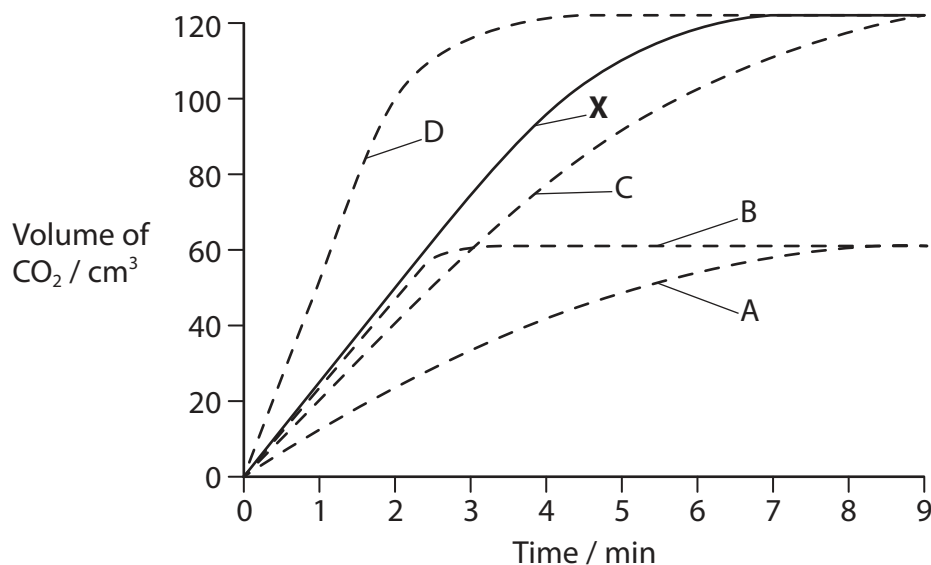
- ☐ A Green gas
- ☐ B Steamy fumes
- ☐ C White smoke
- ☐ D Yellow solid

(Total for Question 12 = 1 mark)



- 13 Curve **X** was obtained when 0.50 g of calcium carbonate **powder** reacted with excess dilute hydrochloric acid at 20°C.

Which curve best represents the reaction of a single 0.25 g **chip** of calcium carbonate with excess of the same dilute hydrochloric acid at the same temperature?



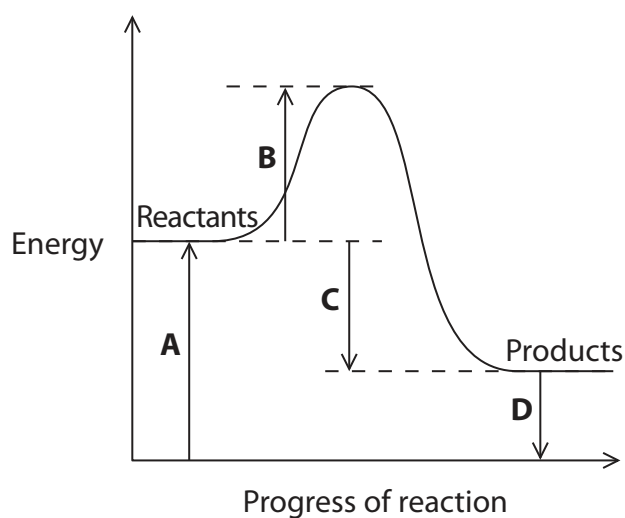
- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 13 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.



14 Consider the following reaction profile.



Which energy change would alter if a catalyst were added to the reaction?

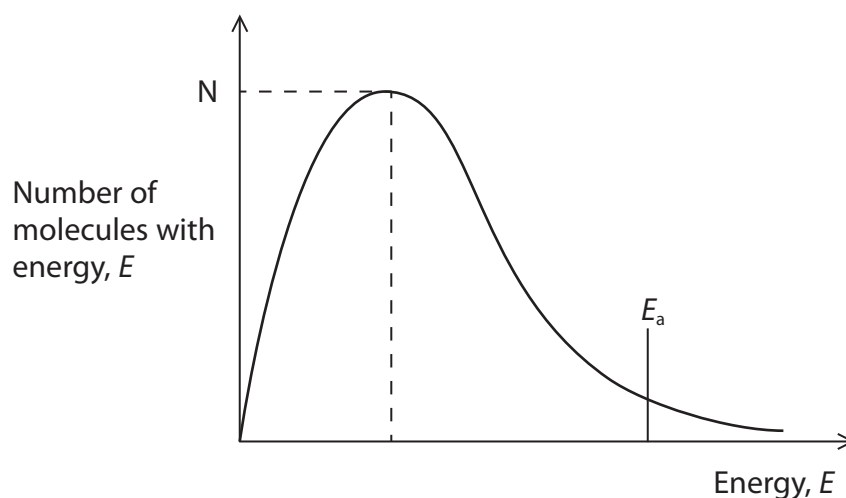
- ☒ A
- ☒ B
- ☒ C
- ☒ D

(Total for Question 14 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.



