DUNMAN SECONDARY SCHOOL

CANDIDATE NAME			
CLASS		**INDEX NUMBER**	

PRELIMINARY EXAMINATION 2025
SECONDARY 4 EXPRESS

SCIENCE (PHYSICS, CHEMISTRY) 5086/03

SCIENCE (CHEMISTRY, BIOLOGY) 5088/03

Paper 3 Chemistry

27 August 2025
1 hour 15 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B
Answer **one** question.
Write your answers in the spaces provided on the question paper.

A copy of the Data Sheet is printed on page 21.
A copy of the Periodic Table is printed on page 22.
The number of marks is given in brackets [ ] at the end of each question or part question.

Section A

Answer **all** the questions in the spaces provided.

1 Table 1.1 below shows information on seven particles. Note that the letters do not represent chemical symbols of the elements.

Table 1.1

particle	A	B	C	D	E	F	G
nucleon number	4	9	12	27	29	35	80
proton number	2	4	6	13	13	17	35
number of electrons	2	2	6	13	13	17	35

(a) Use the letters, A, B, C, D, E, F and G to answer the following questions.

Each letter can be used once, more than once or not at all.

(i) Which particle is an ion with a charge of 2+?

…… [1]

(ii) Which particles are different elements from the same group in the Periodic Table?

…… [1]

(iii) Which two particles chemically combine to form a covalent compound?

…… [1]

(iv) Which particle is chemically inert?

…… [1]

(b) Two of the particles in Table 1.1 are isotopes.

(i) Define the term *isotopes*.

……..

…… [1]

(ii) Identify the isotopes in Table 1.1.

…… [1]

[Total: 6]

2 Geosmin is an organic compound with a melting and boiling point of 78°C and 270°C respectively.

(a) **(i)** In the space provided below, draw the arrangement of particles of geosmin at 280°C. Particles of geosmin may be represented with a ○.

280°C

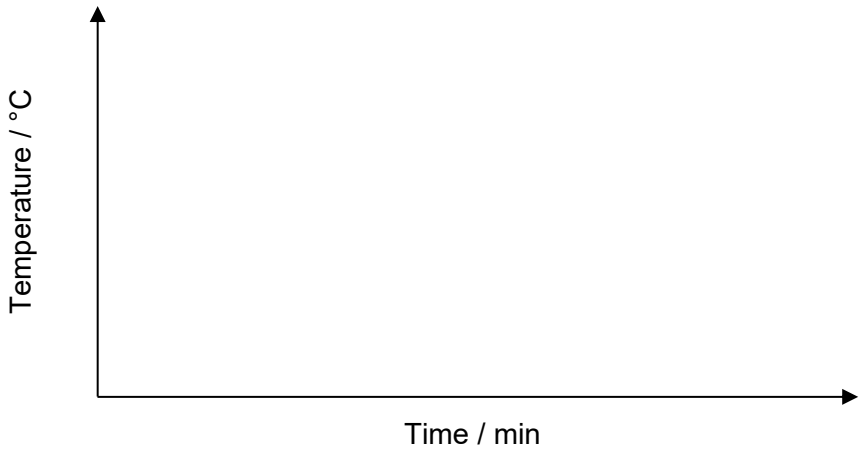
[1]

(ii) Describe, using the kinetic particle theory, the change in motion of particles in solid geosmin as it changes into a liquid.

……

…… [1]

(b) A sample of geosmin was heated from 25°C to 100°C. Using the axes below, draw the heating curve for this sample of geosmin.



[2]

[Total: 4]

3 Sodium chloride exists as a solid while ammonia exists as a gas at room temperature and pressure.

(a) Explain, in terms of structure and bonding why solid sodium chloride cannot conduct electricity.

……..

……..

……..

……..…… [2]

(b) Explain why ammonia gas has a low boiling point.

……..

……..

……..

……..…… [2]

(c) Draw ‘dot-and-cross’ diagrams to show the bonding in sodium chloride and ammonia. Show only the outer shell electrons.

