

Write your name here

Surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

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Candidate Number

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Chemistry

Advanced Subsidiary

Unit 2: Application of Core Principles of Chemistry

Tuesday 3 June 2014 – Afternoon

Time: 1 hour 30 minutes

Paper Reference

WCH02/01

Candidates may use a calculator.

Total Marks

Instructions

- Use **black** ink or 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 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.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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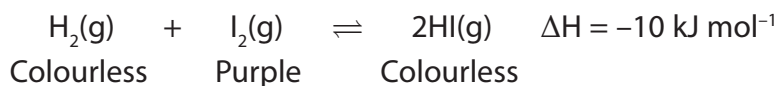
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PEARSON

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 Hydrogen and iodine gases were mixed at 300°C and allowed to reach equilibrium.



- (a) What would you see if the equilibrium mixture was cooled to 250°C and equilibrium allowed to re-establish?

(1)

- ☐ A The mixture goes a darker purple.
- ☐ B The colour gets lighter.
- ☐ C The mixture goes colourless.
- ☐ D No visible change.

- (b) The equilibrium mixture at 300°C was compressed in a gas syringe to occupy a smaller volume. What would be seen immediately after this compression?

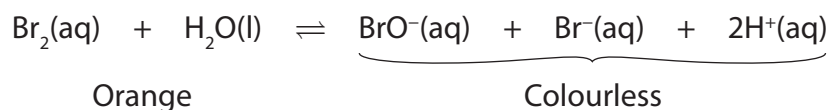
(1)

- ☐ A The mixture goes a darker purple.
- ☐ B The colour gets lighter.
- ☐ C The mixture goes colourless.
- ☐ D No visible change.

(Total for Question 1 = 2 marks)



- 2 A concentrated solution of 'bromine water' is an orange colour. The following equilibrium exists in this solution.



What would be the effect, if any, on the colour of the solution, if five drops of dilute sodium hydroxide solution were added to 5 cm³ of the bromine water?

- ☐ A The solution becomes a deeper orange.
- ☐ B The colour of the solution becomes lighter.
- ☐ C The solution goes colourless.
- ☐ D No visible change.

(Total for Question 2 = 1 mark)

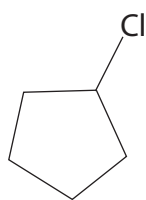
- 3 What is the colour of iodine in the non-polar solvent, cyclohexane?

- ☐ A Black
- ☐ B Brown
- ☐ C Purple
- ☐ D Yellow

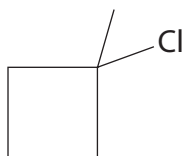
(Total for Question 3 = 1 mark)



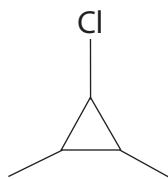
4 The skeletal formulae of some five-carbon halogenoalkanes are shown below.



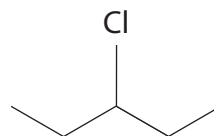
A



B



C



D

(a) Which of the above halogenoalkanes is **not** a structural isomer of the others?

(1)

☐ A

☐ B

☐ C

☐ D

(b) Which of the above is **not** a secondary halogenoalkane?

(1)

☐ A

☐ B

☐ C

☐ D

(Total for Question 4 = 2 marks)

5 The reaction for the preparation of propene from 1-bromopropane is shown below.



This reaction is classified as

☐ A elimination.

☐ B oxidation.

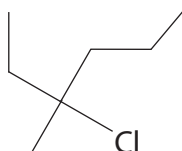
☐ C reduction.

☐ D substitution.

(Total for Question 5 = 1 mark)



- 6 The molecule shown below is 3-chloro-3-methylhexane.



It reacts with hot, alcoholic potassium hydroxide to produce a number of different alkenes. Which of the following could be produced from 3-chloro-3-methylhexane?

- ☐ A hex-2-ene
- ☐ B 3-methylhex-1-ene
- ☐ C 3-methylhex-2-ene
- ☐ D 3-methylhex-4-ene

(Total for Question 6 = 1 mark)

- 7 Which of the following has **not** been a use of chlorofluorocarbons (CFCs)?

