

Please check the examination details below before entering your candidate information

|                                                                                                  |  |                                                             |                   |
|--------------------------------------------------------------------------------------------------|--|-------------------------------------------------------------|-------------------|
| Candidate surname                                                                                |  | Other names                                                 |                   |
| Centre Number                                                                                    |  | Candidate Number                                            |                   |
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| <b>Pearson Edexcel International GCSE (9–1)</b>                                                  |  |                                                             |                   |
| <b>Monday 19 May 2025</b>                                                                        |  |                                                             |                   |
| Morning (Time: 2 hours)                                                                          |  | Paper reference                                             | 4CH1/1CR 4SD0/1CR |
| <b>Chemistry</b><br><b>UNIT: 4CH1</b><br><b>Science (Double Award) 4SD0</b><br><b>PAPER: 1CR</b> |  |                                                             |                   |
| You must have:<br>Calculator, ruler                                                              |  |                                                             | Total Marks       |

### Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*
- Show all the steps in any calculations and state the units.

### Information

- The total mark for this paper is 110.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*

### Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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# The Periodic Table of the Elements

|                                        |                                        |                                     |                                       |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                        |                                      |                                       |                                          |                                       |                                       |                                       |                                      |                                       |                                         |                                        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| 7<br><b>Li</b><br>lithium<br>3         | 9<br><b>Be</b><br>beryllium<br>4       | 11<br><b>Na</b><br>sodium<br>11     | 12<br><b>Mg</b><br>magnesium<br>12    | 13<br><b>Al</b><br>aluminium<br>13    | 14<br><b>Si</b><br>silicon<br>14     | 15<br><b>P</b><br>phosphorus<br>15    | 16<br><b>S</b><br>sulfur<br>16       | 17<br><b>Cl</b><br>chlorine<br>17     | 18<br><b>Ar</b><br>argon<br>18       |                                       |                                      |                                       |                                      |                                        |                                      |                                       |                                          |                                       |                                       |                                       |                                      |                                       |                                         |                                        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| 19<br><b>K</b><br>potassium<br>19      | 20<br><b>Ca</b><br>calcium<br>20       | 21<br><b>Sc</b><br>scandium<br>21   | 22<br><b>Ti</b><br>titanium<br>22     | 23<br><b>V</b><br>vanadium<br>23      | 24<br><b>Cr</b><br>chromium<br>24    | 25<br><b>Mn</b><br>manganese<br>25    | 26<br><b>Fe</b><br>iron<br>26        | 27<br><b>Co</b><br>cobalt<br>27       | 28<br><b>Ni</b><br>nickel<br>28      | 29<br><b>Cu</b><br>copper<br>29       | 30<br><b>Zn</b><br>zinc<br>30        | 31<br><b>Ga</b><br>gallium<br>31      | 32<br><b>Ge</b><br>germanium<br>32   | 33<br><b>As</b><br>arsenic<br>33       | 34<br><b>Se</b><br>selenium<br>34    | 35<br><b>Br</b><br>bromine<br>35      | 36<br><b>Kr</b><br>krypton<br>36         |                                       |                                       |                                       |                                      |                                       |                                         |                                        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| 37<br><b>Rb</b><br>rubidium<br>37      | 38<br><b>Sr</b><br>strontium<br>38     | 39<br><b>Y</b><br>yttrium<br>39     | 40<br><b>Zr</b><br>zirconium<br>40    | 41<br><b>Nb</b><br>niobium<br>41      | 42<br><b>Mo</b><br>molybdenum<br>42  | 43<br><b>Tc</b><br>technetium<br>43   | 44<br><b>Ru</b><br>ruthenium<br>44   | 45<br><b>Rh</b><br>rhodium<br>45      | 46<br><b>Pd</b><br>palladium<br>46   | 47<br><b>Ag</b><br>silver<br>47       | 48<br><b>Cd</b><br>cadmium<br>48     | 49<br><b>In</b><br>indium<br>49       | 50<br><b>Sn</b><br>tin<br>50         | 51<br><b>Sb</b><br>antimony<br>51      | 52<br><b>Te</b><br>tellurium<br>52   | 53<br><b>I</b><br>iodine<br>53        | 54<br><b>Xe</b><br>xenon<br>54           |                                       |                                       |                                       |                                      |                                       |                                         |                                        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| 55<br><b>Cs</b><br>caesium<br>55       | 56<br><b>Ba</b><br>barium<br>56        | 57<br><b>La*</b><br>lanthanum<br>57 | 58<br><b>Ce</b><br>cerium<br>58       | 59<br><b>Pr</b><br>praseodymium<br>59 | 60<br><b>Nd</b><br>neodymium<br>60   | 61<br><b>Pm</b><br>promethium<br>61   | 62<br><b>Sm</b><br>samarium<br>62    | 