(i) sodium chloride

[2]

(ii) ammonia gas

[2]

[Total: 8]

4 **Fig. 4.1** describes reactions involving alkaline solutions.

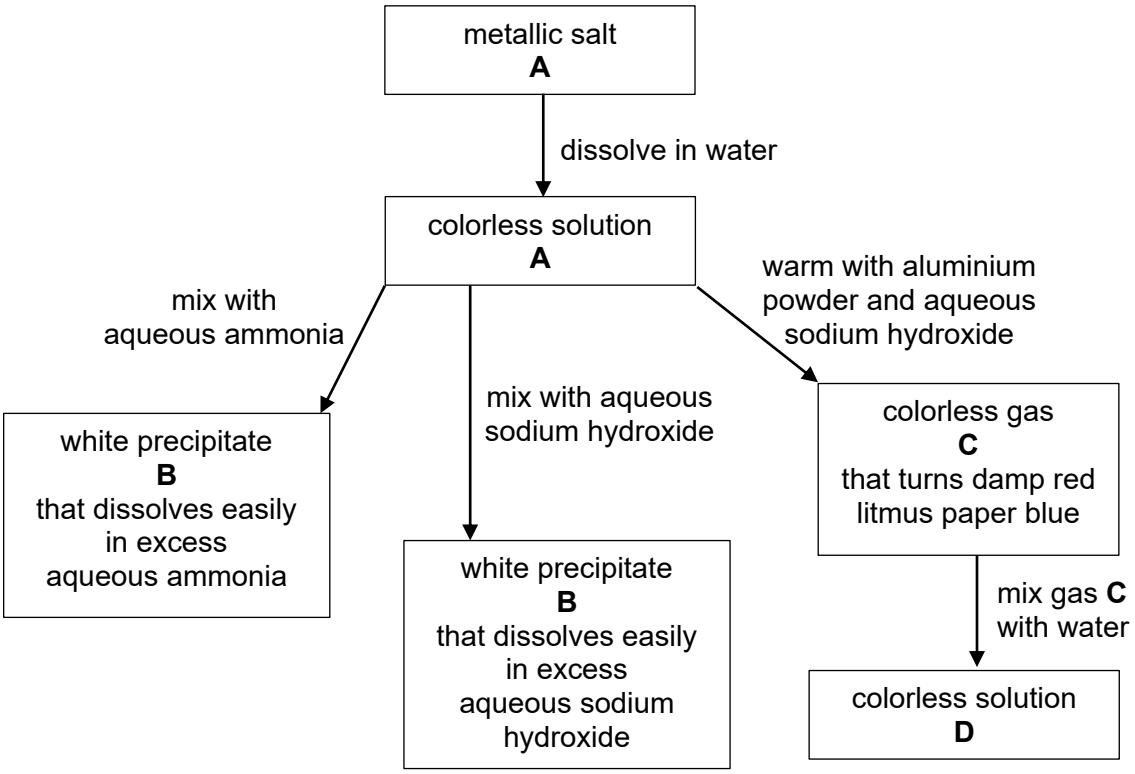


Fig. 4.1

(a) Name the substances **A**, **B**, **C** and **D**.

A ……..

B ……..

C ……..

D …….. [4]

(b) Write a balanced chemical equation, with state symbols, for colorless solution **A** reacting with aqueous sodium hydroxide.

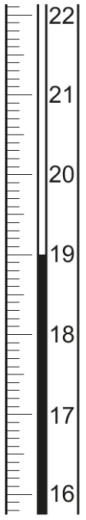
……[2]

[Total: 6]

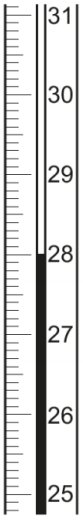
5 In an experiment, a student carried out the following procedures:

- measure 25 cm^3 of 1.0 mol/dm^3 hydrochloric acid into a glass beaker
- measure the initial temperature of the hydrochloric acid ($\mathbf{T_1}$)
- add 30 cm^3 of 1.0 mol/dm^3 aqueous potassium hydroxide, in excess
- record the maximum temperature the mixture reached ($\mathbf{T_2}$)

The temperature readings of the reaction mixture are shown in the thermometers below.