- ☐ A Fuels
- ☐ B Dry-cleaning solvents
- ☐ C Fire-retardants
- ☐ D Refrigerants

(Total for Question 7 = 1 mark)

- 8 Butane is an aerosol propellant now used as an alternative to CFCs. Although it is less destructive to the ozone layer, it has the disadvantage of being

- ☐ A very corrosive.
- ☐ B highly flammable.
- ☐ C hard to evaporate.
- ☐ D highly toxic.

(Total for Question 8 = 1 mark)



9 Which is the **best** explanation of why carbon dioxide, CO_2 , is a greenhouse gas?

- ☐ A It is in high concentration and has a long residence time in the upper atmosphere so it absorbs infrared radiation significantly.
- ☐ B It is a polar molecule and so absorbs infrared radiation.
- ☐ C It absorbs ultra-violet radiation and re-emits infrared radiation.
- ☐ D It has polar bonds that absorb and re-emit infrared radiation.

(Total for Question 9 = 1 mark)

10 The term 'carbon footprint' is concerned with the amount of carbon dioxide produced in generating a certain amount of energy.

The table below gives some data about several fuels.

Fuel	Energy density / MJ l^{-1}	CO_2 produced on combustion / g l^{-1}
Petrol	32	2328
Diesel	36	2614
LPG	24	1533
Bioethanol	21	1503

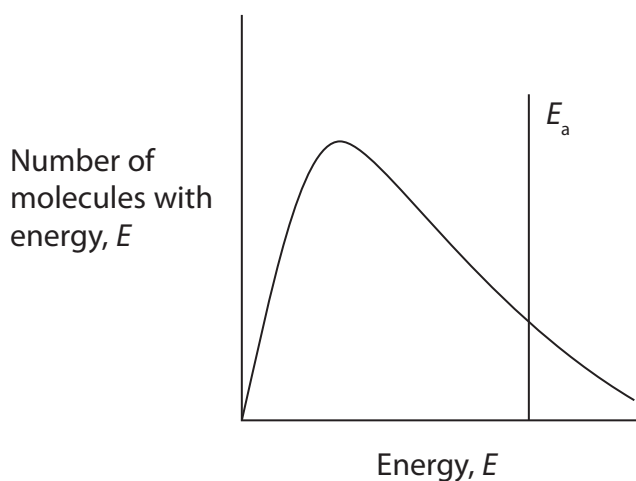
By calculating the mass of CO_2 produced per MJ of energy for each fuel, identify which fuel would give the **smallest** carbon footprint.

- ☐ A Petrol
- ☐ B Diesel
- ☐ C LPG
- ☐ D Bioethanol

(Total for Question 10 = 1 mark)



11 The diagram below is a Maxwell-Boltzmann distribution of molecular energies.



(a) If the temperature was raised, what would be the effect on the shape of the curve? (1)

- ☐ A The peak would shift to the left and be higher.
- ☐ B The peak would shift to the left and be lower.
- ☐ C The peak would shift to the right and be higher.
- ☐ D The peak would shift to the right and be lower.

(b) Which of the following would shift the activation energy line to the left? (1)

- ☐ A An increase in reactant concentration.
- ☐ B The removal of the product.
- ☐ C The addition of a catalyst.
- ☐ D An increase in temperature.

(Total for Question 11 = 2 marks)



12 The table below gives the boiling temperatures of some alcohols.

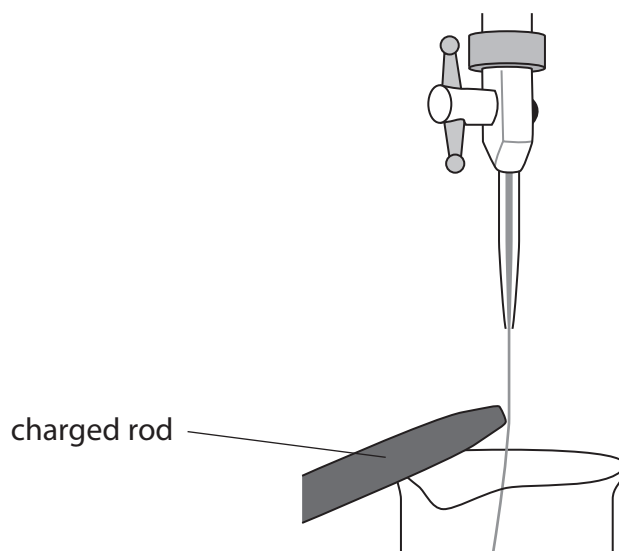
Alcohol	Boiling temperature / °C
Ethanol	78
Propan-1-ol	97
Butan-1-ol	117

From the data in the table, the boiling temperature of hexan-1-ol is most likely to be

- ☐ A 138°C
- ☐ B 148°C
- ☐ C 158°C
- ☐ D 168°C

(Total for Question 12 = 1 mark)

13 An experiment to determine the effect of an electrostatic force on a jet of liquid is carried out using the apparatus as shown.



