ST JOSEPH'S INSTITUTION

END-OF-YEAR EXAMINATION 2020
(YEAR 3)

CANDIDATE NAME								
CLASS						INDEX NUMBER		

CHEMISTRY **6092 / 02**

Paper 2 **1 OCTOBER 2020**

Additional Materials: NIL **1 hour 40 minutes**

(0800 - 0940)

READ THESE INSTRUCTIONS FIRST

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

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

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

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The use of an approved scientific calculator is expected, where appropriate.

A copy of the Periodic Table is printed on page 2.

For Examiner's Use	
Section A	/ 40
Section B	/ 30
Total	/ 70

This document consists of **21** printed pages including this cover page.

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							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											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 –		114 Fl flerovium –		116 Lv livermorium –		

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.).

Section A

Answer ***ALL*** questions in the spaces provided.
The total mark for this section is 40.

A1 An ester is a substance formed between the reaction of two organic compounds, an alcohol and an organic acid.

An example of an ester is propyl ethanoate formed by the reaction of propanol (alcohol, C_3H_7OH, boiling point 97 °C) and ethanoic acid (organic acid, CH_3COOH, boiling point 120 °C) with a small amount of concentrated sulfuric acid as a catalyst.

(a) The glassware, as shown in **Figure 1.1** and **Figure 1.2** below, can be used for the formation of an ester, both using the same quantities of chemicals from the start.

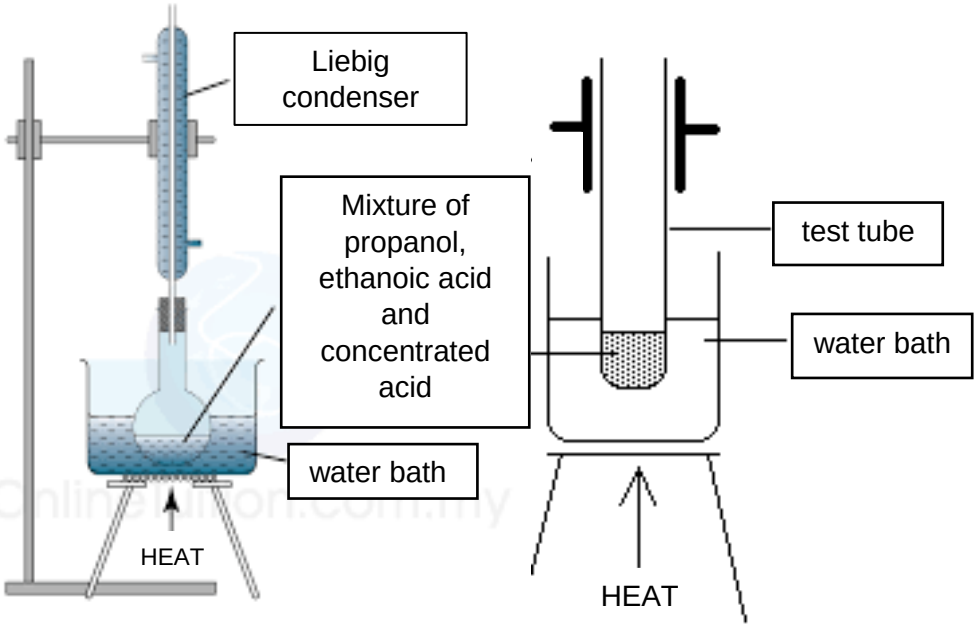


Figure 1.1 **Figure 1.2**

(i) Suggest a reason for using a water bath instead of direct heating.

……

……[1]

(ii) After heating the reaction mixture for a while, a student discovered that the percentage yield of ester from the set up in **Figure 1.2** is less than that from the set up in **Figure 1.1**. Explain why.

