

# Advanced Subsidiary GCE (H032) Advanced GCE (H432)

## Data Sheet for Chemistry A



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## General Information

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Molar gas volume =  $24.0 \text{ dm}^3 \text{ mol}^{-1}$  at room temperature and pressure, RTP

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

Specific heat capacity of water,  $c = 4.18 \text{ J g}^{-1} \text{ K}^{-1}$

Ionic product of water,  $K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$  at 298 K

1 tonne =  $10^6 \text{ g}$

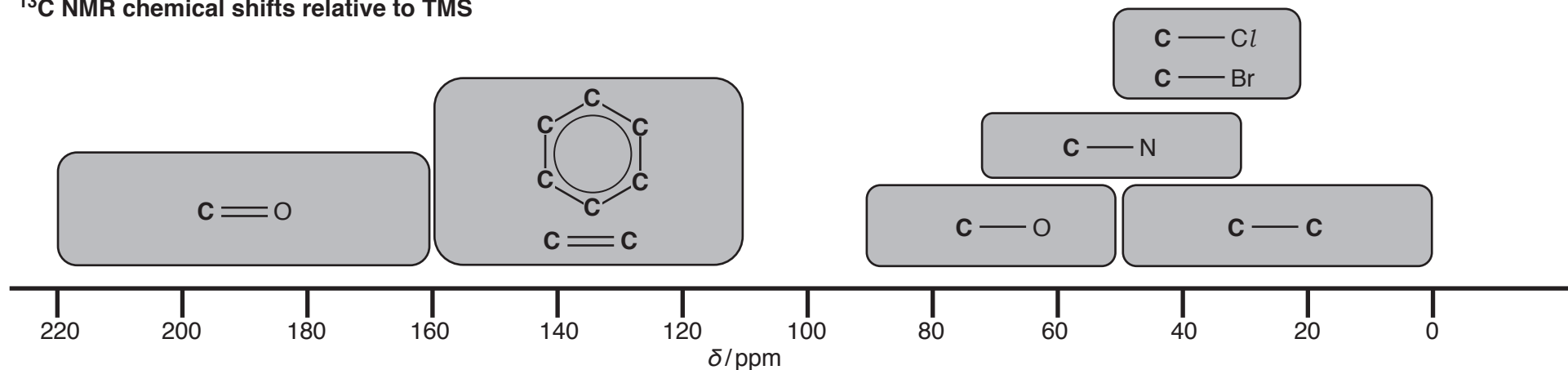
Arrhenius equation:  $k = Ae^{-E_a/RT}$  or  $\ln k = -E_a/RT + \ln A$

Gas constant,  $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$

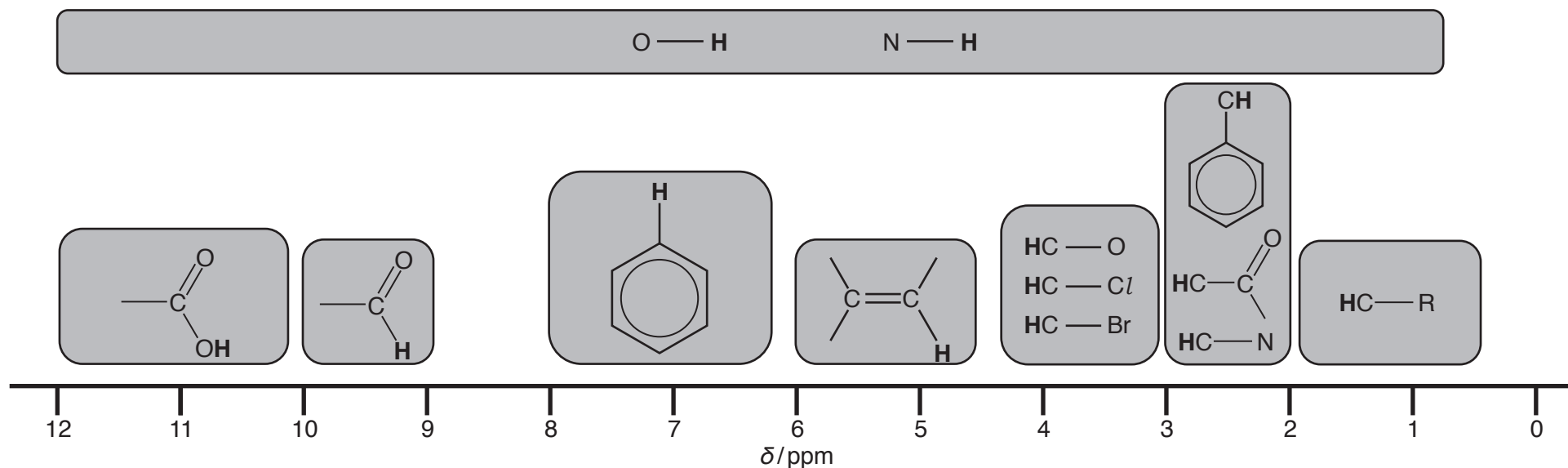
### Characteristic infrared absorptions in organic molecules