Which of the following liquids would **not** be significantly deflected by the electrostatic force applied?

- ☐ A CH_3OH
- ☐ B CCl_4
- ☐ C CHCl_3
- ☐ D H_2O

(Total for Question 13 = 1 mark)



14 Although they have similar relative molecular masses, the boiling temperatures of pentane (36°C) and butan-1-ol (117°C) are significantly different. The reason for this is that, in comparison with pentane,

- ☐ **A** the intermolecular forces between the alcohol molecules are much stronger.
- ☐ **B** the covalent bonds in the alcohol are stronger.
- ☐ **C** there are more covalent bonds in the alcohol and so it requires more energy to break all of them.
- ☐ **D** the molecular shape of the alcohol allows it to form stronger interactions between molecules.

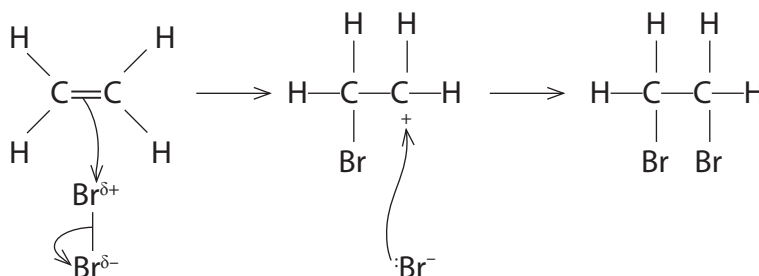
(Total for Question 14 = 1 mark)

15 Compounds such as sodium chloride dissolve in water because the ions interact with the water molecules. The interactions are

- ☐ **A** dipole-dipole.
- ☐ **B** ion-dipole.
- ☐ **C** hydrogen bonds.
- ☐ **D** London forces.

(Total for Question 15 = 1 mark)

16 Consider the reaction mechanism shown below.



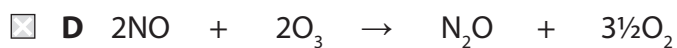
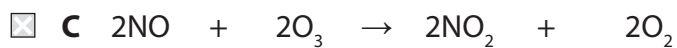
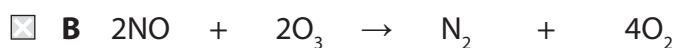
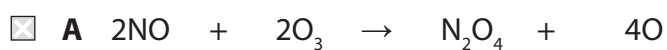
The bromide ion acts as

- ☐ **A** an electrophile.
- ☐ **B** a catalyst.
- ☐ **C** a free radical.
- ☐ **D** a nucleophile.

(Total for Question 16 = 1 mark)



17 Nitrogen oxide, NO, can act as a catalyst in the depletion of the ozone layer. Which of the following reactions is most likely to be a step in the process?



(Total for Question 17 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS



SECTION B

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

18 When concentrated sulfuric acid is added to solid sodium chloride, the gas hydrogen chloride is produced.

(a) Write an equation for this reaction. State symbols are not required.

(1)

(b) Fumes of hydrogen chloride gas can be identified by bringing the fumes into contact with another gas, **X**. Identify gas **X** and state the observation you would make.

(2)

Gas **X**.....

Observation.....

(c) Chloride ions in solution can be distinguished from other halide ions by the addition of silver nitrate solution followed by dilute, aqueous ammonia.

State what you would see when silver nitrate solution is added to chloride ions, followed by dilute aqueous ammonia.

Suggest why concentrated ammonia should not be used to confirm that silver chloride has been formed.

