Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	2	5	2	/	0	1	Signature	

Paper Reference(s)

6252/01

Edexcel GCE

Chemistry (Nuffield)

Advanced Subsidiary

Unit Test 2

Wednesday 6 June 2007 – Morning

Time: 1 hour 30 minutes

Examiner's use only		

Team Leader's use only		

Question Number	Leave Blank
1	
2	
3	
4	
Total	

Materials required for examination
Nil

Items included with question papers
Passage for Section B

A calculator may be used.

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and your signature.
Answer ALL questions in Section A and Section B. Write your answers in the spaces provided in this question paper.
The passage for Section B is provided on a separate insert.
Final answers to calculations should be given to an appropriate number of significant figures.
Do not return the insert with the question paper.

Information for Candidates

A Periodic Table is printed on the back cover of this paper.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
The total mark for this paper is 60. There are 16 pages in this paper. All blank pages are indicated.

Advice to Candidates

You are advised to show all steps in any calculations.
You should aim to spend no more than 55 minutes on Section A and 35 minutes on Section B.
You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking into account your use of grammar, punctuation and spelling.
Up to 2 marks will be awarded for the Quality of Written Communication used in Section B.

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Leave blank

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

SECTION A

You should aim to spend no more than 55 minutes on this section.

1. This question is about the manufacture of bromine from bromide ions found in seawater.

(a) In the first step, chlorine gas is bubbled into acidified seawater. This converts the bromide ions to bromine. The low pH prevents hydrolysis of the liberated bromine.

(i) Complete and balance the equation for the hydrolysis of bromine with water which is a disproportionation reaction.

$Br_2(aq) + H_2O(l) \rightleftharpoons$ .....$H^+(aq)$ + ... + ...

(2)

(ii) What is the meaning of the symbol $\rightleftharpoons$?

.....

.....

(1)

(iii) Explain, using oxidation numbers, why this reaction is known as disproportionation.

.....

.....

.....

.....

(2)

(iv) Write the ionic equation, including state symbols, for the reaction of chlorine gas with bromide ions.

(2)

Leave blank

(b) In the second step, air is blown through the reaction mixture to remove the bromine as a vapour which is then mixed with sulphur dioxide gas and water vapour.

The unbalanced equation for this reaction is

$$Br_2 + H_2O + SO_2 \rightarrow H^+ + Br^- + SO_4^{2-}$$

(i) Identify the elements which are oxidised and reduced and give their oxidation numbers.

Element **oxidised** .....

Oxidation number initial ..... final .....

Element **reduced** .....

Oxidation number initial ..... final .....

(2)

(ii) Using this information, or otherwise, balance the equation.

Br_2 + H_2O + $SO_2 \rightarrow$ H^+ + Br^- + SO_4^{2-}

(1)

(c) These two steps produce a much more concentrated solution of bromide ions.

What test, other than reacting it with chlorine, could you carry out to show the presence of bromide ions in this solution? Give the positive result expected.

Test .....

Result .....

(2)

(d) The hydrobromic acid solution, produced in the second step, is treated with chlorine in the presence of steam which produces bromine gas. This is condensed and then purified.

(i) There are two main impurities in the liquid bromine, one of which is water. Suggest the other.

.....

(1)

(ii) Suggest TWO steps you would use to obtain pure dry liquid bromine.

.....

.....

.....

(2)

Q1

(Total 15 marks)

Leave blank

2. This question is about the manufacture, properties and uses of methanol.

Methanol is manufactured from synthesis gas, a mixture of carbon monoxide, carbon dioxide and hydrogen.

80 years ago, plants making methanol used pressures of about 200 atmospheres and a temperature of 400 °C.

Today, modern plants operate at a pressure of 100 atmospheres, a temperature of 270 °C and with a copper catalyst.

(a) Suggest TWO possible sources of synthesis gas from raw materials containing both carbon and hydrogen.

.....

(1)

(b) In the modern plant, what is the operating temperature in Kelvin?

.....

(1)

(c) (i) Draw a 'dot and cross' diagram for methanol. Show outer shell electrons only.

(1)

(ii) Draw the displayed formula of methanol.

Label and give the values of TWO different bond angles.

(2)

Leave blank

(d) The main reactions involved in the conversion of synthesis gas to methanol in both methods are

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \qquad \Delta H = -91 \text{ kJ mol}^{-1}$$

$$CO_2(g) + 3H_2(g) \rightleftharpoons CH_3OH(g) + H_2O(g) \qquad \Delta H = -49 \text{ kJ mol}^{-1}$$

Compare the old and the new methods by considering their operating conditions. Discuss ONE advantage of the old method and THREE advantages of the new method. Justify your answers.

(i) Advantage of old method.

.....

.....

.....

(1)

(ii) Advantages of new method.

Advantage 1 .....

.....

.....

.....

Advantage 2 .....