Bond	Location	Wavenumber/ $\text{cm}^{-1}$
C–C	Alkanes, alkyl chains	750–1100
C–X	Haloalkanes (X = Cl, Br, I)	500–800
C–F	Fluoroalkanes	1000–1350
C–O	Alcohols, esters, carboxylic acids	1000–1300
C=C	Alkenes	1620–1680
C=O	Aldehydes, ketones, carboxylic acids, esters, amides, acyl chlorides and acid anhydrides	1630–1820
aromatic C=C	Arenes	Several peaks in range 1450–1650 (variable)
C≡N	Nitriles	2220–2260
C–H	Alkyl groups, alkenes, arenes	2850–3100
O–H	Carboxylic acids	2500–3300 (broad)
N–H	Amines, amides	3300–3500
O–H	Alcohols, phenols	3200–3600

### $^{13}\text{C}$ NMR chemical shifts relative to TMS



### $^1\text{H}$ NMR chemical shifts relative to TMS



Chemical shifts are variable and can vary depending on the solvent, concentration and substituents. As a result, shifts may be outside the ranges indicated above.

$\text{OH}$  and  $\text{NH}$  chemical shifts are very variable and are often broad. Signals are not usually seen as split peaks.

Note that  $\text{CH}$  bonded to 'shifting groups' on either side, e.g.  $\text{O}-\text{CH}_2-\text{C}=\text{O}$ , may be shifted more than indicated above.