(3)

Observation on addition of AgNO_3

Observation on addition of dilute NH_3

Reason why concentrated NH_3 should **not** be used

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(Total for Question 18 = 6 marks)



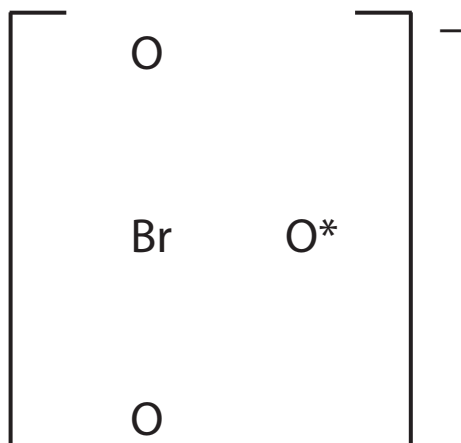
19 Potassium bromate(V), KBrO_3 , is a primary standard, meaning that it can be obtained as a pure substance and used to accurately determine the concentrations of solutions of other chemicals, such as sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3$.

- (a) (i) Complete the dot and cross diagram for the bromate(V) ion. Show only the outer shell electrons.

In this ion, the bromine expands its outer shell to accommodate 12 electrons.

Use **x** for bromine electrons and **•** for oxygen electrons. The symbol * on the diagram represents the extra electron which gives the ion its charge.

(2)



- (ii) Suggest how elements in Period 3 and higher can accommodate more than eight electrons in their outer shell.

(1)

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.....



- (b) Four chemistry students were given a solution of sodium thiosulfate with a concentration of **approximately** 0.1 mol dm^{-3} and asked to determine its **exact** concentration.

They were each given separate tasks to carry out, as described below.

- (i) The first student was given the task of making up a potassium bromate(V) solution. A mass of 8.35 g of KBrO_3 was weighed out, dissolved in deionized water, the volume made up to 250 cm^3 in a volumetric flask and the mixture shaken.

Calculate the concentration of this potassium bromate(V) solution, in mol dm^{-3} .

(2)

- (ii) The second student was asked to determine a suitable mass of potassium iodide to add to 0.0025 mol of potassium bromate(V) to ensure complete reaction. The equation for the reaction is



Calculate the minimum mass of potassium iodide, KI, required and hence suggest a suitable mass to use if the potassium iodide is to be in excess.

You **must** show your working and your mass should be reasonable.

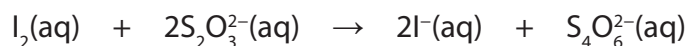
(3)

Minimum mass required g

Suitable mass to use g



(iii) The third student was given the following equation.



This student was asked to estimate the titration reading.

Calculate the volume of 0.1 mol dm^{-3} of sodium thiosulfate solution, in cm^3 , that would be needed to react with 0.00100 mol of iodine present in the conical flask.

(2)

(iv) The fourth student carried out an alternative method for determining the concentration of the sodium thiosulfate solution. A known mass of solid potassium bromate(V) was dissolved in water in a conical flask. An excess of potassium iodide and acid were added and the mixture titrated with the sodium thiosulfate solution. The following measurements were obtained.

Mass of KBrO_3	0.07 g
Volume of water	25 cm^3
Volume of $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$	26.85 cm^3

The student calculated the concentration of the sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3$, to be $0.0937 \text{ mol dm}^{-3}$.

There is uncertainty in the value of the calculated concentration of the sodium thiosulfate. Which measurement, given in the table, has the greatest effect on the uncertainty of this value? Justify your answer.

No calculation is required for this answer.

(2)

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(Total for Question 19 = 12 marks)



20 This question is about Group 2 elements and their compounds.

- *(a) Give **two** reasons why the first ionization energy of calcium is less than that of magnesium, even though the atomic number of calcium is greater than that of magnesium.

(2)

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- (b) A flame test was carried out on a solid calcium compound. Explain the origin of the flame colour in terms of electron movement.

(3)

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- (c) (i) Calcium oxide reacts with dilute nitric acid to form calcium nitrate. Write the equation for this reaction. State symbols are not required.

(1)

- (ii) Identify **two** ways, one of which should be an observation, in which the thermal decomposition of anhydrous calcium nitrate is different from that of anhydrous potassium nitrate.

(2)

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- (d) (i) Calcium reacts with water to produce calcium hydroxide and a gas. Give the name or formula of this gas.

(1)

- (ii) An aqueous solution of calcium hydroxide is used for a common laboratory test. Give the observation for a positive result for this test and complete the equation for the reaction that occurs. State symbols are **not** required.