$\mathbf{T_1}$ (°C)



$\mathbf{T_2}$ (°C)

(a) Use the information provided to complete the table below.

initial temperature (°C)	
final temperature (°C)	
temperature change (°C)	

[2]

(b) Using the information in the table from **(a)**, suggest what kind of reaction occurred. Explain your answer.

……

……

……

…… [2]

(c) Write the ionic equation for the reaction between dilute hydrochloric acid and aqueous potassium hydroxide.

…….. [1]

[Total: 5]

6 Both lemongrass and citronella are used to repel mosquitoes.

A student used paper chromatography to determine the pigments present in both substances, using alcohol as a solvent.

Fig. 6.1 shows the chromatograms of lemongrass and citronella.

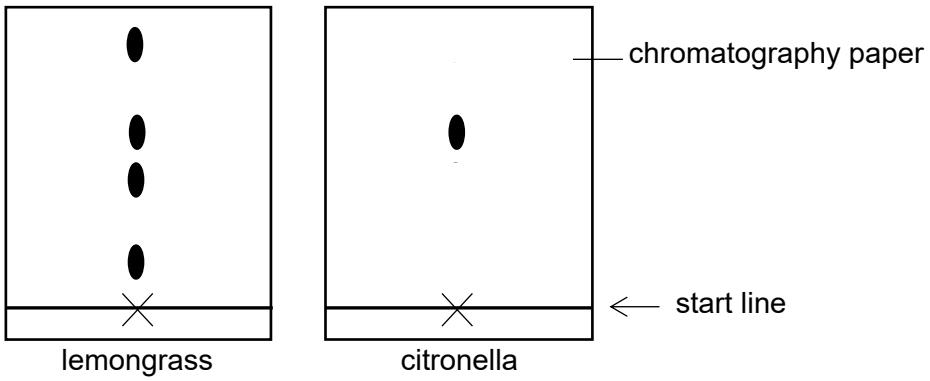


Fig. 6.1

(a) How many components does lemongrass contain?

……..…… [1]

(b) State **two** other conclusions about lemongrass and citronella that can be made from the chromatogram.

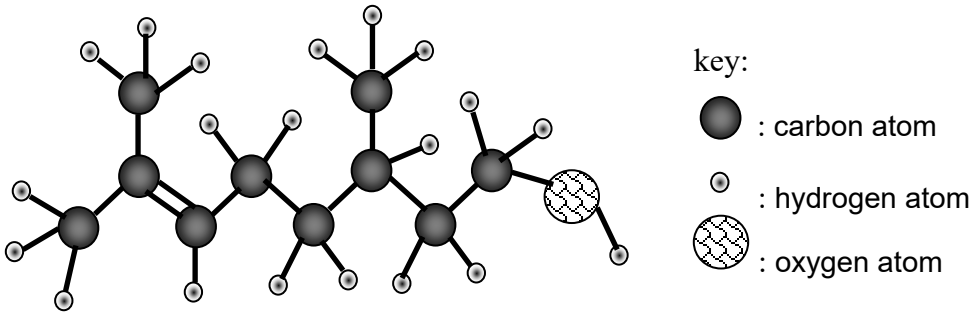
……..……..……...

……..……..……...

……..……..……...

……..……..…… [2]

(c) The structure of a molecule of citronella is as shown below.



Write the molecular formula of a molecule of citronella.

…… [1]

[Total: 4]

7 The halogens fluorine, chlorine bromine, and iodine are found in group 17 of the Periodic table.

(a) State the colour and state of bromine at room temperature and pressure.

……..…….. [1]

(b) Chlorine gas was bubbled into a test tube containing potassium iodide solution.

(i) Write a balanced chemical equation for the reaction between chlorine gas and potassium iodide solution.

……...…….. [2]

(ii) Describe the observations for the reaction.

