OCR
RECOGNISING ACHIEVEMENT

SPECIMEN

Advanced Subsidiary GCE

CHEMISTRY B (SALTERS)

F332 QP

Unit F332: Chemistry of Natural Resources

Specimen Paper

Candidates answer on the question paper.

Time: 1 hour 45 minutes

Additional Materials:
Data Sheet for Chemistry B (Salters) (Inserted)
Advance Notice article (Inserted)
Scientific calculator

Candidate Name									
Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
- You may use a scientific calculator.
- The insert 'Getting tyred with chemistry!' is provided for use with question 5.
- A copy of the *Data Sheet for Chemistry B (Salters)* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **100**.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**18**	
2	**10**	
3	**28**	
4	**24**	
5	**20**	
TOTAL	**100**	

This document consists of **13** printed pages, **3** blank pages, a *Data Sheet for Chemistry B (Salters) and an Advance Notice insert 'Getting tyred with chemistry!'*.

Answer **all** the questions.

1 Chlorine, Cl_2, can be used as a disinfectant for water. Chlorine is transported in pressurised containers.

(a) Explain, in terms of intermolecular bonds, why chlorine is a gas at room temperature and pressure.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

..... **[2]**

(b) In the event of an accident when chlorine is being transported, people living near the accident site are evacuated. Give **two** properties of chlorine that makes this necessary.

1.....

.....

2.....

..... **[2]**

(c) A student bubbled some chlorine through water. The chlorine reacted with the water as shown below.

$$Cl_2(aq) + H_2O(l) \rightleftharpoons H^+(aq) + Cl^-(aq) + HClO(aq) \qquad \textbf{equation 1.1}$$

(i) The student added some solid sodium chloride to the solution of chlorine in water. Use le Chatelier's principle to describe and predict what would happen to the concentration of $Cl_2(aq)$.

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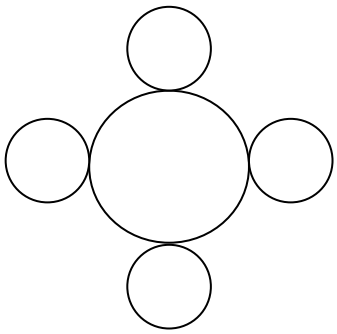
..... **[3]**

(ii) The diagram below shows part of a layer of a sodium chloride lattice.

Label each type of particle and complete the diagram with enough particles to show the structure of the layer clearly.



[2]

(iii) Sodium, like other elements in Group I, readily forms 1+ ions. Explain, in terms of ionisation enthalpies, why this is so and why sodium is unlikely to form compounds containing Na^{2+} ions.

.....

.....

.....

..... **[2]**

(d) **(i)** Give the oxidation states of chlorine in Cl_2 and HC*l*O.

Cl_2 .....

HC*l*O ..... **[2]**

(ii) Give the name of the process in which Cl_2 is changed into HC*l*O.

..... **[1]**

(iii) Explain your choice of answer in **(ii)**.

..... **[1]**

(iv) Write a **half-equation** that shows what happens to the chlorine molecules in **equation 1.1** that are converted into chloride ions.

→

[1]

(e) When a solution of chlorine in water behaves as a disinfectant, the active chemical is HC*l*O.

The disinfecting power decreases when the solution is exposed to sunlight because HC*l*O decomposes to form oxygen and a solution of hydrochloric acid.

Complete the balanced chemical equation for this reaction below. **[2]**

HC*l*O →

[Total: 18]

[Turn over

2 There is considerable concern over rising carbon dioxide levels that most scientists think are causing global warming. This concern has prompted the British Government to charge less in road fund tax for cars that produce less carbon dioxide.

(a) Cars are now more fuel efficient than they used to be and so they produce less carbon dioxide. Suggest **one** design feature that has made cars more fuel efficient.

.....

..... **[1]**

(b) Greenhouse gases like carbon dioxide absorb infrared radiation in the troposphere. Explain the source of this infrared radiation and suggest what happens to a molecule of carbon dioxide when it absorbs this radiation.

In your answer you should make clear how your explanation links with the chemical theory.

.....

.....

.....

.....

..... **[5]**

(c) The Earth's oceans act in a way that regulates the increase in carbon dioxide levels in the troposphere. An equilibrium is set up between gaseous and aqueous carbon dioxide.