(2)

Observation.....



- (iii) Give the name or formula of a Group 2 hydroxide which is more soluble than calcium hydroxide.

(1)

- (e) (i) Describe what you would see if a solution of barium chloride was added to dilute sulfuric acid. State why this observation would differ if magnesium chloride solution was used instead of barium chloride.

(2)

- (ii) Barium compounds are toxic. However, it is safe to give patients a 'barium meal' of barium sulfate when trying to diagnose intestinal disorders. Suggest why this is so.

(1)



- *(f) Calcium carbonate, CaCO_3 , readily reacts with hydrochloric acid. State **two** factors, other than a change in temperature, which would affect the rate of this reaction.

Neither pressure nor the use of a catalyst should be considered.

Explain how each of the **two** factors you have chosen alters the reaction rate.

(4)

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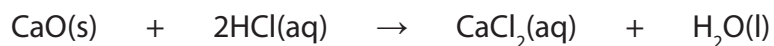
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- (g) Suggest why pressure has little or no effect on the rate of the reaction of calcium oxide and hydrochloric acid, the equation for which is given below.



(1)

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(Total for Question 20 = 20 marks)

TOTAL FOR SECTION B = 38 MARKS



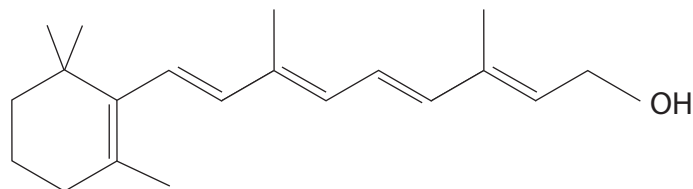
SECTION C

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

- 21** In the human body, one chemical can have a number of different effects.

An example is retinol, one of the substances in vitamin A.

The structure of retinol is shown below.



Retinol can be converted into retinal and a form of this is combined with an opsin molecule in the retina of the eye to make the light-sensitive pigment rhodopsin. When light enters the eye, the shape of the retinal molecule is changed, which results in it separating from the opsin molecule. The outcome of this separation is that we 'see' light.

Retinol can also be converted to retinoic acid, which is important in the body for the correct maintenance of mucous membranes. Failure to produce retinoic acid can lead to a condition known as 'dry eye', or xerophthalmia, which can result in blindness.

The functions of this vitamin, and other nutrient molecules, illustrate the need for a healthy, balanced diet.

- (a) Retinol has an alcohol functional group. Classify the type of alcohol group in retinol and explain the meaning of the term 'functional group'.

(2)

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- (b) Give the molecular formula of retinol.

(2)

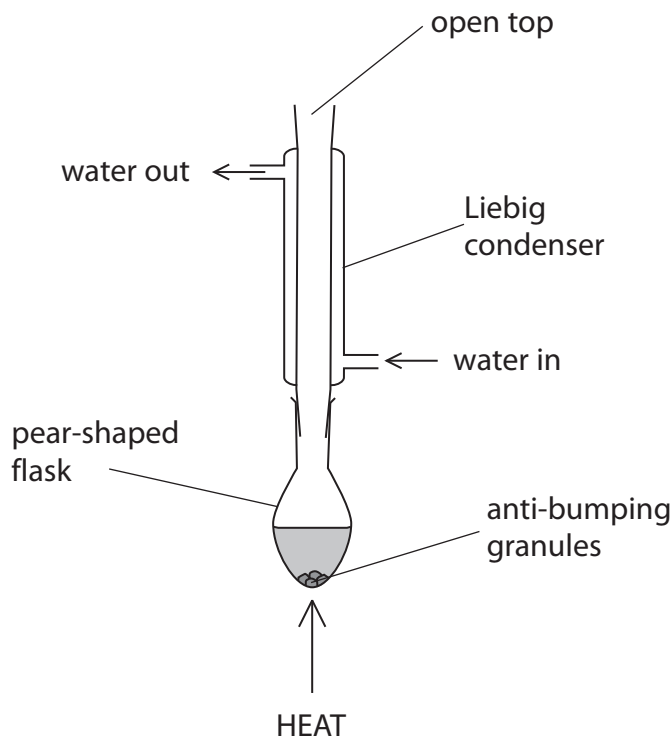
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(c) Retinol can be oxidized to the aldehyde, retinal.