63<br><b>Eu</b><br>europium<br>63     | 64<br><b>Gd</b><br>gadolinium<br>64  | 65<br><b>Tb</b><br>terbium<br>65      | 66<br><b>Dy</b><br>dysprosium<br>66  | 67<br><b>Ho</b><br>holmium<br>67      | 68<br><b>Er</b><br>erbium<br>68      | 69<br><b>Tm</b><br>thulium<br>69       | 70<br><b>Yb</b><br>ytterbium<br>70   | 71<br><b>Lu</b><br>lutetium<br>71     | 72<br><b>Hf</b><br>hafnium<br>72         | 73<br><b>Ta</b><br>tantalum<br>73     | 74<br><b>W</b><br>tungsten<br>74      | 75<br><b>Re</b><br>rhenium<br>75      | 76<br><b>Os</b><br>osmium<br>76      | 77<br><b>Ir</b><br>iridium<br>77      | 78<br><b>Pt</b><br>platinum<br>78       | 79<br><b>Au</b><br>gold<br>79          | 80<br><b>Hg</b><br>mercury<br>80       | 81<br><b>Tl</b><br>thallium<br>81     | 82<br><b>Pb</b><br>lead<br>82        | 83<br><b>Bi</b><br>bismuth<br>83      | 84<br><b>Po</b><br>polonium<br>84      | 85<br><b>At</b><br>astatine<br>85     | 86<br><b>Rn</b><br>radon<br>86       |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |         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             |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                       |
| 87<br><b>Fr</b><br>francium<br>87      | 88<br><b>Ra</b><br>radium<br>88        | 89<br><b>Ac*</b><br>actinium<br>89  | 90<br><b>Th</b><br>thorium<br>90      | 91<br><b>Pa</b><br>protactinium<br>91 | 92<br><b>U</b><br>uranium<br>92      | 93<br><b>Np</b><br>neptunium<br>93    | 94<br><b>Pu</b><br>plutonium<br>94   | 95<br><b>Am</b><br>americium<br>95    | 96<br><b>Cm</b><br>curium<br>96      | 97<br><b>Bk</b><br>berkelium<br>97    | 98<br><b>Cf</b><br>californium<br>98 | 99<br><b>Es</b><br>einsteinium<br>99  | 100<br><b>Fm</b><br>fermium<br>100   | 101<br><b>Md</b><br>mendelevium<br>101 | 102<br><b>No</b><br>nobelium<br>102  | 103<br><b>Lr</b><br>lawrencium<br>103 | 104<br><b>Rf</b><br>rutherfordium<br>104 | 105<br><b>Db</b><br>dubnium<br>105    | 106<br><b>Sg</b><br>seaborgium<br>106 | 107<br><b>Bh</b><br>bohrium<br>107    | 108<br><b>Hs</b><br>hassium<br>108   | 109<br><b>Mt</b><br>meitnerium<br>109 | 110<br><b>Ds</b><br>darmstadtium<br>110 | 111<br><b>Rg</b><br>roentgenium<br>111 | 112<br><b>Cn</b><br>copernicium<br>112 | 113<br><b>Nh</b><br>nihonium<br>113   | 114<br><b>Fl</b><br>flerovium<br>114 | 115<br><b>Mc</b><br>moscovium<br>115  | 116<br><b>Lv</b><br>livermorium<br>116 | 117<br><b>Ts</b><br>tennessine<br>117 | 118<br><b>Og</b><br>oganesson<br>118 |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |         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             |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                                       |                                      |                       |