- 15 The Maxwell–Boltzmann distribution for a reaction mixture is shown below.
 E_a is the activation energy and N is the number of molecules with the most probable energy.



What is the effect of **increasing** the temperature on E_a and on N ?

	Effect on E_a	Effect on N
<input type="checkbox"/> A	increases	decreases
<input type="checkbox"/> B	increases	increases
<input type="checkbox"/> C	constant	decreases
<input type="checkbox"/> D	constant	increases

(Total for Question 15 = 1 mark)

- 16 Which statement regarding a chemical reaction at equilibrium is **always** true?

- ☐ A The rates of the forward and backward reactions are equal.
☐ B The concentrations of reactants and products are equal.
☐ C The forward and backward reactions have stopped.
☐ D The addition of a catalyst changes the position of equilibrium.

(Total for Question 16 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



17 In which system will a change in pressure have **no** effect on the position of equilibrium?

- ☐ A $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$
- ☐ B $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$
- ☐ C $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$
- ☐ D $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$

(Total for Question 17 = 1 mark)

18 1.00 dm^3 of a solution with a **sodium** ion concentration of $0.100 \text{ mol dm}^{-3}$ is required. What volume of $0.200 \text{ mol dm}^{-3}$ sodium sulfate solution is needed to make this solution by dilution with water?

- ☐ A 100 cm^3
- ☐ B 250 cm^3
- ☐ C 500 cm^3
- ☐ D 1000 cm^3

(Total for Question 18 = 1 mark)

19 Propan-2-ol is produced from the reaction of propene and steam. Assuming a 65% yield, what is the mass of propene required to produce 390 g of propan-2-ol?

[Molar masses / g mol^{-1} propene = 42.0 propan-2-ol = 60.0]

- ☐ A 254 g
- ☐ B 273 g
- ☐ C 420 g
- ☐ D 600 g

(Total for Question 19 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.



20 Propene can be formed by heating 1-bromopropane with alcoholic potassium hydroxide solution.

This reaction is an example of

- ☐ **A** reduction.
- ☐ **B** hydrolysis.
- ☐ **C** elimination.
- ☐ **D** condensation.

(Total for Question 20 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



SECTION B

Answer ALL the questions. Write your answers in the spaces provided.

21 There are **four** isomeric alcohols with the molecular formula $C_4H_{10}O$.

(a) Two of these alcohols are butan-1-ol ($CH_3CH_2CH_2CH_2OH$) and butan-2-ol. The other two isomers are alcohol **X** and alcohol **Y**.

(i) Draw the **displayed** formula for butan-2-ol, showing all the bonds.

(1)

(ii) Alcohol **X** does not react with acidified potassium dichromate(VI) solution. Give the structure of alcohol **X**.

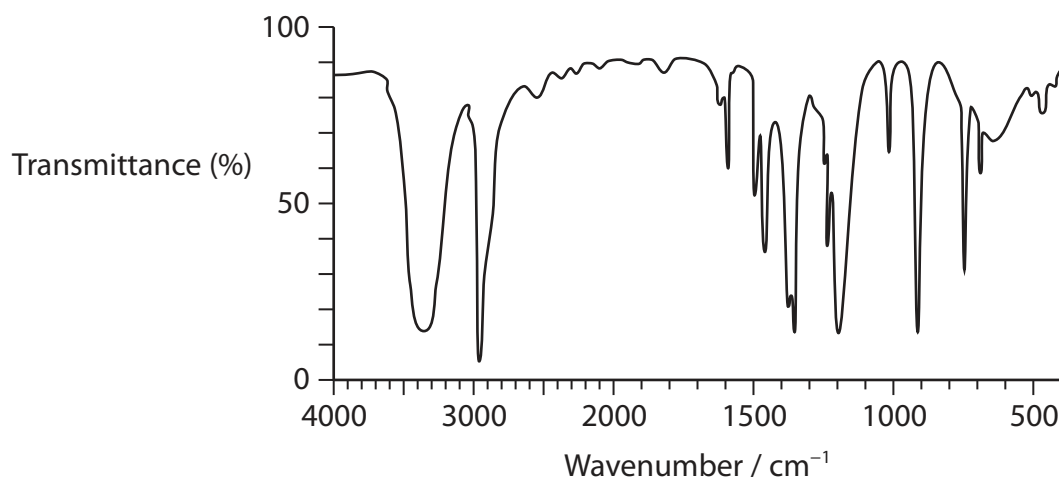
(1)

(iii) **Name** the fourth isomer, alcohol **Y**.

