NAME:	NO:	CLASS:

RIVERSIDE SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2022

SUBJECT	:	Chemistry
CODE/PAPER	:	6092/02
LEVEL/STREAM	:	4 Express
DURATION	:	1 hour 45 minutes

Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B8 The formation of a covalent bond involves the sharing of electrons between two atoms to form a balance between attractive and repulsive forces between the two atoms being bonded.

In a hydrogen molecule, the hydrogen atoms share a valence electron each via covalent bonding. The bond energy is the amount of energy required to break one mole of bonds. The bond energy of a H — H bond is 432 kJ/mol.

Figure 8.1 shows how the bond energy between two hydrogen atoms varies with the distance between their nuclei.

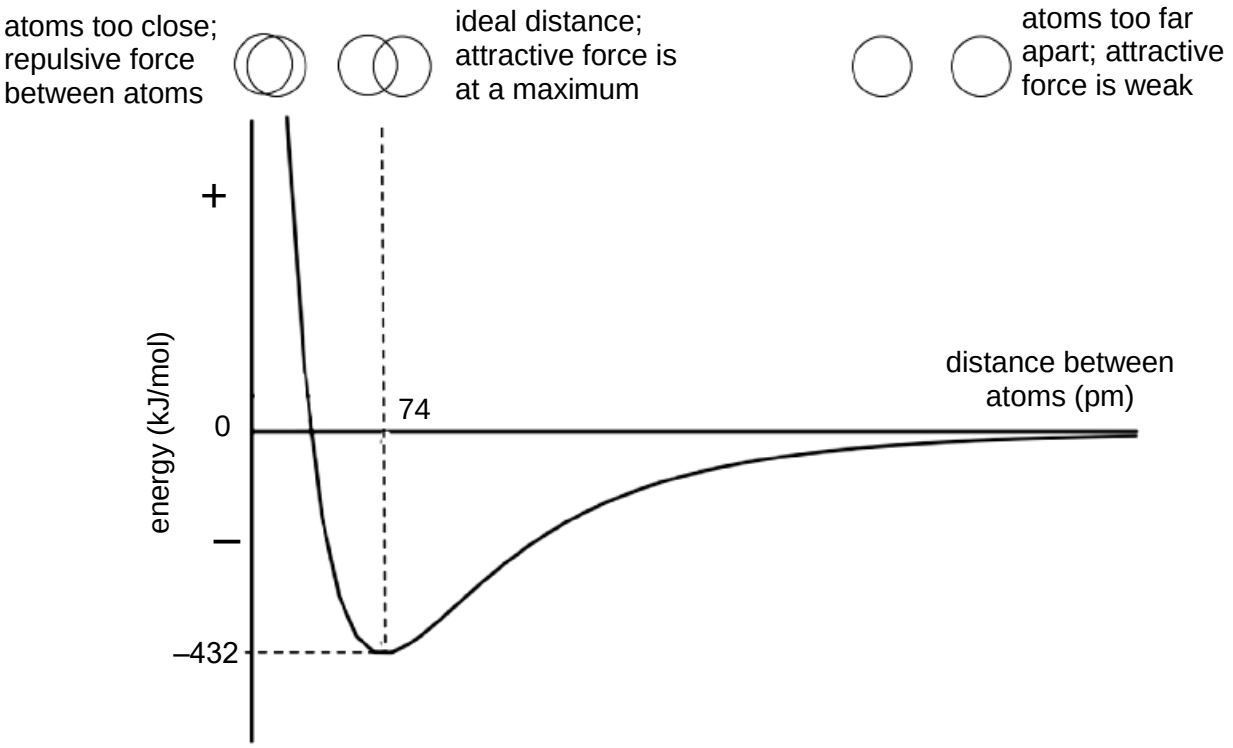


Fig. 8.1

A positive energy value means that repulsive forces between atoms are dominant, while a negative energy value means that attractive forces between atoms are dominant.

The bond length is the average distance between the nuclei of two bonded atoms in a molecule where the attractive force is greatest. For a hydrogen molecule, this distance is 74 picometres.

Table 8.2 shows how the H—H bond compares with the number of bonds, average bond energy and bond length of some elements in Period 2.