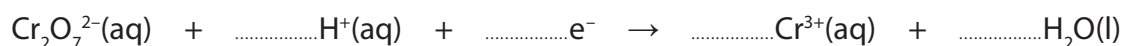
- *(i) To illustrate the conversion of an alcohol to an aldehyde in the laboratory, a student suggested using the following apparatus and an excess of an oxidizing agent. Explain why this proposed method would have been unsuitable for the production of an aldehyde and explain what modifications are necessary for successful conversion. A new diagram is not required.

(3)



- (ii) The oxidizing agent suggested was sodium dichromate, $\text{Na}_2\text{Cr}_2\text{O}_7$, in acidic solution. Complete the ionic half-equation below. Give the oxidation numbers of the chromium in the chromium species and state their colours.

(5)



Oxidation
Number

.....

.....

Colour

.....

.....



*(iii) Describe **two** features on the infrared spectrum which could be used to determine whether the retinol has been completely converted to retinal.

Select some of the following infrared data to support your answer.

(2)

O—H stretching in alcohols (variable, broad) at	3750 – 3200 cm ⁻¹
O—H stretching in carboxylic acids (weak) at	3300 – 2500 cm ⁻¹
C=O stretching in aldehydes (strong) at	1740 – 1720 cm ⁻¹
C=O stretching in ketones (strong) at	1700 – 1680 cm ⁻¹
C=O stretching in carboxylic acids, alkyl (strong) at	1725 – 1700 cm ⁻¹
C—H stretching in aldehydes (weak) at	2900 – 2820 cm ⁻¹
C—H stretching in aldehydes (weak) at	2775 – 2700 cm ⁻¹

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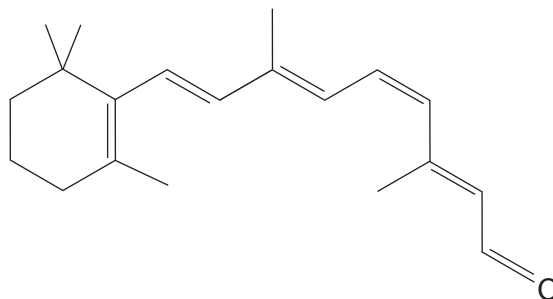


- (iv) The structure of the retinal molecule that combines with opsin in the human body differs from the structure expected from the oxidation of retinol.

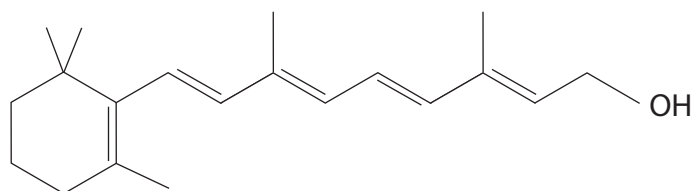
The structures of retinal and retinol are shown below.

(1)

Retinal



Retinol



As well as an oxidation, a structural change has occurred within the molecule. Circle only the part of the **retinal** molecule where this change has occurred.

- (v) The bond angle around each carbon atom in a carbon-carbon double bond is about 120° . Explain the reason for this bond angle and state the name of the shape around each carbon atom.

(3)

Reason

.....

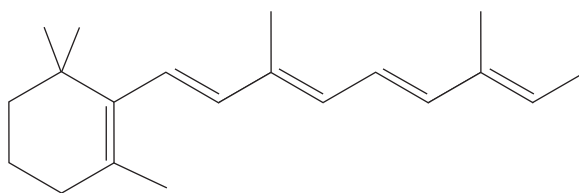
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Shape



(d) Complete the diagram below to show the skeletal formula of retinoic acid.

(1)



*(e) Retinoic acid and retinol both have OH groups. Suggest **one** chemical reagent that you could use to test for the presence of an OH group which would work for both compounds. You may assume that both organic compounds are dissolved in suitable solvents.

Give the positive observation for the test and state **one** necessary experimental precaution that you would make to reduce the risk from carrying out this test.