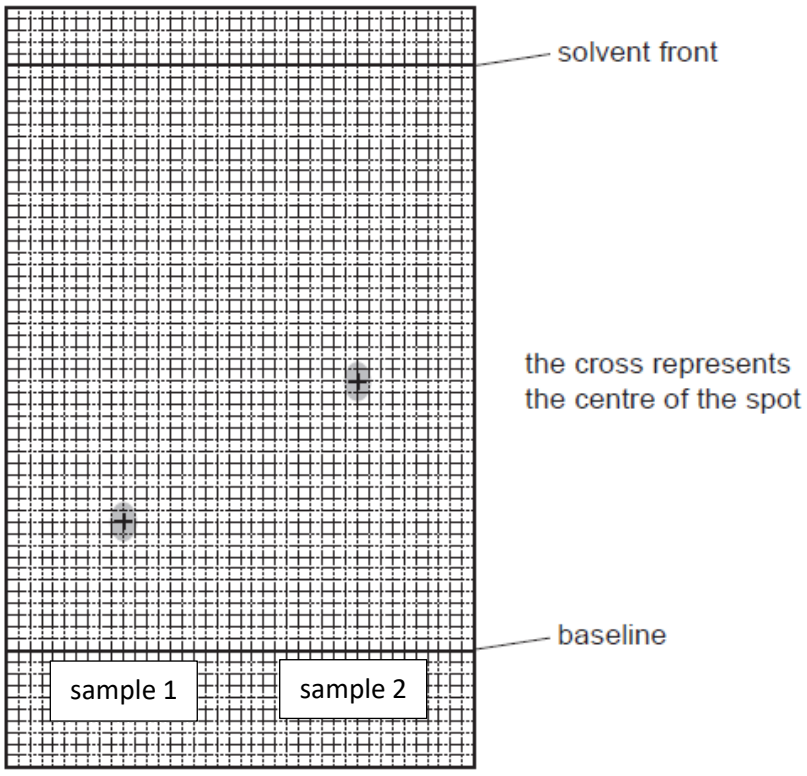
……

……

……

……[2]

(b) Esters can be used as solvents in chromatography. The following shows a chromatogram of plant acids which is drawn to scale.



An ester was used as the solvent and the chromatogram was sprayed with a locating agent, bromothymol blue.

(i) Suggest why it was necessary to spray the chromatogram with bromothymol blue.

.....

……..... [1]

(ii) Using evidence from the chromatogram, state which sample is more soluble in the ester.

.....

……..... [1]

(iii) Explain what is meant by the R_f value of a sample.

.....

……..... [1]

(iv) Calculate the R_f values of the two samples and use the data in the table to identify the plant acids.

plant acid	R_f value
tartaric acid	0.22
citric acid	0.30
oxalic acid	0.36
malic acid	0.46
succinic acid	0.60

sample 1 R_f = ...

It is ..... acid.

sample 2 R_f = ...

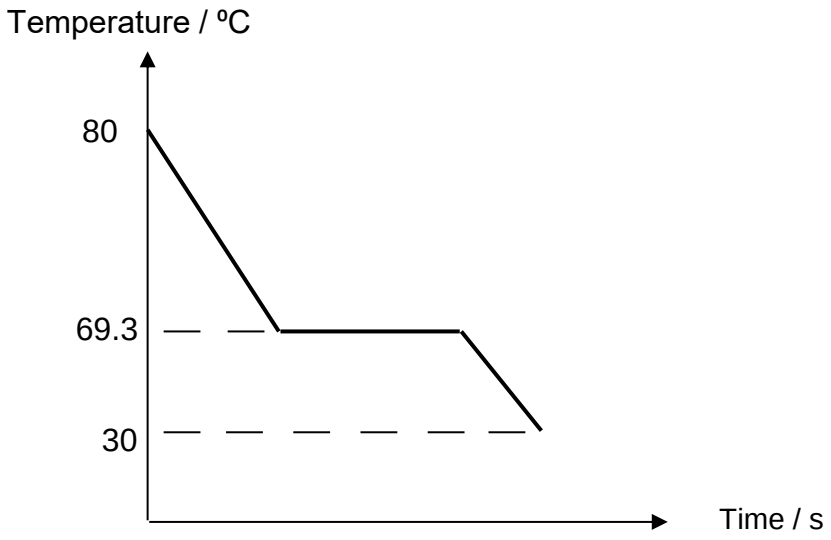
It is ..... acid.

[2]

[Total : 8]

A2 Pure stearic acid melts at 69.3ºC and boils at 361ºC. A solid sample of stearic acid was heated to 80ºC and allowed to cool to 30ºC.

The graph of temperature versus time for the cooling process is shown below.



(a) Describe the changes in **movement** and **arrangement** of the stearic acid particles as temperature decreases from 80ºC to 68ºC.

…….....

…….....

…….....

…….....[2]

(b) Draw, on the same axes in the graph above, the expected graph of temperature versus time if the sample of stearic acid was impure. [1]

(c) A pure sample of stearic acid was heated from 350ºC to 370ºC.

State and explain, in terms of kinetic particle theory, the change in state that occurred.