| 119<br><b>Uue</b><br>unbinilium<br>119 | 120<br><b>Uub</b><br>unbinilium<br>120 | 121<br><b>Uut</b><br>untrium<br>121 | 122<br><b>Uuq</b><br>unquadium<br>122 | 123<br><b>Uup</b><br>unpentium<br>123 | 124<br><b>Uuh</b><br>unhexium<br>124 | 125<br><b>Uus</b><br>unseptium<br>125 | 126<br><b>Uuo</b><br>unoctium<br>126 | 127<br><b>Uuh</b><br>unheptium<br>127 | 128<br><b>Uuo</b><br>unoctium<br>128 | 129<br><b>Uuh</b><br>unheptium<br>129 | 130<br><b>Uuo</b><br>unoctium<br>130 | 131<br><b>Uuh</b><br>unheptium<br>131 | 132<br><b>Uuo</b><br>unoctium<br>132 | 133<br><b>Uuh</b><br>unheptium<br>133  | 134<br><b>Uuo</b><br>unoctium<br>134 | 135<br><b>Uuh</b><br>unheptium<br>135 | 136<br><b>Uuo</b><br>unoctium<br>136     | 137<br><b>Uuh</b><br>unheptium<br>137 | 138<br><b>Uuo</b><br>unoctium<br>138  | 139<br><b>Uuh</b><br>unheptium<br>139 | 140<br><b>Uuo</b><br>unoctium<br>140 | 141<br><b>Uuh</b><br>unheptium<br>141 | 142<br><b>Uuo</b><br>unoctium<br>142    | 143<br><b>Uuh</b><br>unheptium<br>143  | 144<br><b>Uuo</b><br>unoctium<br>144   | 145<br><b>Uuh</b><br>unheptium<br>145 | 146<br><b>Uuo</b><br>unoctium<br>146 | 147<br><b>Uuh</b><br>unheptium<br>147 | 148<br><b>Uuo</b><br>unoctium<br>148   | 149<br><b>Uuh</b><br>unheptium<br>149 | 150<br><b>Uuo</b><br>unoctium<br>150 | 151<br><b>Uuh</b><br>unheptium<br>151 | 152<br><b>Uuo</b><br>unoctium<br>152 | 153<br><b>Uuh</b><br>unheptium<br>153 | 154<br><b>Uuo</b><br>unoctium<br>154 | 155<br><b>Uuh</b><br>unheptium<br>155 | 156<br><b>Uuo</b><br>unoctium<br>156 | 157<br><b>Uuh</b><br>unheptium<br>157 | 158<br><b>Uuo</b><br>unoctium<br>158 | 159<br><b>Uuh</b><br>unheptium<br>159 | 160<br><b>Uuo</b><br>unoctium<br>160 | 161<br><b>Uuh</b><br>unheptium<br>161 | 162<br><b>Uuo</b><br>unoctium<br>162 | 163<br><b>Uuh</b><br>unheptium<br>163 | 164<br><b>Uuo</b><br>unoctium<br>164 | 165<br><b>Uuh</b><br>unheptium<br>165 | 166<br><b>Uuo</b><br>unoctium<br>166 | 167<br><b>Uuh</b><br>unheptium<br>167 | 168<br><b>Uuo</b><br>unoctium<br>168 | 169<br><b>Uuh</b><br>unheptium<br>169 | 170<br><b>Uuo</b><br>unoctium<br>170 | 171<br><b>Uuh</b><br>unheptium<br>171 | 172<br><b>Uuo</b><br>unoctium<br>172 | 173<br><b>Uuh</b><br>unheptium<br>173 | 174<br><b>Uuo</b><br>unoctium<br>174 | 175<br><b>Uuh</b><br>unheptium<br>175 | 176<br><b>Uuo</b><br>unoctium<br>176 | 177<br><b>Uuh</b><br>unheptium<br>177 | 178<br><b>Uuo</b><br>unoctium<br>178 | 179<br><b>Uuh</b><br>unheptium<br>179 | 180<br><b>Uuo</b><br>unoctium<br>180 | 181<br><b>Uuh</b><br>unheptium<br>181 | 182<br><b>Uuo</b><br>unoctium<br>182 | 183<br><b>Uuh</b><br>unheptium<br>183 | 184<br><b>Uuo</b><br>unoctium<br>184 | 185<br><b>Uuh</b><br>unheptium<br>185 | 186<br><b>Uuo</b><br>unoctium<br>186 | 187<br><b>Uuh</b><br>unheptium<br>187 | 188<br><b>Uuo</b><br>unoctium<br>188 | 189<br><b>Uuh</b><br>unheptium<br>189 | 190<br><b>Uuo</b><br>unoctium<br>190 | 191<br><b>Uuh</b><br>unheptium<br>191 | 192<br><b>Uuo</b><br>unoctium<br>192 | 193<br><b>Uuh</b><br>unheptium<br>193 | 194<br><b>Uuo</b><br>unoctium<br>194 | 195<br><b>Uuh</b><br>unheptium<br>195 | 196<br><b>Uuo</b><br>unoctium<br>196 | 197<br><b>Uuh</b><br>unheptium<br>197 | 198<br><b>Uuo</b><br>unoctium<br>198 | 199<br><b>Uuh</b><br>unheptium<br>199 | 200<br><b>Uuo</b><br>unoctium<br>200 | 201<br><b>Uuh</b><br>unheptium<br>201 | 202<br><b>Uuo</b><br>unoctium<br>202 | 203<br><b>Uuh</b><br>unheptium<br>203 | 204<br><b>Uuo</b><br>unoctium<br>204 | 205<br><b>Uuh</b><br>unheptium<br>205 | 206<br><b>Uuo</b><br>unoctium<br>206 | 207<br><b>Uuh</b><br>unheptium<br>207 | 208<br><b>Uuo</b><br>unoctium<br>208 | 209<br><b>Uuh</b><br>unheptium<br>209 | 210<br><b>Uuo</b><br>unoctium<br>210 | 