……..……

……..……

……..……

……..…….. [2]

(iii) Explain why the reaction between chlorine and potassium iodide solution is redox in nature.

……..……

……..……

……..……

……..…….. [2]

[Total: 7]

8 A reaction between 2.32 g of iron(II) carbonate and dilute hydrochloric acid is carried out. The chemical equation for the reaction is shown.

$$FeCO_3\,(s) + 2\,HCl\,(aq) \rightarrow FeCl_2\,(aq) + CO_2\,(g) + H_2O\,(l)$$

(a) Calculate the number of moles of iron(II) carbonate used in the reaction.

[Ar = C; 12, O; 16, Fe; 56]

…….. mol [1]

(b) Calculate the volume of carbon dioxide produced, at room temperature and pressure.

volume: …….…….. dm^3 [2]

(c) Calculate the maximum mass of iron(II) chloride produced in the reaction.

maximum mass: …….…….. g [1]

(d) 50 cm^3 of hydrochloric acid was used to react with 2.32 g of iron (II) carbonate.

Calculate the concentration in mol/dm^3 of hydrochloric acid used in the reaction.

concentration: …….…….. mol/dm^3 [1]

[Total: 5]

9 Nitrogen dioxide is a reddish-brown gas with a pungent and irritating odour. It is an air pollutant that creates some harmful effects to the environment.

Fig 9.1 is a pie chart that shows the emission of nitrogen dioxide by different sources in a city.

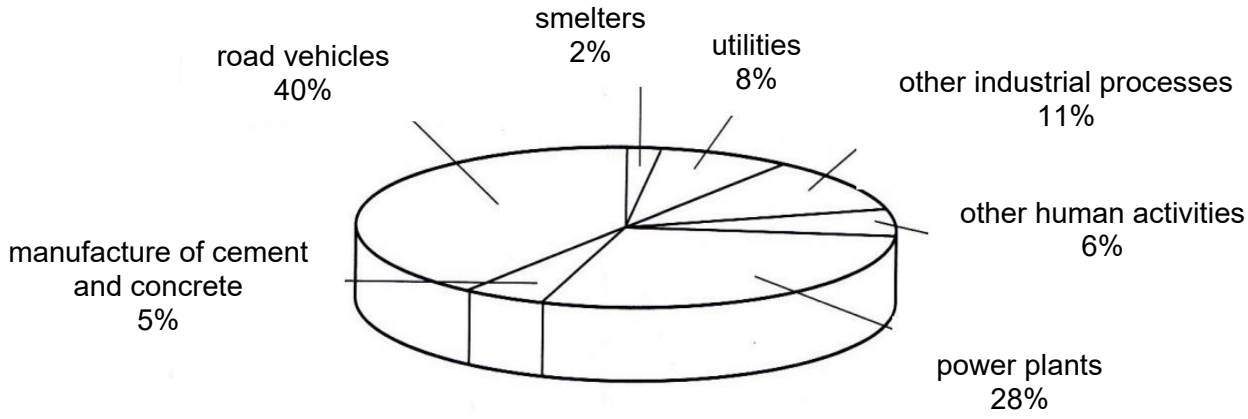


Fig 9.1

(a) Which sector contributes the most to nitrogen dioxide emission?

……..…… [1]

(b) Explain how nitrogen dioxide is produced in the sector named in **(a).**

……..……

……..…… [2]

(c) State the natural source of oxides of nitrogen in the atmosphere.

……..…… [1]

(d) State one harmful effect that oxides of nitrogen have on the environment and on humans.

environment:	
humans:	

[2]

(e) Other than nitrogen dioxide, carbon dioxide also creates negative impact to the environment.

Burning of fossil fuel in factories and vehicles increases the production of carbon dioxide to the environment. The increase in production of carbon dioxide leads to the greenhouse effect.

To offset the production of carbon dioxide to the environment, biofuel such as bioethanol is used in place of fossil fuels. Bioethanol can be produced from plants such as sugar cane and corn.

(i) Describe how bioethanol, compared to fossil fuels, can be more environmentally sustainable in terms of carbon dioxide emission.