……

……

……

…… [2]

[Total: 5]

A3 The table shows some information about atoms of the elements **P**, **Q**, **R** and **S**. (The letters do not represent the atomic symbols of the elements.)

Element	Number of protons	Number of neutrons	Nucleon number	Electronic configuration
P	16	16	32	2,8,6
Q	12	12	24	2,8,2
R	18	22		
S	17	18	35	2,8,7

(a) Complete the table above by filling in the nucleon number and electronic configuration for element **R**. [1]

(b) Explain why element **R** tends to be monatomic.

……

……[1]

(c) Describe the change in electronic configuration of an atom of element **Q** when it combines with an atom of element **P**.

…….....

……..……..... [1]

(d) Elements **P** and **S** combine to form a compound. Draw a 'dot-and-cross' diagram to show the bonding in this compound.

Your diagram should show only valence electrons.

[2]

(e) Another isotope of element **S** has a nucleon number of 37. Isotopes of elements have different physical properties but similar chemical properties.

(i) Define the term 'isotope'.

…….....

……..……..... [1]

(ii) Explain why the isotopes of elements possess similar chemical properties.

…….....

…….....[1]

[Total: 7]

A4 Methane, CH_4, is a commonly used gas for household cooking. It is colourless, odourless and burns with a bright blue flame.

20 cm^3 of methane and 60 cm^3 of oxygen are reacted to form carbon dioxide and water as the only products.

(a) Write a balanced chemical equation with state symbols for the reaction of methane and oxygen.

…….....[2]

(b) Determine which is the limiting reagent for the reaction in **(a)**

[3]

(c) Calculate the total volume of gas remaining at the end of the reaction at room temperature and pressure.

[2]

(d) In reality, the percentage yield of carbon dioxide produced is only 70%. Calculate the volume of CO_2 produced.

[1]

[Total : 8]

A5 A student prepares barium sulfate by mixing two solutions of barium nitrate and potassium sulfate. Barium sulfate salt, which was collected as residue, was washed with distilled water. The salt was dried using sheets of filter paper.

(a) Write a balanced chemical equation for the reaction between barium nitrate and potassium sulfate. Hence, construct the ionic equation for the reaction.

chemical equation

……[1]

ionic equation

…… [1]

(b) Suggest another substance that can react with barium nitrate to form a good yield of barium sulfate.

……[1]

[Total : 3]

A6 Some reactions of dilute hydrochloric acid are shown in **Fig. 6.1** below.