.....

.....

.....

Advantage 3 .....

.....

.....

(3)

Leave blank

(e) A methanol molecule has 18 electrons **in total**.

(i) Give the name and formula of a hydrocarbon with the same number of electrons.

Name .....

Formula

(1)

(ii) Which intermolecular force depends to a large extent on the number of electrons present?

.....

(1)

(iii) Would you expect methanol or your hydrocarbon in (e)(i) to have the higher boiling point? Justify your answer.

.....

.....

.....

(1)

(iv) Draw a diagram to show the strongest intermolecular force between TWO molecules of the compound with the higher boiling point.
Indicate and give the value of the bond angle between these two molecules.

.....

(2)

Leave blank

(f) One use of methanol is as a fuel.

(i) Write the equation, including state symbols, for the complete combustion of methanol.

(2)

(ii) Suggest ONE reason why methanol might be preferable to petrol as a fuel.

.....

.....

.....

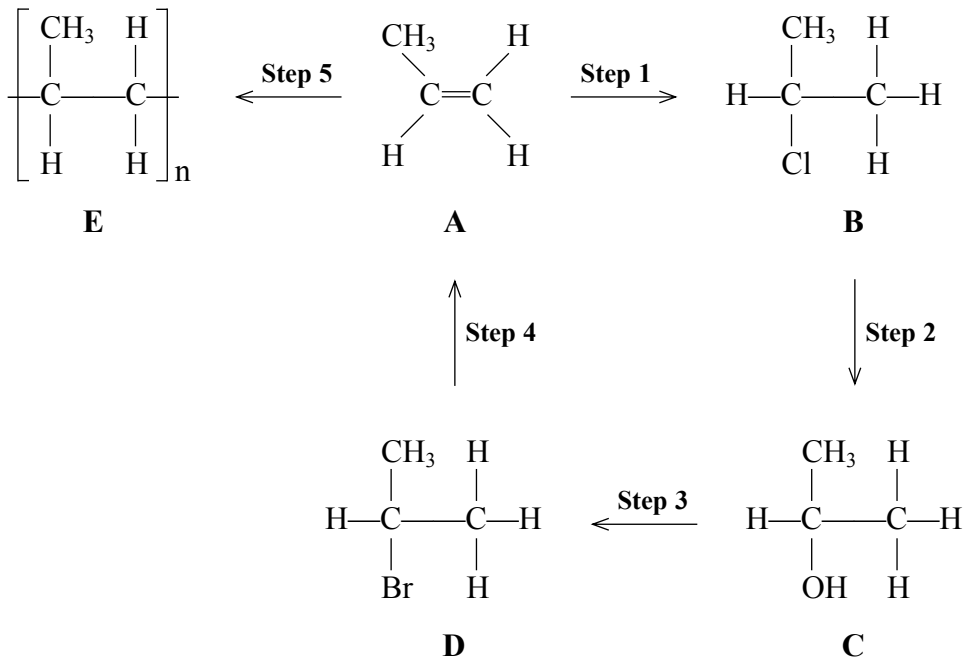
(1)

Q2

(Total 17 marks)

Leave blank

3. This question concerns the compounds and reactions shown in the following reaction scheme.



(a) From the compounds, **A** to **E**, state

(i) which is a member of the same homologous series as pent-1-ene.

.....

(1)

(ii) which are described as secondary compounds.

.....

(2)

(b) Give the systematic name for

(i) compound **D** .....

(1)

(ii) compound **E**.....

(1)

Leave blank

(c) (i) What reagent and conditions would you use for **step 4**?

Reagent .....

Conditions .....

(2)

(ii) What type of reaction is this? .....

(1)

(d) Compound **B** could be made from chlorine and propane in the presence of sunlight.

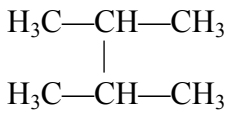
(i) Write an equation to represent the initiation step in this chain reaction.

(1)

(ii) Write an equation for the overall reaction to produce **B** in this way.

(1)

(iii) Another possible product of this reaction has the following structural formula.



Name this compound .....

Suggest how this compound formed in the reaction mixture.

Name the type of step involved in its formation.

.....

(3)

Q3

(Total 13 marks)

TOTAL FOR SECTION A: 45 MARKS

Leave blank

SECTION B

You should aim to spend no more than 35 minutes on this section. The passage needed for this section is provided on a separate sheet.

4. Read the passage on **RADON: NOT SO NOBLE?** straight through and then more carefully. Answer the following questions.

(a) (i) What TWO things do all isotopes of the same element have in common?

.....

(1)

(ii) What else do all the isotopes of radon have in common?

.....

(1)

(b) Suggest why radon is more hazardous than the other decay products of thorium, uranium and actinium.

.....

.....

(1)

(c) By considering the forces between radon particles and between water particles, why is it surprising that the passage says that radon is soluble in water?

