

40 Chromatography is used to separate and analyse mixtures of soluble substances.

The first steps of the process are listed.

- apply sample to baseline
- develop chromatogram in solvent

What is the next step in the process to detect soluble **colourless** substances?

- A** calculate the R_f values
- B** compare the results with known substances
- C** count the number of spots
- D** use a suitable locating agent

The Periodic Table of Elements

Group																	
I	II	Key										III	IV	V	VI	VII	VIII
		atomic number atomic symbol name relative atomic mass										1 H hydrogen 1					
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	2 He helium 4
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulphur 32	17 Cl chlorine 35.5	10 Ne neon 20
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium (85)	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —
87 Fr francium —	88 Ra radium —	89–103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —
lanthanoids		57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175	
actinoids		89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —	

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

40 A colourless mixture is separated by paper chromatography.

The steps below describe the method. These steps are **not** in the correct order.

- 1 Remove the chromatography paper from the solvent when the solvent front is near the top of the paper.
- 2 Place the chromatography paper in the solvent.
- 3 Spray the chromatography paper with a locating agent.
- 4 Place a spot of the mixture on the pencil line.
- 5 Draw a pencil line at the bottom of the chromatography paper.
- 6 Draw a pencil line to mark the position of the solvent front.

What is the correct order for these steps?

- A 3 → 5 → 6 → 4 → 2 → 1
- B 5 → 4 → 3 → 2 → 1 → 6
- C 3 → 5 → 4 → 1 → 2 → 6
- D 5 → 4 → 2 → 1 → 6 → 3

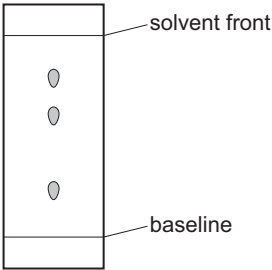
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actinoids																			

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40 A mixture of four different colourless amino acids is analysed by paper chromatography.

The final chromatogram is shown.



- Why does the chromatogram only show three spots?
- A A locating agent is **not** used.
 - B One of the amino acids is insoluble in the solvent.
 - C The solvent front is too near the top of the paper.
 - D Two of the amino acids have the same R_f value.

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40 In paper chromatography, what is the equation for the R_f value?

- A $R_f = \frac{\text{distance travelled by solvent}}{\text{distance travelled by substance}}$
- B $R_f = \frac{\text{distance travelled by locating agent}}{\text{distance travelled by substance}}$
- C $R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by locating agent}}$
- D $R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$

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The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

40 A mixture of soluble substances can be separated by paper chromatography. Each substance can be identified using its R_f value.

Which formula shows how the R_f value is calculated?

- A $R_f = \frac{\text{distance travelled by solvent}}{\text{distance travelled by substance}}$
- B $R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$
- C $R_f = \text{distance travelled by solvent} - \text{distance travelled by substance}$
- D $R_f = \text{distance travelled by solvent} \times \text{distance travelled by substance}$

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I	II	Key										III	IV	V	VI	VII	VIII
		atomic number										1					
		atomic symbol										H					
		name										hydrogen					
		relative atomic mass										1					
3	4											5	6	7	8	9	2
Li	Be											B	C	N	O	F	He
lithium	beryllium											boron	carbon	nitrogen	oxygen	fluorine	helium
7	9											11	12	14	16	19	10
Na	Mg											Al	Si	P	S	Cl	Ne
sodium	magnesium											aluminium	silicon	phosphorus	sulfur	chlorine	neon
23	24											27	28	31	32	35.5	20
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
potassium	calcium	scandium	titanium	vanadium	chromium	manganese	iron	cobalt	nickel	copper	zinc	gallium	germanium	arsenic	selenium	bromine	krypton
39	40	45	48	51	52	55	56	59	59	64	65	70	73	75	79	80	84
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
rubidium	strontium	yttrium	zirconium	niobium	molybdenum	technetium	ruthenium	rhodium	palladium	silver	cadmium	indium	tin	antimony	tellurium	iodine	krypton
85	88	89	91	93	96	—	101	103	106	108	112	115	119	122	128	127	86
Hg		lanthanoids	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	86
mercury		lanthanoids	hafnium	tantalum	tungsten	rhenium	osmium	iridium	platinum	gold	mercury	thallium	lead	bismuth	polonium	astatine	radon
201		89–103	178	181	184	186	190	192	195	197	201	204	207	209	—	—	—
Cs	Ba	actinoids	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og
cesium	barium	actinoids	rutherfordium	niobium	seaborgium	bohrium	hassium	meitnerium	darmstadtium	roentgenium	copernicium	nihonium	flerovium	moscovium	livermorium	tennessine	oganesson
133	137	89–103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118
Fr	Ra	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids
francium	radium	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids	actinoids
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

lanthanoids	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
	lanthanum	cerium	praseodymium	neodymium	promethium	samarium	eurogium	gadolinium	terbium	dysprosium	holmium	erbium	thulium	ytterbium	lutetium
	139	140	141	144	—	150	152	157	159	163	165	167	169	173	175
actinoids	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
	actinium	thorium	protactinium	uranium	neptunium	plutonium	americium	curium	berkelium	californium	emmenium	fermium	mendelevium	nobelium	lawrencium
	—	232	231	238	—	—	—	—	—	—	—	—	—	—	—

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