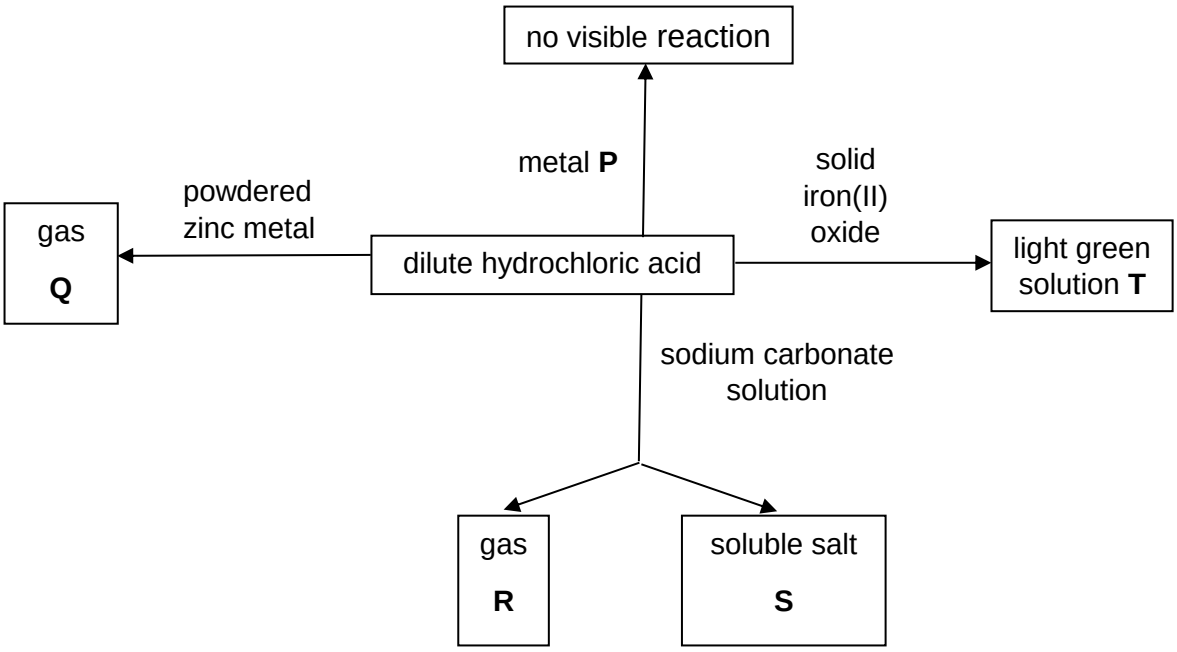


Fig. 6.1

(a) Identify the following substances.

P: …… **Q**: ……

R: …… **S**: ……

T: …… [5]

(b) Describe, using the starting materials shown in the flow chart, how you will prepare pure, dry crystals of substance **T**.

……

……

……

……

……

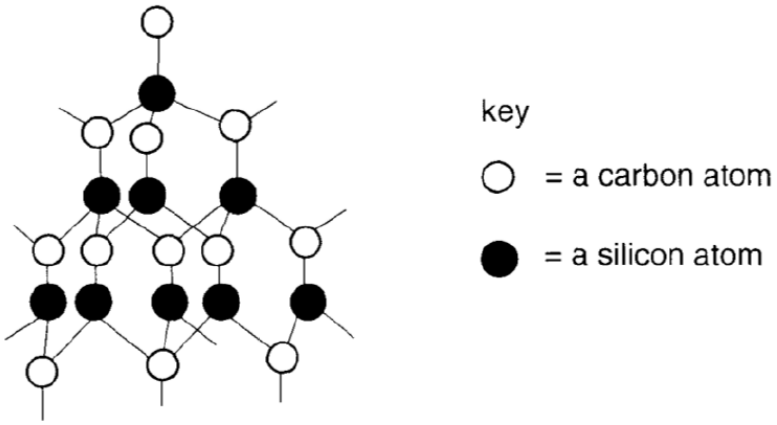
…… [4]

[Total : 9]

Section B

Answer **all** questions from this section in the spaces provided.
The total mark for this section is 30.

B7 **(a)** Diamond and silicon carbide have giant molecular structures. Part of the structure of silicon carbide is shown below:



(i) State one similarity and one difference in structure between silicon carbide and diamond.

……..

……..

……..

……[2]

(ii) Silicon carbide is hard and is a poor conductor of electricity. Explain why in terms of bonding.

……..

……..

……..

……..

……..

……..

……..

……[4]

(iii) Suggest one possible use of silicon carbide.

……[1]

(b) Silicon tetrachloride, $SiCl_4$, is another compound of silicon. It is a colourless, volatile liquid and has a melting and boiling point of -68.7ºC and 57.6ºC respectively.

(i) State the structure of silicon tetrachloride.

……[1]

(ii) Explain, in terms of the bonding present, why the melting point of silicon tetrachloride is low.

……..

……..

……..

……..

……[2]

[Total: 10]

B8 **(a)** Hydrochloric acid is a strong acid with pH 1 while ethanoic acid is a weak acid with pH 5.

(i) What is meant by the term ‘weak acid’?

……

……..[1]

(ii) Starting with acids of the same concentration, describe a chemical test that you can conduct to show that sulfuric acid is a strong acid but ethanoic acid is a weak acid.

Include in your answer, the chemicals you have used, the expected observations and conclusion.

……

……

……

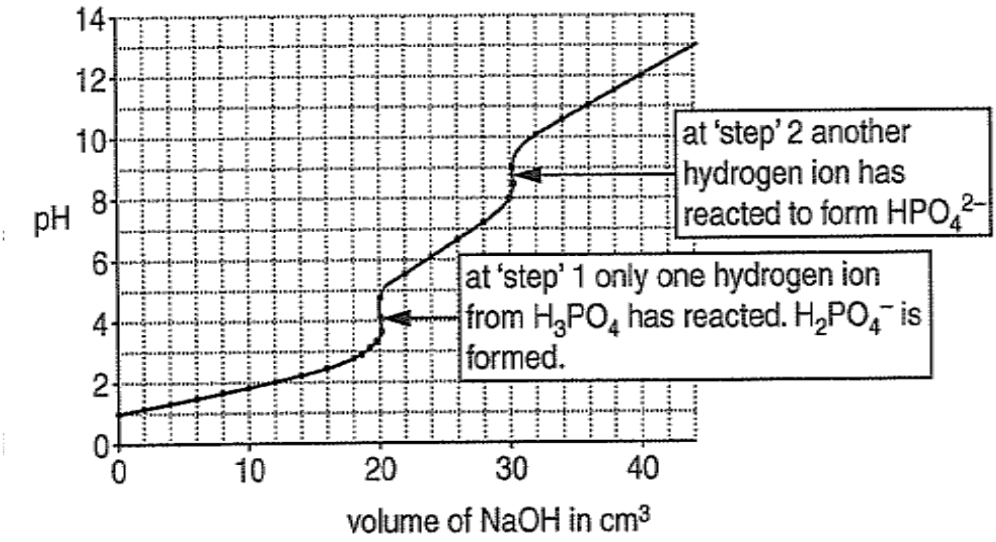
……...