.....

.....

.....

(2)

Leave blank

(d) (i) The volume of a normal breath when resting is about 3 dm^3.

How many gas particles are breathed in when you take a normal breath?
[Molar volume of a gas is 24 dm^3 at room temperature and pressure.
The Avogadro constant, $L = 6.0 \times 10^{23}$]

(1)

(ii) In an average house, what percentage of the particles inhaled in a single breath are radon?

(1)

(e) Summarise the ways in which radioactivity caused by radon can get into your home and how the risk of developing lung cancer as a result can be reduced. Use no more than 100 words.

(8)

You are NOT asked to summarise the whole passage, nor to include equations in your summary. At the end of your summary state the number of words you have used. You should write your summary on the lined pages provided in this question paper.

Credit will be given for answers written in good English, using complete sentences and using technical words correctly and chemical names rather than formulae. Avoid copying long sections from the original text. Numbers count as one word, as do standard abbreviations, units and hyphenated words. Any title you give your passage does not count in your word total.

There are penalties for the use of words in excess of 100.

START YOUR SUMMARY ON PAGE 12

Leave blank

Leave blank

Q4

(Total 15 marks)

TOTAL FOR SECTION B: 15 MARKS

TOTAL FOR PAPER: 60 MARKS

END

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THE PERIODIC TABLE

Period	1	2	Group										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
Molar mass in g mol^{-1}

► Lanthanide 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
►► Actinide 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)

Paper Reference(s)

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Passage for Section B

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6252/01 - Unit Test 2

RADON: NOT SO NOBLE?

There are three naturally occurring isotopes of radon which result from the decay of thorium, uranium and actinium. In addition, there are 26 isotopes which have been produced artificially. The most stable isotope is $^{222}_{86}Rn$ which has a half-life of 3.28 days and decays by emitting α-particles.

Artificial radiation contributes only 13% to the total in the UK. 12% of this is from medical sources such as X-rays for the examination of our lungs, teeth and broken bones. This means that 87% of our total radiation dose comes from naturally occurring sources in the Earth's crust, and enters the air, our food and water. Of this, 51% comes from radon. Food and drink account for a further 10%. Other sources of natural radiation are γ-rays (14%) and cosmic rays (10%).

In the uranium-238 decay series, all of the decay fragments are both radioactive and solid and remain in the soil apart from radon-222. If the radon gas decays in the ground, it forms daughter products, which are solid and thus remain in the ground. However, some radon gas may escape through cracks in the rocks and soil. This gas, and its decay products, are normally diluted in the atmosphere, and thus pose no significant danger. However, if radon collects in enclosed spaces it may be a health risk.

It was first recognised in the 1920s that radon was probably associated with the high rate of lung cancer in groups of metal miners. In recent years, there has been concern about the risk of lung cancer because radon is thought to build up in houses. The gas could be produced by the building materials, particularly if the building is made of granite. However, the radon that enters through cracks or through porous building materials from the ground, is thought to pose a much more serious problem. Furthermore, since radon is soluble in water it may travel considerable distances underground. Radon may also enter houses through the drains.

The levels of radon in houses vary from month to month throughout the year, being lowest in the summer and highest in the winter. This is probably related to having more windows open in summer. Similarly, the level also increases with the time of day, building up during the night.

It is estimated that in a room in an average house, each breath of air inhaled contains 3000 atoms of radon. Most of these atoms are breathed out again, so no harm is done. However, some may dissolve in the blood and a few radon atoms will decay and give off α-radiation which may be harmful to the lungs.

When radon decays in the air, the daughter products formed are solids and are absorbed onto dust or smoke particles which remain in the air. When these particles are breathed in, they stick to the moist surface of the bronchi and lungs emitting α-radiation over a longer time.

Although about 2800 deaths per year in England and Wales can be attributed to radon-induced cancer, you are 96 times more likely to die from a heart attack or stroke.

The amount of radon building up in a house can be reduced by improving the ventilation, provided that the replacement air is drawn from the outside and is not drawn up through the floor. Paradoxically, the use of extractor fans may aggravate radon problems by drawing more gas from the ground. The use of coal fires gives excellent ventilation with up to four room changes of air per hour, whereas with modern central heating the trend is to keep houses sealed up.

There are several ways of limiting the amount of radon entering a house. Where the ground floor is suspended timber, it can be sealed by using a polythene sheet or hardboard to prevent air being sucked in through cracks. The ventilation beneath the floor can be improved by adding more air bricks or an extractor fan.

Don't panic. Devon and Cornwall are by far the most affected counties in the UK but estimates for these two counties suggest only 1000 – 2000 houses exceed the potentially dangerous level of radiation.

(691 words)

(Source: adapted from *Radon: not so noble?* by JD Lee and TE Edmonds. Education in Chemistry, November 1991)

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