(i) Suggest and explain why the balance between gaseous and aqueous carbon dioxide is not a true equilibrium.

.....

..... **[1]**

(ii) Suggest **two** possible methods that could be used for the capture and storage of carbon dioxide, to prevent its build-up in the atmosphere.

1.....

.....

2.....

..... **[2]**

(iii) For **one** of your methods in **(ii)**, suggest an environmental impact that could arise from its use.

..... **[1]**

[Total: 10]

3 The polymer commonly known as PVC exists in two forms. Plasticised PVC is used where flexibility is required. Unplasticised PVC, uPVC, is rigid at room temperature and is used to make things such as guttering for houses.

(a) Suggest **one** other use for uPVC in the construction of a house.

.....**[1]**

(b) PVC is manufactured by polymerising chloroethene. Chloroethene is produced in a two stage synthesis as outlined below.

stage 1 $CH_2 = CH_2 + Cl_2 \xrightarrow{FeCl_3} ClCH_2CH_2Cl$

stage 2 $ClCH_2CH_2Cl \xrightarrow{heat} CH_2{=}CHCl + HCl$

(i) Underline **two** of the following words to describe the reaction in **stage 1**.

addition electrophilic elimination nucleophilic radical substitution

[2]

(ii) Select **one** word from the list to describe the reaction in **stage 2**.

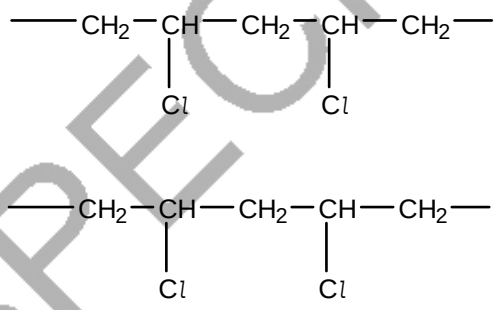
.....**[1]**

(c) PVC owes many of its properties to the intermolecular bonds between the polymer chains.

(i) Name the strongest type of intermolecular bond that is present in PVC.

.....**[1]**

(ii) Use the diagram below to show how these intermolecular bonds hold the PVC chains together.



[2]

(d) Chloroethene will also undergo the following sequence of reactions.

$$CH_2 = CHCl \longrightarrow CH_3CH_2Cl \longrightarrow CH_3CH_2OH \longrightarrow CH_3CHO$$

chloroethene **chloroethane** **ethanol** **compound A**

(i) Name the reagent and conditions needed to turn **chloroethene** into **chloroethane**.

.....

..... **[2]**

(ii) Classify **ethanol** as primary, secondary or tertiary, giving a reason.

.....

..... **[2]**

(iii) Name the functional group in **compound A**.

..... **[1]**

(iv) Give the reagents and conditions for the conversion of **ethanol** to **compound A** in the laboratory.

.....

.....

..... **[3]**

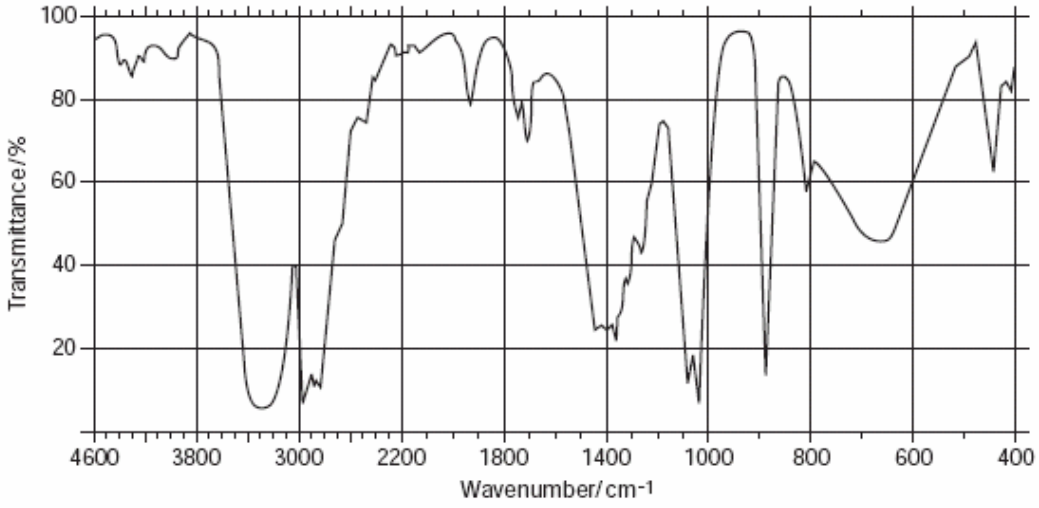
(e) In a laboratory experiment, 10 g of chloroethene, CH_2CHCl, produced 1.5 g of ethanol, CH_3CH_2OH.