……...

……[3]

(b) A pH probe attached to a computer measures pH changes during reaction of sodium hydroxide solution with dilute phosphoric acid.

A graph of pH against volume of sodium hydroxide used is shown below.



There appears to be three hydrogen atoms in dilute phosphoric acid that may ionise. In practice, only first two hydrogen atoms form ions. At the end of titration, HPO_4^{2-} ions are left.

In 'step' 1, the salt formed is sodium dihydrogen phosphate, NaH_2PO_4.

A few drops of Universal Indicator have been added to the sodium hydroxide solution.

(i) Write a balanced chemical equation with state symbols for the reaction between sodium hydroxide solution and dilute phosphoric acid solution if sodium phosphate is formed as a salt.

……..……..……..…[2]

(ii) Name the salt formed in 'step' 2.

……[1]

(iii) Complete the following table to show the

- colour of the Universal Indicator
- ions present in the solution

when various volumes of sodium hydroxide solution have been added.

volume of NaOH/cm^3	**colour of Universal Indicator**	**ions present**
0		
20		
40		

[3]

[Total : 10]

B9 The atomic and ionic radius of an element can be defined as the average distances between the valence electron shell to the nucleus. The tables below show some information about the atomic radii and ionic radii of some elements in Group **I** and **VII**.

element	no. of electron shells in the atoms	atomic radius / pm	no. of electron shells when it forms ion	ionic radius / pm
lithium	2	152		68
sodium	3	185		98
potassium	4	227		133

element	no. of electron shells in the atoms	atomic radius / pm	no. of electron shells when it forms ion	ionic radius / pm
fluorine	2	71		133
chlorine	3	99		181
bromine	4	115		196

(Note: 1 pm = 10^{-12} m)

(a) Complete the table to show the number of electron shells in the ions of Group **I** and **VII**. [2]

(b) **(i)** Describe the change in the radius when a lithium atom becomes a lithium ion. Suggest a reason why the radius of a lithium atom differs from its ion.

……..……..

……..……..

……..……..

……..……..

……..……..

……..……[2]

(ii) How is the atomic radius of Group **I** and **VII** elements in period 2 different? Suggest a reason for the difference in atomic radius.

……

……

……

……

……

……[2]

(c) **(i)** Describe the trend in the chemical reactivity of elements down Group **VII**.

……

……[1]

(ii) Chlorine gas is passed through potassium bromide and potassium iodide placed in a horizontal tube as shown in **Fig 9.1**.

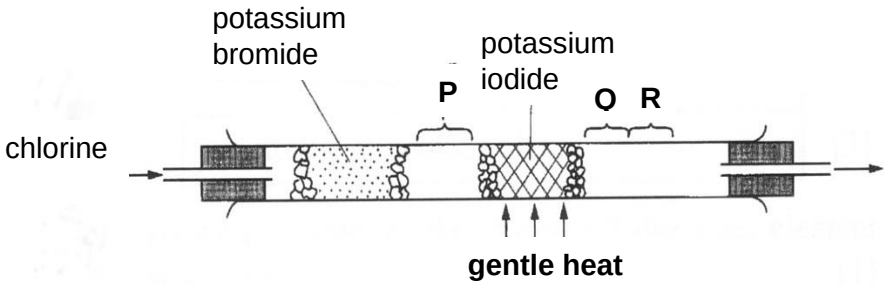


Fig 9.1

Describe the appearance at each of the positions labelled **P, Q,** and **R.**

positions	appearance
P	
Q	
R	

[3]

[Total:10]

END OF PAPER