211<br><b>Uuh</b><br>unheptium<br>211 | 212<br><b>Uuo</b><br>unoctium<br>212 | 213<br><b>Uuh</b><br>unheptium<br>213 | 214<br><b>Uuo</b><br>unoctium<br>214 | 215<br><b>Uuh</b><br>unheptium<br>215 | 216<br><b>Uuo</b><br>unoctium<br>216 | 217<br><b>Uuh</b><br>unheptium<br>217 | 218<br><b>Uuo</b><br>unoctium<br>218 | 219<br><b>Uuh</b><br>unheptium<br>219 | 220<br><b>Uuo</b><br>unoctium<br>220 | 221<br><b>Uuh</b><br>unheptium<br>221 | 222<br><b>Uuo</b><br>unoctium<br>222 | 223<br><b>Uuh</b><br>unheptium<br>223 | 224<br><b>Uuo</b><br>unoctium<br>224 | 225<br><b>Uuh</b><br>unheptium<br>225 | 226<br><b>Uuo</b><br>unoctium<br>226 | 227<br><b>Uuh</b><br>unheptium<br>227 | 228<br><b>Uuo</b><br>unoctium<br>228 | 229<br><b>Uuh</b><br>unheptium<br>229 | 230<br><b>Uuo</b><br>unoctium<br>230 | 231<br><b>Uuh</b><br>unheptium<br>231 | 232<br><b>Uuo</b><br>unoctium<br>232 | 233<br><b>Uuh</b><br>unheptium<br>233 | 234<br><b>Uuo</b><br>unoctium<br>234 | 235<br><b>Uuh</b><br>unheptium<br>235 | 236<br><b>Uuo</b><br>unoctium<br>236 | 237<br><b>Uuh</b><br>unheptium<br>237 | 238<br><b>Uuo</b><br>unoctium<br>238 | 239<br><b>Uuh</b><br>unheptium<br>239 | 240<br><b>Uuo</b><br>unoctium<br>240 | 241<br><b>Uuh</b><br>unheptium<br>241 | 242<br><b>Uuo</b><br>unoctium<br>242 | 243<br><b>Uuh</b><br>unheptium<br>243 | 244<br><b>Uuo</b><br>unoctium<br>244 | 245<br><b>Uuh</b><br>unheptium<br>245 | 246<br><b>Uuo</b><br>unoctium<br>246 | 247<br><b>Uuh</b><br>unheptium<br>247 | 248<br><b>Uuo</b><br>unoctium<br>248 | 249<br><b>Uuh</b><br>unheptium<br>249 | 250<br><b>Uuo</b><br>unoctium<br>250 | 251<br><b>Uuh</b><br>unheptium<br>251 | 252<br><b>Uuo</b><br>unoctium<br>252 | 253<br><b>Uuh</b><br>unheptium<br>253 | 254<br><b>Uuo</b><br>unoctium<br>254 | 255<br><b>Uuh</b><br>unheptium<br>255 | 256<br><b>Uuo</b><br>unoctium<br>256 | 257<br><b>Uuh</b><br>unheptium<br>257 | 258<br><b>Uuo</b><br>unoctium<br>258 | 259<br><b>Uuh</b><br>unheptium<br>259 | 260<br><b>Uuo</b><br>unoctium<br>260 | 261<br><b>Uuh</b><br>unheptium<br>261 | 262<br><b>Uuo</b><br>unoctium<br>262 | 263<br><b>Uuh</b><br>unheptium<br>263 | 264<br><b>Uuo</b><br>unoctium<br>264 | 265<br><b>Uuh</b><br>unheptium<br>265 | 266<br><b>Uuo</b><br>unoctium<br>266 | 267<br><b>Uuh</b><br>unheptium<br>267 | 268<br><b>Uuo</b><br>unoctium<br>268 | 269<br><b>Uuh</b><br>unheptium<br>269 | 270<br><b>Uuo</b><br>unoctium<br>270 | 271<br><b>Uuh</b><br>unheptium<br>271 | 272<br><b>Uuo</b><br>unoctium<br>272 | 273<br><b>Uuh</b><br>unheptium<br>273 | 274<br><b>Uuo</b><br>unoctium<br>274 | 275<br><b>Uuh</b><br>unheptium<br>275 | 276<br><b>Uuo</b><br>unoctium<br>276 | 277<br><b>Uuh</b><br>unheptium<br>277 | 278<br><b>Uuo</b><br>unoctium<br>278 | 279<br><b>Uuh</b><br>unheptium<br>279 | 280<br><b>Uuo</b><br>unoctium<br>280 | 281<br><b>Uuh</b><br>unheptium<br>281 | 282<br><b>Uuo</b><br>unoctium<br>282 | 283<br><b>Uuh</b><br>unheptium<br>283 | 284<br><b>Uuo</b><br>unoctium<br>284 | 285<br><b>Uuh</b><br>unheptium<br>285 | 286<br><b>Uuo</b><br>unoctium<br>286 | 287<br><b>Uuh</b><br>unheptium<br>287 | 288<br><b>Uuo</b><br>unoctium<br>288 | 289<br><b>Uuh</b><br>unheptium<br>289 | 290<br><b>Uuo</b><br>unoctium<br>290 | 291<br><b>Uuh</b><br>unheptium<br>291 | 