Table 8.2

type of bond	number of bonds	average bond energy (kJ/mol)	bond length (pm)
H – H	1	432	74
O – O	1	142	148
O = O	2	494	121
N – N	1	167	145
N = N	2	418	
N ≡ N	3	942	110
F – F	1	155	142

(a) Describe how the bond energy of H—H changes with the distance between the two hydrogen atoms.

……

……

……

……

……[3]

(b) In terms of the forces between the subatomic particles present in the hydrogen atoms, explain the trend of the bond energy as the distance between the hydrogen atoms increases from 74 pm.

……

……

……[2]

(c) **(i)** A student makes the following statement:

"The greater the number of bonds, the shorter the bond length for an element."

Do you agree with the student? Use the information in Table 8.2 to explain your reasoning.

……

……

……[2]

(ii) Use the information in Table 8.2 to predict the length of the N = N bond.

……[1]

(d) Chlorine is in Period 3. The bond length of C*l* – C*l* is 199 pm.

In terms of atomic structure, suggest the difference in bond length between chlorine and fluorine.

……

……

……[2]

(e) When lightning strikes, nitrogen and oxygen in the air react to form nitrogen dioxide.

$$N_2(g) + 2O_2(g) \rightarrow 2NO_2(g) \quad (\Delta H = +180 \text{ kJ/ mol.})$$

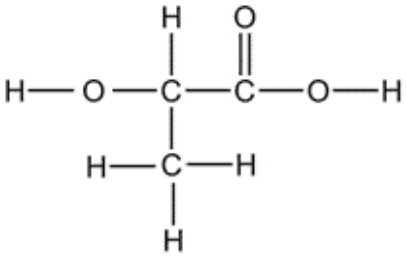
Calculate the energy released during bond forming.

[2]

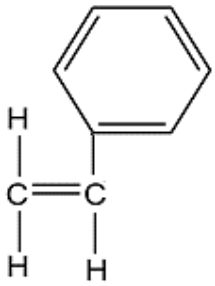
[Total: 12]

B9 Polylactic acid (PLA) is a biodegradable plastic whose feedstock is derived from starch-rich crops such as sugarcane, maize or wheat. It has gained popularity as a suitable plastic to replace polystyrene to make disposable plastic cups and plates.

The monomer of PLA is lactic acid, and the monomer of polystyrene is styrene. Their structures are shown below.



lactic acid



styrene

(a) Describe a chemical test, including observations, to distinguish between lactic acid and styrene.

……

……

……[2]

(b) Outline **one** similarity and **two** differences between the polymerisation of lactic acid and styrene.

……

……

……

……

……[3]

(c) **(i)** Draw the structure of the polymer PLA, showing **one** repeat unit.

[1]

(ii) A polymer of PLA has an M_r of 1,800,000.

Calculate the number of repeat units in this polymer.

number of repeat units = …… [1]

(d) Explain, in terms of the impact on the environment, why polystyrene is being replaced by PLA to make disposable plastic cups and plates.

……..…….

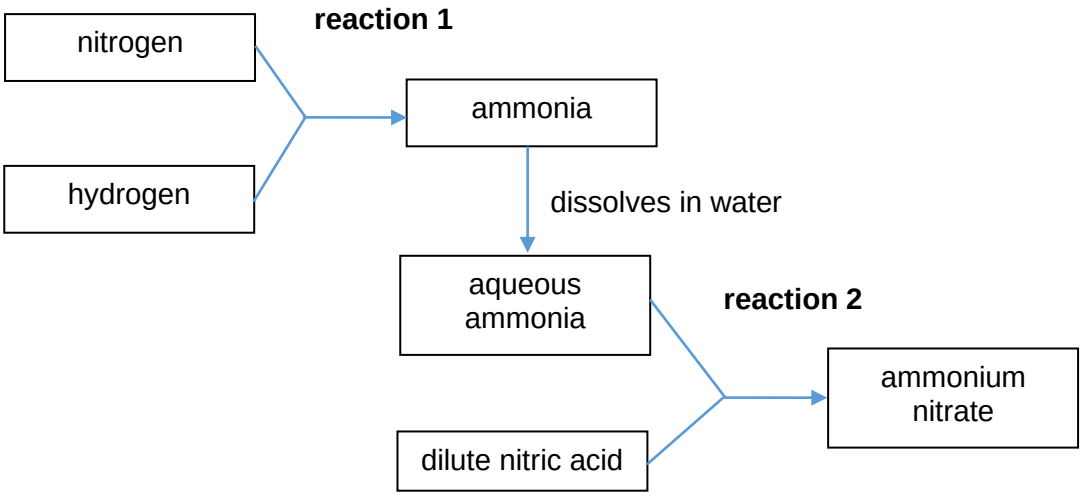
……..……..….[1]