Work out the percentage yield of the conversion of chloroethene to ethanol.

Give your answer to **two** significant figures.

yield = ...% **[5]**

(f) Infrared spectroscopy was carried out on the product formed in the reaction of chloroethene to give ethanol. The spectrum that was produced is shown below.



(i) Use information from this spectrum to explain how it confirms that an alcohol had been produced.

.....**[1]**

(ii) Suggest how you would be able to confirm, using infrared spectroscopy, that the product was ethanol.

.....

.....

.....**[2]**

(g) Much of the ethanol is made industrially from ethene.

(i) Give the reagents and conditions by which ethanol is made from ethene in industry.

.....

.....**[2]**

(ii) The reaction in which ethanol is produced from ethene involves attack by an electrophile. Explain what is meant by the term *electrophile*.

.....

.....**[2]**

(iii) Suggest a reason, other than cost, why ethanol is **not** manufactured from chloroethene.

.....

.....**[1]**

[Total: 28]

4 Hydrofluorocarbons, HFCs, have replaced CFCs for many of their uses. They are broken down in the troposphere before they have time to reach the stratosphere.

(a) **(i)** Give the formula of a CFC.

.....**[1]**

(ii) CFCs were used as the refrigerant in domestic fridges. The presence of CFCs makes disposing of old fridges difficult. Give **one** property of CFCs that made them suitable as refrigerants.

.....

.....**[1]**

(b) CFCs cause depletion of the ozone layer. Describe how they do this.

.....

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.....

.....**[4]**

(c) Initially, studies of changes in the Earth's atmosphere did not reveal the problem of ozone depletion. Explain why the information about ozone depletion was overlooked.

.....

.....

.....**[2]**

(d) Other atmospheric pollutants can contribute to a build-up in tropospheric ozone. For example, hydrocarbons can interfere with the normal reactions for the formation and breakdown of ozone. The reaction for the breakdown of ozone involves naturally occurring NO_2 and NO.

$NO_2 \xrightarrow{h\nu} NO + O$ **equation 4.1**

$NO + O_3 \rightarrow NO_2 + O_2$ **equation 4.2**

$O + O_2 \rightarrow O_3$ **equation 4.3**

(i) Combine **two** of these equations to show how ozone is broken down.

$\rightarrow$

[1]

(ii) Hydrocarbons lead to reactions in which NO is converted into NO_2. Explain how this leads to a build-up of ozone.

.....

.....

..... **[2]**

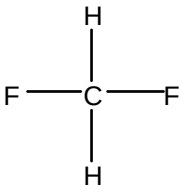
(iii) Suggest **one** disadvantage of a build-up of tropospheric ozone.

.....

..... **[1]**

(e) One example of an HFC is CH_2F_2. The C–F bond is polar.

(i) Mark partial charges on the C and F atoms in the structure below.



[1]

(ii) Explain what determines where the partial charges are placed on this molecule.

.....

.....

..... **[2]**

(iii) Does the whole molecule have a dipole? Explain your answer.

.....

..... **[2]**

(f) If molecules of CH_2F_2 reach the stratosphere, they do not break down to produce F radicals.

(i) Suggest why C–F bonds are not broken in the stratosphere.

.....

..... **[2]**

(ii) The bond enthalpy of the C–F bond is +467 kJ mol^{-1}.

Calculate the minimum energy (in joules) needed to break a single C–F bond.

Avogadro constant, $N_A = 6.02 \times 10^{23}$ mol^{-1}

minimum energy = ... **[2]**

(iii) Calculate the minimum frequency of radiation needed to break a C–F bond.