……..

……..

……..

……..…… [2]

(ii) Name the process and state the conditions required for ethanol to be formed from sugar cane plants.

……..

……..

……..

……..…… [2]

[Total: 10]

Candidate Name:	Class:	Index No:

Section B

Answer **one** question from this section.

10 One substance which is responsible for the fragrance of roses is 2-phenylethanol. The structure of this molecule is shown in Fig. 9.1.

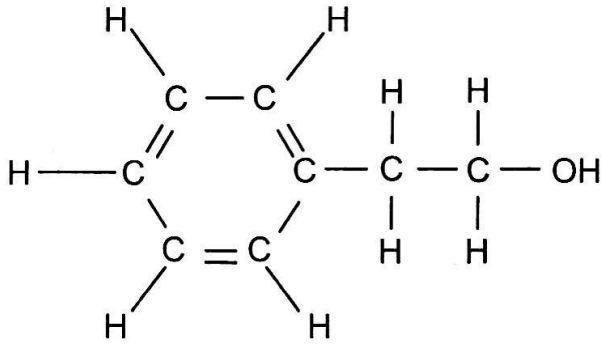


Fig. 9.1

(a) **(i)** **Circle** the functional group(s) found in 2-phenylethanol. [1]

(ii) A student commented that the molecule is a 'hydrocarbon'.

Do you agree with the statement? Explain your answer.

……

……...[1]

(iii) Suggest a suitable chemical reagent with relevant observation(s) to convert the 2-phenylethanol molecule to a compound with a pH of 6.0.

……

……

……

……...[2]

(iv) Draw the structural formula of the compound with a pH of 6.0 formed in **(iii)**.

[1]

(b) Fig 9.2 below shows the structure of an organic compound X.

compound X

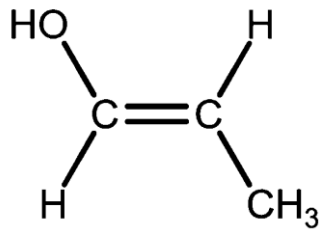


Fig 9.2

(i) Explain why compound X is an unsaturated compound and describe a chemical test for its unsaturation.

……

……

……

……

……

……..[3]

(ii) Compound X is able to undergo addition polymerisation.

Draw the structural formula of part of the addition polymer formed from monomers of compound X. Show three repeating units.

[2]

[Total: 10]

11 Methanoic acid, HCOOH, and ethanoic acid, CH_3COOH, are the first two members of the homologous series of organic acids.

(a) Explain what is meant by *homologous series*, using these two acids as examples.

……..

……..

……..

……..…… [2]

(b) Write the name and draw the full structural formula of the next member in the homologous series of organic acids.

name:…… [1]

structural formula:

[1]

(c) Ethanoic acid is produced from oxidation of alcohol **Y**.

Alcohol **Y** can be produced from a reaction as shown in the equation below.

$$C_6H_{12}O_6\ (aq) \rightarrow 2 \text{ moles of alcohol } \mathbf{Y} + 2CO_2\ (g)$$

(i) What is the name and chemical formula of alcohol **Y**?

name: ……

chemical formula: …… [1]

(ii) Alcohol **Y** can also be produced by the catalytic addition of steam to ethene.

Write the balanced chemical equation, including state symbols, for this addition reaction.

…… [2]

(d) Both ethanoic acid and alcohol **Y** are colourless solutions.

Describe a chemical test that can be used, and the results, to determine if a colourless solution is ethanoic acid or alcohol **Y**.

chemical test:	
result with ethanoic acid:	
result with alcohol **Y**:	

[3]

[Total: 10]

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Data Sheet

Colours of Some Common Metal Hydroxides

aluminium hydroxide	white
calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
zinc hydroxide	white

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		Key: proton (atomic) number / atomic symbol / name / relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
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 dm^3 at room temperature and pressure (r.t.p.).

The Avogadro constant, $L = 6.02 \times 10^{23}$ mol^{-1}