(1)



(b) The infrared spectrum of one of the four alcohols with the formula $C_4H_{10}O$ is shown.



Some infrared data is given in the table below.

Bond	Wavenumber / cm^{-1}
C—H stretch, alkane	2962 — 2853
C—H stretch, alkene	3100 — 3010
O—H stretch (weak), carboxylic acids	3300 — 2500
O—H stretch (broad), alcohols	3750 — 3200

- (i) Circle the relevant part of the infrared spectrum which confirms that this isomer is an alcohol. (1)
- (ii) State how the infrared spectrum can be used to identify which one of the four alcohols with the formula $C_4H_{10}O$ is present. (1)

.....

.....

.....

.....



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c) Butan-1-ol reacts with acidified potassium dichromate(VI) solution to form two different organic products, depending on the reaction conditions.

(i) Classify the alcohol butan-1-ol.

(1)

(ii) Draw the **displayed** formula of the organic product formed when butan-1-ol is heated under reflux with acidified potassium dichromate(VI) solution.

(1)

(iii) Draw the **displayed** formula of the organic product formed when butan-1-ol is gently heated with acidified potassium dichromate(VI) solution and the product distilled off as it is formed.

(1)

(iv) State the type of reaction butan-1-ol undergoes in both (c)(ii) and (c)(iii).

(1)

Type of reaction:

(Total for Question 21 = 9 marks)



22 This question is about halogenoalkanes.

- (a) A student investigates the relative rate of hydrolysis of three halogenoalkanes.

The student mixes 5 cm³ of ethanol with five drops of halogenoalkane. This mixture is warmed to 50 °C in a water bath. The student adds 5 cm³ of aqueous silver nitrate, also heated to 50 °C, to the halogenoalkane. The time taken for a precipitate to form is recorded in a table.

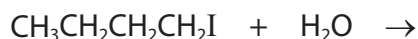
Halogenoalkane	Time taken for a precipitate to form /s
CH ₃ CH ₂ CH ₂ CH ₂ Cl	120
CH ₃ CH ₂ CH ₂ CH ₂ Br	62
CH ₃ CH ₂ CH ₂ CH ₂ I	20

- (i) Explain why ethanol is added to each halogenoalkane.

(1)

- (ii) Complete the equation for the hydrolysis of 1-iodobutane, CH
- ₃
- CH
- ₂
- CH
- ₂
- CH
- ₂
- I.

(1)



- (iii) Give the
- name**
- of the organic product which forms in each of these hydrolysis reactions.

(1)

- (iv) Classify the type and mechanism of the reaction occurring when halogenoalkanes undergo hydrolysis, under the conditions described in this investigation.

(2)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



*(v) Describe and explain the trend in the rates of hydrolysis of the three halogenoalkanes.

(3)

(b) Chlorofluorocarbons (CFCs) are halogenoalkanes which have been shown to play a role in ozone depletion. Halogenoalkanes, which contain fluorine as the only halogen (HFCs), do not harm the ozone layer.

Following the Montreal Protocol of September 1987, CFCs have been replaced in many applications by HFCs.

*(i) Explain why CFCs deplete the ozone layer, whereas HFCs do not.

(2)

(ii) Suggest a reason why ozone depletion still occurs.

(1)

(Total for Question 22 = 11 marks)



23 A student was asked to find the identity of a Group 1 metal hydroxide by titration.

The student was given the following outline method.

- Fill a burette with dilute hydrochloric acid
- Accurately weigh about 1.14 g of the metal hydroxide
- **Carefully** dissolve all the metal hydroxide in water, transfer the solution and washings to a volumetric flask and then add more water to make 250.0 cm^3 of solution
- Thoroughly mix the contents of the volumetric flask
- Accurately transfer 25.0 cm^3 of this solution to a conical flask
- Add two or three drops of a suitable indicator to the solution in the flask
- Carry out a rough titration of the solution in the flask with the dilute hydrochloric acid
- Accurately repeat the titration several times and calculate a mean titre.

The student's results and relevant data are shown.

Mass of metal hydroxide = 1.14 g

Concentration of the hydrochloric acid = 0.730 g in 100 cm^3 of solution

Mean titre = 23.80 cm^3

- (a) Give a reason why the student does not simply add 1.14 g of the metal hydroxide to 250 cm^3 of water.

(1)

- (b) Name the most suitable piece of apparatus for transferring 25.0 cm^3 of the metal hydroxide solution to the conical flask.

(1)

- (c) Name a suitable indicator to add to the solution in the conical flask and give the colour change at the end-point.

(3)

Colour change from to

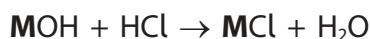
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



- (d) The equation for the reaction between the metal hydroxide and hydrochloric acid is shown. The letter **M** represents the unknown Group 1 metal.