# The Periodic Table of the Elements

(1)	(2)											(3)	(4)	(5)	(6)	(7)	(0)	
<b>1</b>		<b>Key</b> atomic number <b>Symbol</b> name relative atomic mass																<b>18</b>
<b>1</b> <b>H</b> hydrogen 1.0	<b>2</b>											<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>	<b>17</b>	<b>2</b> <b>He</b> helium 4.0	
<b>3</b> <b>Li</b> lithium 6.9	<b>4</b> <b>Be</b> beryllium 9.0											<b>5</b> <b>B</b> boron 10.8	<b>6</b> <b>C</b> carbon 12.0	<b>7</b> <b>N</b> nitrogen 14.0	<b>8</b> <b>O</b> oxygen 16.0	<b>9</b> <b>F</b> fluorine 19.0	<b>10</b> <b>Ne</b> neon 20.2	
<b>11</b> <b>Na</b> sodium 23.0	<b>12</b> <b>Mg</b> magnesium 24.3											<b>13</b> <b>Al</b> aluminium 27.0	<b>14</b> <b>Si</b> silicon 28.1	<b>15</b> <b>P</b> phosphorus 31.0	<b>16</b> <b>S</b> sulfur 32.1	<b>17</b> <b>Cl</b> chlorine 35.5	<b>18</b> <b>Ar</b> argon 39.9	
<b>19</b> <b>K</b> potassium 39.1	<b>20</b> <b>Ca</b> calcium 40.1	<b>21</b> <b>Sc</b> scandium 45.0	<b>22</b> <b>Ti</b> titanium 47.9	<b>23</b> <b>V</b> vanadium 50.9	<b>24</b> <b>Cr</b> chromium 52.0	<b>25</b> <b>Mn</b> manganese 54.9	<b>26</b> <b>Fe</b> iron 55.8	<b>27</b> <b>Co</b> cobalt 58.9	<b>28</b> <b>Ni</b> nickel 58.7	<b>29</b> <b>Cu</b> copper 63.5	<b>30</b> <b>Zn</b> zinc 65.4	<b>31</b> <b>Ga</b> gallium 69.7	<b>32</b> <b>Ge</b> germanium 72.6	<b>33</b> <b>As</b> arsenic 74.9	<b>34</b> <b>Se</b> selenium 79.0	<b>35</b> <b>Br</b> bromine 79.9	<b>36</b> <b>Kr</b> krypton 83.8	
<b>37</b> <b>Rb</b> rubidium 85.5	<b>38</b> <b>Sr</b> strontium 87.6	<b>39</b> <b>Y</b> yttrium 88.9	<b>40</b> <b>Zr</b> zirconium 91.2	<b>41</b> <b>Nb</b> niobium 92.9	<b>42</b> <b>Mo</b> molybdenum 95.9	<b>43</b> <b>Tc</b> technetium	<b>44</b> <b>Ru</b> ruthenium 101.1	<b>45</b> <b>Rh</b> rhodium 102.9	<b>46</b> <b>Pd</b> palladium 106.4	<b>47</b> <b>Ag</b> silver 107.9	<b>48</b> <b>Cd</b> cadmium 112.4	<b>49</b> <b>In</b> indium 114.8	<b>50</b> <b>Sn</b> tin 118.7	<b>51</b> <b>Sb</b> antimony 121.8	<b>52</b> <b>Te</b> tellurium 127.6	<b>53</b> <b>I</b> iodine 126.9	<b>54</b> <b>Xe</b> xenon 131.3	
<b>55</b> <b>Cs</b> caesium 132.9	<b>56</b> <b>Ba</b> barium 137.3	● 57–71 lanthanoids	<b>72</b> <b>Hf</b> hafnium 178.5	<b>73</b> <b>Ta</b> tantalum 180.9	<b>74</b> <b>W</b> tungsten 183.8	<b>75</b> <b>Re</b> rhenium 186.2	<b>76</b> <b>Os</b> osmium 190.2	<b>77</b> <b>Ir</b> iridium 192.2	<b>78</b> <b>Pt</b> platinum 195.1	<b>79</b> <b>Au</b> gold 197.0	<b>80</b> <b>Hg</b> mercury 200.6	<b>81</b> <b>Tl</b> thallium 204.4	<b>82</b> <b>Pb</b> lead 207.2	<b>83</b> <b>Bi</b> bismuth 209.0	<b>84</b> <b>Po</b> polonium	<b>85</b> <b>At</b> astatine	<b>86</b> <b>Rn</b> radon	
<b>87</b> <b>Fr</b> francium	<b>88</b> <b>Ra</b> radium	● 89–103 actinoids	<b>104</b> <b>Rf</b> rutherfordium	<b>105</b> <b>Db</b> dubnium	<b>106</b> <b>Sg</b> seaborgium	<b>107</b> <b>Bh</b> bohrium	<b>108</b> <b>Hs</b> hassium	<b>109</b> <b>Mt</b> meitnerium	<b>110</b> <b>Ds</b> darmstadtium	<b>111</b> <b>Rg</b> roentgenium	<b>112</b> <b>Cn</b> copernicium		<b>114</b> <b>Fl</b> flerovium		<b>116</b> <b>Lv</b> livermorium			

<b>57</b> <b>La</b> lanthanum 138.9	<b>58</b> <b>Ce</b> cerium 140.1	<b>59</b> <b>Pr</b> praseodymium 140.9	<b>60</b> <b>Nd</b> neodymium 144.2	<b>61</b> <b>Pm</b> promethium 144.9	<b>62</b> <b>Sm</b> samarium 150.4	<b>63</b> <b>Eu</b> europium 152.0	<b>64</b> <b>Gd</b> gadolinium 157.2	<b>65</b> <b>Tb</b> terbium 158.9	<b>66</b> <b>Dy</b> dysprosium 162.5	<b>67</b> <b>Ho</b> holmium 164.9	<b>68</b> <b>Er</b> erbium 167.3	<b>69</b> <b>Tm</b> thulium 168.9	<b>70</b> <b>Yb</b> ytterbium 173.0	<b>71</b> <b>Lu</b> lutetium 175.0
<b>89</b> <b>Ac</b> actinium	<b>90</b> <b>Th</b> thorium 232.0	<b>91</b> <b>Pa</b> protactinium	<b>92</b> <b>U</b> uranium 238.1	<b>93</b> <b>Np</b> neptunium	<b>94</b> <b>Pu</b> plutonium	<b>95</b> <b>Am</b> americium	<b>96</b> <b>Cm</b> curium	<b>97</b> <b>Bk</b> berkelium	<b>98</b> <b>Cf</b> californium	<b>99</b> <b>Es</b> einsteinium	<b>100</b> <b>Fm</b> fermium	<b>101</b> <b>Md</b> mendelevium	<b>102</b> <b>No</b> nobelium	<b>103</b> <b>Lr</b> lawrencium