(3)

Reagent

Observation

Precaution

(Total for Question 21 = 22 marks)

TOTAL FOR SECTION C = 22 MARKS

TOTAL FOR PAPER = 80 MARKS



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The Periodic Table of Elements

1	2	3	4	5	6	7	0 (8)
6.9 Li lithium 3	9.0 Be beryllium 4	10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	209.0 Po polonium 84	210 At astatine 85	222 Rn radon 86
223 Fr francium 87	226 Ra radium 88	200.6 Hg mercury 80	201.0 Tl thallium 81	204.4 Pb lead 82	207.2 Bi bismuth 83	209.0 Po polonium 84	210 At astatine 85
Elements with atomic numbers 112-116 have been reported but not fully authenticated							
138.9 La* lanthanum 57	139.9 Ce cerium 58	140.9 Pr praseodymium 59	144 Nd neodymium 60	147 Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64
173.0 Tb terbium 65	175.0 Dy dysprosium 66	177.0 Ho holmium 67	178.9 Er erbium 68	180.9 Tm thulium 69	183.8 Yb ytterbium 70	186.2 Lu lutetium 71	188.9 Hf hafnium 72
188.9 Ta tantalum 73	190.2 W tungsten 74	192.2 Re rhenium 75	194.0 Os osmium 76	196.0 Ir iridium 77	197.0 Pt platinum 78	198.0 Au gold 79	200.6 Hg mercury 80
200.6 Tl thallium 81	201.0 Pb lead 82	204.4 Bi bismuth 83	207.2 Po polonium 84	210 At astatine 85	210 Rn radon 86	210 Fr francium 87	210 Ra radium 88
210 Ac* actinium 89	210 Th thorium 90	210 Pa protactinium 91	210 U uranium 92	210 Np neptunium 93	210 Pu plutonium 94	210 Am americium 95	210 Cm curium 96
210 Bk berkelium 97	210 Cf californium 98	210 Es einsteinium 99	210 Fm fermium 100	210 Md mendelevium 101	210 No nobelium 102	210 Lr lawrencium 103	210 Rf rutherfordium 104
210 Sg seaborgium 106	210 Bh bohrium 107	210 Hs hassium 108	210 Mt meitnerium 109	210 Ds darmstadtium 110	210 Rg roentgenium 111	210 Uu unnilium 112	210 Uub ununium 113
210 Uut ununium 114	210 Uuq ununium 115	210 Uub ununium 116	210 Uuh ununium 117	210 Uus ununium 118	210 Uuo ununium 119	210 Uu110 ununium 120	210 Uu111 ununium 121
210 Uu112 ununium 122	210 Uu113 ununium 123	210 Uu114 ununium 124	210 Uu115 ununium 125	210 Uu116 ununium 126	210 Uu117 ununium 127	210 Uu118 ununium 128	210 Uu119 ununium 129
210 Uu120 ununium 130	210 Uu121 ununium 131	210 Uu122 ununium 132	210 Uu123 ununium 133	210 Uu124 ununium 134	210 Uu125 ununium 135	210 Uu126 ununium 136	210 Uu127 ununium 137
210 Uu128 ununium 138	210 Uu129 ununium 139	210 Uu130 ununium 140	210 Uu131 ununium 141	210 Uu132 ununium 142	210 Uu133 ununium 143	210 Uu134 ununium 144	210 Uu135 ununium 145
210 Uu136 ununium 146	210 Uu137 ununium 147	210 Uu138 ununium 148	210 Uu139 ununium 149	210 Uu140 ununium 150	210 Uu141 ununium 151	210 Uu142 ununium 152	210 Uu143 ununium 153
210 Uu144 ununium 154	210 Uu146 ununium 156	210 Uu148 ununium 158	210 Uu150 ununium 160	210 Uu152 ununium 162	210 Uu154 ununium 164	210 Uu156 ununium 166	210 Uu158 ununium 168
210 Uu160 ununium 170	210 Uu162 ununium 172	210 Uu164 ununium 174	210 Uu166 ununium 176	210 Uu168 ununium 178	210 Uu170 ununium 180	210 Uu172 ununium 182	210 Uu174 ununium 184
210 Uu176 ununium 186	210 Uu178 ununium 188	210 Uu180 ununium 190	210 Uu182 ununium 192	210 Uu184 ununium 194	210 Uu186 ununium 196	210 Uu188 ununium 198	210 Uu190 ununium 200