Give the appropriate units for your answer.

Planck constant, $h = 6.63 \times 10^{-34}$ J Hz^{-1}.

minimum frequency = ...

units..... **[3]**

[Total: 24]

5 This question is based on the Advance Notice article '**Getting tyred with chemistry!**' which is provided as an insert to this paper.

(a) **(i)** Draw the structural formula of 2-methylpropene and the formula of the repeating unit of the rubber formed from it.

2-methylpropene	**repeating unit in the polymer**

[3]

(ii) Suggest the formula of the repeating unit of the rubber formed from butadiene and styrene that has one double bond per butadiene remaining (**Fig. 2**). Include one unit of butadiene and one unit of styrene.

[2]

(iii) Describe a simple chemical test that might enable you to distinguish between the rubbers in parts **(i)** and **(ii)**.

.....

.....

..... **[3]**

(b) Draw the structure of the repeating unit of *trans* poly(isoprene).

[1]

(c) Explain why *trans* poly(isopropene) cannot be rotated to give *cis* poly(isopropene).

.....

..... **[1]**

(d) Explain the meaning of the term *thermoplastic*.

.....

.....

..... **[1]**

(e) Suggest how ultraviolet light might affect rubber.

.....

.....

.....

..... **[3]**

(f) Vulcanisation improves the properties of rubber and accelerator molecules catalyse the process.

Use information from the article about polymer structures and your knowledge of catalysts to explain this.

In your answer you should make clear how your explanation links with the chemical theory.

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..... **[6]**

[Total: 20]

Paper Total [100]

END OF QUESTION PAPER

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OXFORD CAMBRIDGE AND RSA EXAMINATIONS

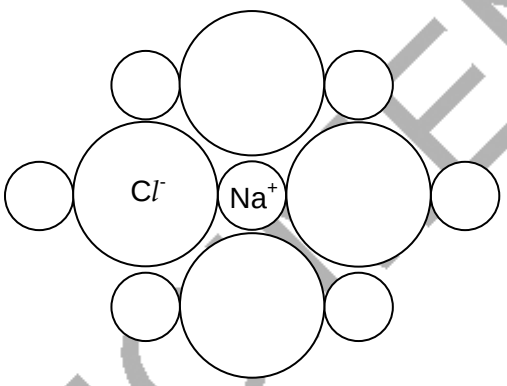
Advanced Subsidiary GCE

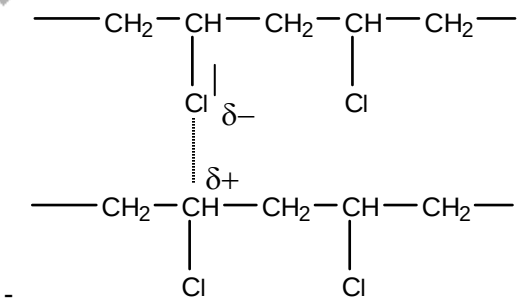
CHEMISTRY B (SALTERS) F332 MS

Unit F332: Chemistry of Natural Resources

Specimen Mark Scheme

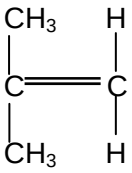
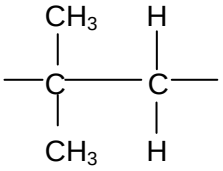
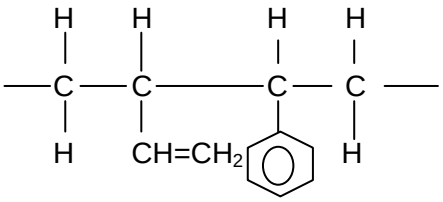
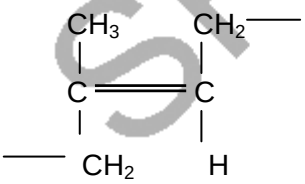
The maximum mark for this paper is 100.