[Total: 8]

EITHER

B10 Ammonium nitrate is commonly used in fertilisers as it contains nitrogen, which is essential for plant growth.

The following flow diagram shows how ammonium nitrate is manufactured from nitrogen, hydrogen and nitric acid.



(a) Describe the conditions required for **reaction 1** to take place.

……...[2]

(b) Construct the ionic equation, with state symbols, for **reaction 2**.

……...[2]

(c) Calculate the percentage of nitrogen by mass in ammonium nitrate.

percentage by mass of nitrogen = ……..[1]

(d) Draw a dot-and-cross diagram to show the bonding in ammonia.

Show outer-shell electrons only.

[2]

(e) Ammonium nitrate can also be produced from the following reaction.

$$Ca(NO_3)_2(aq) + 2NH_3(g) + CO_2(g) + H_2O(l) \rightarrow 2NH_4NO_3(aq) + CaCO_3(s)$$

Describe how a pure and dry sample of ammonium nitrate crystals can be obtained from the products of this reaction after all the aqueous calcium nitrate has reacted.

……...

……...

……...

……...

……...

……...[3]

[Total: 10]

OR

B10 Methanol, CH_3OH, is a member of the homologous series of alcohols.

(a) Methanol can be made from methane in a two-step process.

step 1 Methane is reacted with chlorine gas to produce chloromethane, CH_3Cl.

step 2 CH_3Cl is reacted with sodium hydroxide to produce CH_3OH and one other product.

(i) State the type of reaction occurring in **step 1**, and the condition needed.

type of organic reaction: ……..

condition needed: ……. [2]

(ii) Write the chemical equation for the reaction which occurs in **step 1**.

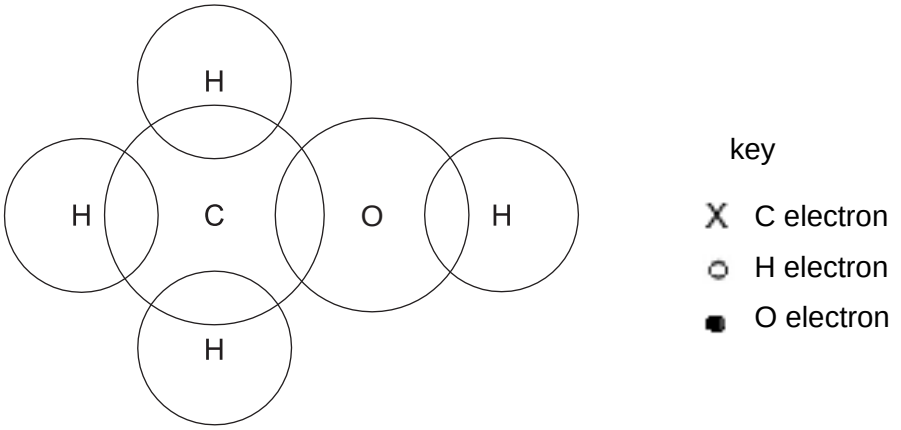
……...[1]

(iii) Complete the chemical equation for **step 2**.

$CH_3Cl + NaOH \rightarrow CH_3OH +$ ..... [1]

(b) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of methanol.

Show outer-shell electrons only.



[2]

(c) Methanol reacts with propanoic acid to form a small molecule and an ester with a molecular formula $C_4H_8O_2$.

(i) Name the products formed when methanol reacts with propanoic acid.

……...[1]

(ii) Draw the full structural formula of an ester which is an isomer of the ester named in **(c)(i)**.

Show all the atoms and bonds.

[2]

(iii) Compare the esters in **(c)(i)** and **(c)(ii)**.

……

……..…[1]

[Total: 10]

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											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 –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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.).