Centre No.					Paper Reference (complete below)							
Candidate No.									/			Signature

Paper Reference(s)

6082/P.01

Edexcel GCE

Chemistry

Advanced Level/ Advanced Supplementary

Module Test 2

Friday 12 January 2001 – Morning

Time: 1 hour 20 minutes

Examiner's use only

Team Leader's use only

Materials required for examination
Nil

Items included with question papers
Nil

Question Number	Leave Blank
1	
2	
3	
4	
Total	

Instructions to Candidates

In the boxes above, write your centre number, candidate number, the paper reference, your signature, surname and initials. The paper reference is shown above.
Answer all questions in the spaces provided in this question paper.
Show all the steps in any calculations and state the units. Calculators may be used.
Final answers to calculations should be given to an appropriate number of significant figures.
Include diagrams in your answers where these are helpful.

Information for Candidates

A periodic table is printed on the back cover of this question paper.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 4 questions in this question paper.
The total mark for this paper is 60.
Pages 14 and 15 are blank.

Advice to Candidates

You are reminded of the need to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.
Additional answer sheets may be used.

Turn over

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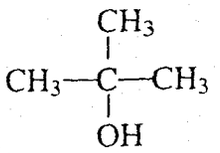
Edexcel

1. One of the isomers of $C_4H_{10}O$ is the alcohol 2-methylpropan-2-ol which has the structural formula



(a) There are three other **structural** isomers of $C_4H_{10}O$ which are also alcohols.

(i) Draw their structural formulae.

(3)

(ii) One of these isomers exhibits stereoisomerism. Name the type of isomerism shown and draw diagrams showing clearly how these stereoisomers differ from one another.

Type of isomerism .....

Diagrams of isomers

(3)

(iii) Describe a test to show that each of the isomers in (i) contains an OH group.

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(2)

(b) Draw the structural formula of the final organic product of the reaction when each of the three alcohols in (a)(i) is heated under reflux with a solution of potassium dichromate(VI) in dilute sulphuric acid.

ALCOHOL	STRUCTURAL FORMULA OF PRODUCT

(3)

QUESTION 1 CONTINUES ON PAGE 4

(c) 2-methylpropan-2-ol can be prepared by the reaction of 2-bromo-2-methylpropane with dilute aqueous potassium hydroxide.

Leave blank

(i) Give the mechanism for this reaction.

(3)

(ii) If a concentrated solution of potassium hydroxide in ethanol is used instead of dilute aqueous potassium hydroxide, a different organic product is obtained. Draw the structural formula of this product.

(1)

Q1

(Total 15 marks)

2. (a) Define:

Leave blank

(i) the standard enthalpy of formation of benzene, $C_6H_6(l)$;

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(2)

(ii) the standard enthalpy of combustion of benzene, $C_6H_6(l)$.

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(2)

(b) Calculate the standard enthalpy of formation of benzene, $C_6H_6(l)$, using the following enthalpy of combustion data:

Substance	$\Delta H_c^{\ominus}$ / kJ mol^{-1}
$C_6H_6(l)$	−3273
$H_2(g)$	−286
C(s)	−394

(3)

QUESTION 2 CONTINUES ON PAGE 6

(c) If the standard enthalpy of formation is calculated from average bond enthalpy data assuming that benzene has three C=C and three C—C bonds, its value is found to be +215 kJ mol^{-1}.

Explain, with reference to the structure and stability of benzene, why this value differs from that calculated in (b). Use an enthalpy level diagram to illustrate your answer.

Lea
bla

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(4)

(d) Benzene reacts with bromine when gently warmed in the presence of a catalyst of anhydrous iron(III) bromide.

Leave blank

(i) The reaction is first order with respect to benzene and first order with respect to bromine. Write the rate equation for the reaction.

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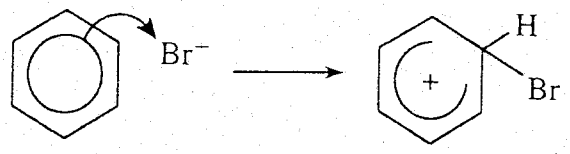
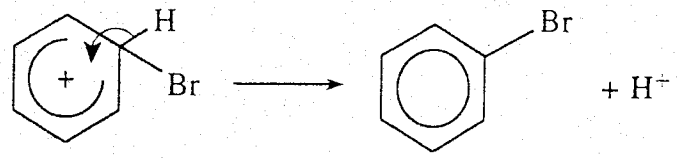
(1)

(ii) The mechanism of this reaction involves an attack by Br^- followed by loss of H^-.

Step 1.



Step 2.



Deuterium, symbol D, is an isotope of hydrogen, and the C---D bond is slightly **stronger** than the C—H bond. If step 2 were the rate-determining (slower) step, suggest how the rate of this reaction would alter if deuterated benzene, C_6D_6, were used instead of ordinary benzene, C_6H_6, and explain your answer.

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(2)

Q2

(Total 14 marks)

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3. Cars are fitted with catalytic converters in order to reduce the pollution caused by the combustion of petrol. Potential pollutant gases include carbon monoxide, nitrogen monoxide and unburnt hydrocarbons. The first two compounds are removed by passing the hot gases over a platinum catalyst.

$$CO(g) + NO(g) \longrightarrow CO_2(g) + \tfrac{1}{2}N_2(g) \qquad \Delta H = -373\,kJ\,mol^{-1}$$

In the absence of a catalyst, this reaction is extremely slow.

(a) (i) Define the term **activation energy**.