Question Number	Answer	Max Mark
1(a)	Instantaneous dipole – induced dipole forces (must be correctly spelled) between molecules (1); these are weak, so need little energy to overcome them and produce chlorine gas (1)	[2]
(b)	Volatile/gas (1); toxic to humans/causes respiratory diseases/choking gas (1)	[2]
(c)(i)	increase in (chloride ion) concentration (1); will cause equilibrium (position) to move to the left AW (1); (molecular) chlorine/Cl_2 (concentration) increases (1)	[3]
(ii)	For example:  correct sized ions for Cl^- and Na^+ (1); 4 oppositely charged ions or atoms around each type of ion/atom (1)	[2]
(iii)	1st IE is low (1), 2nd IE is very (AW) high (1).	[2]
(d)(i)	Cl_2 = 0 (1) HOCl = +1 (1)	[2]
(ii)	Oxidation/redox (1)	[1]
(iii)	Oxidation state of Cl has increased/ Cl has lost electrons (1)	[1]
(iv)	$Cl_2 + 2e^- \rightarrow 2\ Cl^-$	[1]
(e)	$2\ HClO \rightarrow 2\ HCl + O_2$ Correct formulae for products (1) Balancing (1)	[2]

Question Number	Answer	Max Mark
2(a)	Lean burn engines/ oxygen sensors/ reduced drag/ more complete combustion/ more oxygenates (1)	**[1]**
(b)	Four from: UV/ visible (1); (warms) Earth (1); which radiates IR (1); makes bonds vibrate (1) more (1) warm Earth must be related to IR and IR related to vibration (1)	**[5]**
(c)(i)	System not closed/ as CO_2 (g) moves away from surface/ CO_2 is ionised (1)	**[1]**
(ii)	1. Pump it under pressure onto the ocean floor (1); 2. Pump it underground into spent oil or gas wells (1)	**[2]**
(iii)	The CO_2 combines with any minerals in the surrounding rocks to convert them to carbonates/ pH of Oceans might be affected (1)	**[1]**
3(a)	(drain)pipes/window <u>frames</u>/doors/roofing (1)	**[1]**
(b)(i)	electrophilic (1) addition (1)	**[2]**
(ii)	elimination (1)	**[1]**
(c)(i)	permanent dipole–permanent dipole (1)	**[1]**
(ii)	 δ+, δ- correct (1); indication of attraction (1)	**[2]**

Question Number	Answer	Max Mark
(d)(i)	Hydrogen (1); Ni, hot **or** Pt (room temperature and pressure) (1)	**[2]**
(ii)	Primary (1); as OH is attached to CH_2/ C with OH attached to one other C (1)	**[2]**
(iii)	Aldehyde (1)	**[1]**
(iv)	(potassium/sodium) dichromate/ correct formula (1); (sulfuric) acid (1); distil (1) *NOT heat*	**[3]**
(e)	M_r chloroethene = 62.5 ethanol = 46 (1); Moles chloroethene = 10/62.5 (=0.16) moles ethanol = 1.5/46 (=0.0326/0.033) (1); = moles ethanol (0.16) (1); % = 0.0326 x 100/0.16 = 20% (1) 2 s.f. (1) Mark separately provided some working shown. ecf from figures above (allow 21% if 0.033 moles ethanol used)	**[5]**
(f)(i)	Peak at ~3200 cm^{-1} *(or indicated on spectrum)* shows (alcoholic) OH bond (1)	**[1]**
(ii)	Run IR spectrum for known sample of ethanol (1); compare spectra – they have identical fingerprint/peak pattern (1)	**[2]**
(g)(i)	Water (1); Catalyst with high temp & pressure/ catalyst of sulfuric or phosphoric acid *(second mark dependant on first)*	**[2]**
(ii)	(Partially) positively charged/electron deficient reagent/attracted to areas of high electron density (1); Bonds by accepting a pair of electrons (can be shown via mechanism) (1);	**[2]**
(iii)	Low yield (1)	**[1]**