210 Uu192 ununium 202	210 Uu194 ununium 204	210 Uu196 ununium 206	210 Uu198 ununium 208	210 Uu200 ununium 210	210 Uu202 ununium 212	210 Uu204 ununium 214	210 Uu206 ununium 216
210 Uu208 ununium 218	210 Uu210 ununium 220	210 Uu212 ununium 222	210 Uu214 ununium 224	210 Uu216 ununium 226	210 Uu218 ununium 228	210 Uu220 ununium 230	210 Uu222 ununium 232
210 Uu224 ununium 234	210 Uu226 ununium 236	210 Uu228 ununium 238	210 Uu230 ununium 240	210 Uu232 ununium 242	210 Uu234 ununium 244	210 Uu236 ununium 246	210 Uu238 ununium 248
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210 Uu272 ununium 282	210 Uu274 ununium 284	210 Uu276 ununium 286	210 Uu278 ununium 288	210 Uu280 ununium 290	210 Uu282 ununium 292	210 Uu284 ununium 294	210 Uu286 ununium 296
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210 Uu304 ununium 314	210 Uu306 ununium 316	210 Uu308 ununium 318	210 Uu310 ununium 320	210 Uu312 ununium 322	210 Uu314 ununium 324	210 Uu316 ununium 326	210 Uu318 ununium 328
210 Uu320 ununium 330	210 Uu322 ununium 332	210 Uu324 ununium 334	210 Uu326 ununium 336	210 Uu328 ununium 338	210 Uu330 ununium 340	210 Uu332 ununium 342	210 Uu334 ununium 344
210 Uu336 ununium 346	210 Uu338 ununium 348	210 Uu340 ununium 350	210 Uu342 ununium 352	210 Uu344 ununium 354	210 Uu346 ununium 356	210 Uu348 ununium 358	210 Uu350 ununium 360
210 Uu352 ununium 362	210 Uu354 ununium 364	210 Uu356 ununium 366	210 Uu358 ununium 368	210 Uu360 ununium 370	210 Uu362 ununium 372	210 Uu364 ununium 374	210 Uu366 ununium 376
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210 Uu464 ununium 474	210 Uu466 ununium 476	210 Uu468 ununium 478	210 Uu470 ununium 480	210 Uu472 ununium 482	210 Uu474 ununium 484	210 Uu476 ununium 486	210 Uu478 ununium 488
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210 Uu528 ununium 538	210 Uu530 ununium 540	210 Uu532 ununium 542	210 Uu534 ununium 544	210 Uu536 ununium 546	210 Uu538 ununium 548	210 Uu540 ununium 550	210 Uu542 ununium 552
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210 Uu560 ununium 570	210 Uu562 ununium 572	210 Uu564 ununium 574	210 Uu566 ununium 576	210 Uu568 ununium 578	210 Uu570 ununium 580	210 Uu572 ununium 582	210 Uu574 ununium 584
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210 Uu608 ununium 618	210 Uu610 ununium 620	210 Uu612 ununium 622	210 Uu614 ununium 624	210 Uu616 ununium 626	210 Uu618 ununium 628	210 Uu620 ununium 630	210 Uu622 ununium 632
210 Uu624 ununium 634	210 Uu626 ununium 636	210 Uu628 ununium 638	210 Uu630 ununium 640	210 Uu632 ununium 642	210 Uu634 ununium 644	210 Uu636 ununium 646	210 Uu638 ununium 648
210 Uu640 ununium 650	210 Uu642 ununium 652	210 Uu644 ununium 654	210 Uu646 ununium 656	210 Uu648 ununium 658	210 Uu650 ununium 660	210 Uu652 ununium 662	210 Uu654 ununium 664
210 Uu656 ununium 666	210 Uu658 ununium 668	210 Uu660 ununium 670	210 Uu662 ununium 672	210 Uu664 ununium 674	210 Uu666 ununium 676	210 Uu668 ununium 678	210 Uu670 ununium 680
210 Uu672 ununium 682	210 Uu674 ununium 684	210 Uu676 ununium 686	210 Uu678 ununium 688	210 Uu680 ununium 690	210 Uu682 ununium 692	210 Uu684 ununium 694	210 Uu686 ununium 696
210 Uu688 ununium 698	210 Uu690 ununium 700	210 Uu692 ununium 702	210 Uu694 ununium 704	210 Uu696			