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(1)

(ii) Comment on the relative value of the activation energy of this reaction compared with the much faster reaction of nitrogen monoxide with oxygen.

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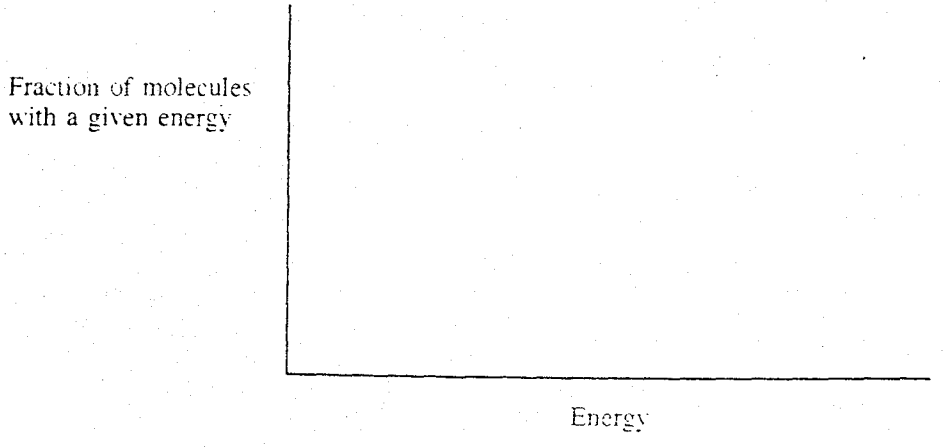
(1)

(b) (i) Draw a distribution of the molecular energies of gas molecules at two different temperatures, T_1 and a higher temperature T_2. Label the curves T_1 and T_2 and mark the energy corresponding to the activation energy, E_A.



(3)

(ii) Use the diagram to explain why the rate of a reaction, such as that between carbon monoxide and nitrogen monoxide, will change as the temperature increases.

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(2)

(c) *The reaction between carbon monoxide and nitrogen monoxide requires a platinum catalyst with a large surface area. Explain the effect of a catalyst on the rate of this reaction and why the surface area needs to be large.

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(4)

Q3

(Total 11 marks)

4. (a) (i) Calculate the concentration, in mol dm^{-3}, of a solution of hydrochloric acid, HCl, which has a pH of 1.13.

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(1)

(ii) Calculate the concentration, in mol dm^{-3}, of a solution of chloric(I) acid, HOCl, which has a pH of 4.23.
Chloric(I) acid is a weak acid with $K_a = 3.72 \times 10^{-8}$ mol dm^{-3}.

(4)

(b) The pH of 0.100 mol dm^{-3} sulphuric acid is 0.98.

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(i) Calculate the concentration of hydrogen ions, H^+, in this solution.

(1)

(ii) Write equations to show the two successive ionisations of sulphuric acid, H_2SO_4, in water.

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(2)

(iii) Suggest why the concentration of hydrogen ions is not 0.20 mol dm^{-3} in 0.100 mol dm^{-3} sulphuric acid.

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(1)

QUESTION 4 CONTINUES ON PAGE 12

(c) Many industrial organic reactions produce hydrogen chloride as an additional product. This can be oxidised to chlorine by the Deacon process:

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$$4HCl(g) + O_2(g) \rightleftharpoons 2Cl_2(g) + 2H_2O(g) \qquad \Delta H = -115\,kJ\,mol^{-1}.$$

0.800 mol of hydrogen chloride was mixed with 0.200 mol of oxygen in a vessel of volume 10.0 dm^3 in the presence of a copper(I) chloride catalyst at 400 °C. At equilibrium it was found that the mixture contained 0.200 mol of hydrogen chloride.

(i) Write an expression for the equilibrium constant K_c.

(1)

(ii) Calculate the value of K_c at 400 °C.

(4)

(d) State and explain the effect, if any, on the **position of equilibrium** in (c) of:

Leave blank

(i) decreasing the temperature;

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(2)

(ii) decreasing the volume;

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(2)

(iii) removing the catalyst.

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(2)

Q4

(Total 20 marks)

TOTAL FOR PAPER: 60 MARKS

END

THE PERIODIC TABLE

Period	Group 1	2											3	4	5	6	7	0
1	1 H Hydrogen 1																	2 He Helium 4
2	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	10 Ne Neon 20
3	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	18 Ar Argon 40
4	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 63.5	30 Zn Zinc 65.4	31 Ga Gallium 70	32 Ge Germanium 73	33 As Arsenic 75	34 Se Selenium 79	35 Br Bromine 80	36 Kr Krypton 84
5	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 (99)	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
6	55 Cs Caesium 133	56 Ba Barium 137	57 ▶ La Lanthanum 139	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 (210)	85 At Astatine (210)	86 Rn Radon (222)
7	87 Fr Francium (223)	88 Ra Radium (226)	89 ▶▶ Ac Actinium (227)	104 Unq Unnil-quadium (261)	105 Unp Unnil-pentium (262)	106 Unh Unnil-hexium (263)												

Key

Atomic Number
Symbol
Name
Relative atomic mass

▶ Lanthanoid elements	58 Ce Cerium 140	59 Pr Praseo-dymium 141	60 Nd Neodymium 144	61 Pm Promethium (147)	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
▶▶ Actinoid elements	90 Th Thorium 232	91 Pa Protactinium (231)	92 U Uranium 238	93 Np Neptunium (237)	94 Pu Plutonium (242)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (245)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (253)	101 Md Mendelevium (256)	102 No Nobelium (254)	103 Lr Lawrencium (257)