Question Number	Answer	Max Mark
4(a)(i)	Any carbon compound with chlorine and fluorine only (1)	**[1]**
(ii)	High heat of vaporisation/volatile/non-toxic/unreactive (1)	**[1]**
(b)	In the stratosphere/ upper atmosphere (1); they break down under the influence of <u>high-energy/ high frequency</u> UV/radiation(1); to form chlorine atoms/ *radicals*/ C*l* (1); that *catalyse* the breakdown of ozone (1) QWC: *link between first and second marking points or first and third [1]*	**[4]**
(c)	So much data was being collected that any outside expected ranges was discarded (1); values for ozone concentration were significantly below expected values (1)	**[2]**
(d)(i)	$O_3 \rightarrow O_2 + O$	**[1]**
(ii)	Hydrocarbons provide an alternative to equation 4.2 (1); so less ozone is broken down/ more ozone is made because of increased O (1)	**[2]**
(iii)	Photochemical smog/ an effect like breathing difficulties (1)	**[1]**
(e)(i)	δ+ on carbon, δ- on fluorines (1)	
(ii)	Mention of electronegativity (1); Fluorine more electronegative than carbon (1)	**[2]**
(iii)	Yes, the charges do not balance (1); Shape is tetrahedral (1)	**[2]**
(f)(i)	UV/radiation (1); does not have enough energy/ does not have high enough frequency (1) REJECT for second mark answers that imply intensity of radiation "C–F is strong/ stronger than C–C*l*" scores (1)	**[3]**
(ii)	467/6.02 x 10^{23} (1) x 1000 = 7.75(7)/ 7.76 x 10^{-19} J (1)	**[2]**
(iii)	7.757 x 10^{-19} *ecf*/ 6.63 x 10^{-34} (1) = 1.17 x 10^{15} (1) Hz (1)	**[3]**

Question Number	Answer	Max Mark
5(a)(i)	 C=C correct (1); Completely correct (2)	
	 (1)	[3]
(ii)	 or–CH_2–CH=CH–CH_2–CHAr–CH_2– -CH_2-CH = CH – CH_2 – CHAr – CH2 - Correct structure for part of repeat from butadiene (1); Correct structure for part of repeat from styrene (1)	[2]
(iii)	Add bromine water (1); Colour stays brown with rubber in part (i) (1); Bromine water is decolourised/ colour changes from brown to colourless with rubber in (ii) (1)	[3]
(b)		[1]
(c)	The C=C double bond can't be rotated (1)	[1]
(d)	Softens/ flows/ melts when heated/ warmed (1)	[1]

Question Number	Answer	Max Mark
(e)	(enough) energy(1); to break bonds (1); breaking down structure (1)	**[3]**
(f)	strong S–S bonds (1); stop chains sliding over each other (1) *relation between strong bonds and stopping sliding (1)* path of lower E_a (1); molecules contain sulfur (1); form intermediates (1)	**[6]**
	Paper Total	**[100]**

Assessment Objectives Grid (includes QWC)

Question	AO1	AO2	AO3	Total
1(a)	1	1		**2**
1(b)	2			**2**
1(c)(i)		3		**3**
1(c)(ii)	2			**2**
1(c)(iii)	2			**2**
1(d)(i)	2			**2**
1(d)(ii)	1			**1**
1(d)(iii)		1		**1**
1(d)(iv)	1			**1**
1(e)		2		**2**
2(a)		1		**1**
2(b)	4	1		**5**
2(c)(i)		1		**1**
2(c)(ii)		2		**2**
2(c)(iii)		1		**1**
3(a)		1		**1**
3(b)(i)	2			**2**
3(b)(ii)		1		**1**
3(c)(i)		1		**1**
3(c)(ii)		2		**2**
3(d)(i)	2			**2**
3(d)(ii)	2			**2**
3(d)(iii)	1			**1**
3(d)(iv)			3	**3**
3(e)			5	**5**
3(f)(i)			1	**1**
3(f)(ii)		2		**2**
3(g)(i)	2			**2**
3(g)(ii)	2			**2**
3(g)(iii)		1		**1**
4(a)(i)	1			**1**
4(a)(ii)	1			**1**
4(b)	4			**4**
4(c)			2	**2**
4(d)(i)	1			**1**
4(d)(ii)		2		**2**
4(d)(iii)		1		**1**
4(e)(i)		1		**1**
4(e)(ii)	2			**2**
4(e)(iii)		2		**2**

4(f)(i)		2		**2**
4(f)(ii)		2		**2**
4(f)(iii)		3		**3**
5(a)(i)		3		**3**
5(a)(ii)		2		**2**
5(a)(iii)			3	**3**
5(b)	1			**1**
5(c)	1			**1**
5(d)	1			**1**
5(e)		3		**3**
5(f)		3		**3**
5(f)		3		**3**
Totals	**38**	**48**	**14**	**100**

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