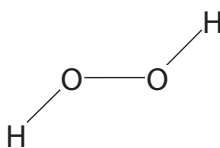


- (i) Calculate the concentration, in mol dm^{-3} , of the hydrochloric acid in the burette. (2)
- (ii) Calculate the number of moles of hydrochloric acid used in the titration. (1)
- (iii) Deduce the number of moles of **MOH** in 25.0 cm^3 of solution. (1)
- (iv) Calculate the total number of moles of **MOH** in the original solution. (1)
- (v) Calculate the molar mass of **MOH**, in g mol^{-1} . (1)
- (vi) Deduce the Group 1 metal present in the compound **MOH**. (1)

(Total for Question 23 = 12 marks)



24 A hydrogen peroxide molecule can be represented by the structure shown.



(a) Suggest a value for the H—O—O bond angle.

(1)

(b) Hydrogen peroxide dissolves in water.

(i) State the strongest type of interaction that occurs between molecules of hydrogen peroxide and water.

(1)

(ii) Draw a diagram to show the interaction named in (b)(i) between one molecule of hydrogen peroxide and one molecule of water. Show any relevant lone pairs and dipoles in your diagram.

(3)

*(c) Explain, in terms of electronegativity, why the boiling temperature of H_2S_2 is lower than that of H_2O_2 .

(2)

(Total for Question 24 = 7 marks)

TOTAL FOR SECTION B = 39 MARKS

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



SECTION C

Answer ALL the questions. Write your answers in the spaces provided.

- 25** This question is about some aspects of the chemistry of Group 7 elements.
The elements in this group can also be described as p-block elements.
The elements chlorine, bromine and iodine can all be extracted from sea water.

The bromine in sea water is present as bromide ions, Br^- .

The extraction of bromine from sea water occurs in four main stages.

Stage 1: Formation of bromine when gaseous chlorine molecules are bubbled into an aqueous solution of bromide ions

Stage 2: Removal of bromine vapour

Stage 3: Production of hydrobromic acid solution from bromine

Stage 4: Oxidation of hydrobromic acid to bromine.

- (a) State why the halogens are described as p-block elements.

(1)

- (b) Give the physical states of bromine and iodine at room temperature.

(2)

Bromine

Iodine



- (c) (i) Give an **ionic** equation for the reaction occurring in Stage 1.
Include state symbols in your answer.

(2)

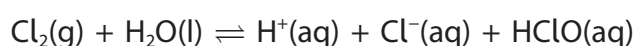
- (ii) Describe what you would **see** when the reaction in (c)(i) is carried out.

(1)

- (iii) State the role of the chlorine during the reaction in (c)(i).
Justify your answer in terms of electron transfer.

(2)

- *(d) If Stage 1 is carried out under conditions of high acidity, this prevents the disproportionation of chlorine molecules.



Explain, in terms of the above equilibrium, why this is so.

(2)



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(e) In Stage 3, bromine vapour is converted into hydrobromic acid by the reaction of bromine with a mixture of sulfur dioxide and water vapour.

- (i) Give the half-equation for the formation of bromide ions from bromine molecules. State symbols are not required.

(1)

- (ii) Give the half-equation for the reaction between sulfur dioxide and water molecules to form hydrogen ions and sulfate(VI) ions. State symbols are not required.

(1)

- (iii) Hence write the ionic equation for the reaction between bromine and sulfur dioxide, in the presence of water, to form hydrogen ions, bromide ions and sulfate(VI) ions. State symbols are not required.

(2)



- (f) (i) Identify, by name or formula, a **compound** that can be used to distinguish between separate aqueous solutions of potassium bromide and potassium iodide. (1)

- (ii) State what would be observed when a solution of the compound in (f)(i) is added to each of the separate aqueous solutions of potassium bromide and potassium iodide. (2)

Observation with potassium bromide:

Observation with potassium iodide:

- (iii) Identify, by name, a further reagent that could be added to the mixtures resulting from the test in (f)(ii) to confirm the identity of the halide ions. (2)

- (iv) Compare the observations that would be made when the reagent identified in (f)(iii) is added to the mixtures formed in (f)(ii). (2)

(Total for Question 25 = 21 marks)

TOTAL FOR SECTION C = 21 MARKS

TOTAL FOR PAPER = 80 MARKS



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

BLANK PAGE



P 5 0 7 8 6 A 0 2 3 2 4

The Periodic Table of Elements

1	2	Key														18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426	1427	1428	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481	1482	1483	1484	1485	1486	1487	1488	1489	1490	1491	1492	1493	1494	1495	1496	1497	1498	1499	1500	1501	1502	1503	1504	1505	1
---	---	-----	--	--	--	--	--	--	--	--	--	--	--	--	--	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	---

Elements with atomic numbers 112-116 have been reported but not fully authenticated.

Laotian series:

Acting center