292<br><b>Uuo</b><br>unoctium<br>292 | 293<br><b>Uuh</b><br>unheptium<br>293 | 294<br><b>Uuo</b><br>unoctium<br>294 | 295<br><b>Uuh</b><br>unheptium<br>295 | 296<br><b>Uuo</b><br>unoctium<br>296 | 297<br><b>Uuh</b><br>unheptium<br>297 | 298<br><b>Uuo</b><br>unoctium<br>298 | 299<br><b>Uuh</b><br>unheptium<br>299 | 300<br><b>Uuo</b><br>unoctium<br>300 | 301<br><b>Uuh</b><br>unheptium<br>301 | 302<br><b>Uuo</b><br>unoctium<br>302 | 303<br><b>Uuh</b><br>unheptium<br>303 | 304<br><b>Uuo</b><br>unoctium<br>304 | 305<br><b>Uuh</b><br>unheptium<br>305 | 306<br><b>Uuo</b><br>unoctium<br>306 | 307<br><b>Uuh</b><br>unheptium<br>307 | 308<br><b>Uuo</b><br>unoctium<br>308 | 309<br><b>Uuh</b><br>unheptium<br>309 | 310<br><b>Uuo</b><br>unoctium<br>310 | 311<br><b>Uuh</b><br>unheptium<br>311 | 312<br><b>Uuo</b><br>unoctium<br>312 | 313<br><b>Uuh</b><br>unheptium<br>313 | 314<br><b>Uuo</b><br>unoctium<br>314 | 315<br><b>Uuh</b><br>unheptium<br>315 | 316<br><b>Uuo</b><br>unoctium<br>316 | 317<br><b>Uuh</b><br>unheptium<br>317 | 318<br><b>Uuo</b><br>unoctium<br>318 | 319<br><b>Uuh</b><br>unheptium<br>319 | 320<br><b>Uuo</b><br>unoctium<br>320 | 321<br><b>Uuh</b><br>unheptium<br>321 | 322<br><b>Uuo</b><br>unoctium<br>322 | 323<br><b>Uuh</b><br>unheptium<br>323 | 324<br><b>Uuo</b><br>unoctium<br>324 | 325<br><b>Uuh</b><br>unheptium<br>325 | 326<br><b>Uuo</b><br>unoctium<br>326 | 327<br><b>Uuh</b><br>unheptium<br>327 | 328<br><b>Uuo</b><br>unoctium<br>328 | 329<br><b>Uuh</b><br>unheptium<br>329 | 330<br><b>Uuo</b><br>unoctium<br>330 | 331<br><b>Uuh</b><br>unheptium<br>331 | 332<br><b>Uuo</b><br>unoctium<br>332 | 333<br><b>Uuh</b><br>unheptium<br>333 | 334<br><b>Uuo</b><br>unoctium<br>334 | 335<br><b>Uuh</b><br>unheptium<br>335 | 336<br><b>Uuo</b><br>unoctium<br>336 | 337<br><b>Uuh</b><br>unheptium<br>337 | 338<br><b>Uuo</b><br>unoctium<br>338 | 339<br><b>Uuh</b><br>unheptium<br>339 | 340<br><b>Uuo</b><br>unoctium<br>340 | 341<br><b>Uuh</b><br>unheptium<br>341 | 342<br><b>Uuo</b><br>unoctium<br>342 | 343<br><b>Uuh</b><br>unheptium<br>343 | 344<br><b>Uuo</b><br>unoctium<br>344 | 345<br><b>Uuh</b><br>unheptium<br>345 | 346<br><b>Uuo</b><br>unoctium<br>346 | 347<br><b>Uuh</b><br>unheptium<br>347 | 348<br><b>Uuo</b><br>unoctium<br>348 | 349<br><b>Uuh</b><br>unheptium<br>349 | 350<br><b>Uuo</b><br>unoctium<br>350 | 351<br><b>Uuh</b><br>unheptium<br>351 | 352<br><b>Uuo</b><br>unoctium<br>352 | 353<br><b>Uuh</b><br>unheptium<br>353 | 354<br><b>Uuo</b><br>unoctium<br>354 | 355<br><b>Uuh</b><br>unheptium<br>355 | 356<br><b>Uuo</b><br>unoctium<br>356 | 357<br><b>Uuh</b><br>unheptium<br>357 | 358<br><b>Uuo</b><br>unoctium<br>358 | 359<br><b>Uuh</b><br>unheptium<br>359 | 360<br><b>Uuo</b><br>unoctium<br>360 | 361<br><b>Uuh</b><br>unheptium<br>361 | 362<br><b>Uuo</b><br>unoctium<br>362 | 363<br><b>Uuh</b><br>unheptium<br>363 | 364<br><b>Uuo</b><br>unoctium<br>364 | 365<br><b>Uuh</b><br>unheptium<br>365 | 366<br><b>Uuo</b><br>unoctium<br>366 | 367<br><b>Uuh</b><br>unheptium<br>367 | 368<br><b>Uuo</b><br>unoctium<br>368 | 369<br><b>Uuh</b><br>unheptium<br>369 | 370<br><b>Uuo</b><br>unoctium<br>370 | 371<br><b>Uuh</b><br>unheptium<br>371 | 372<br><b>Uuo</b><br>unoctium<br>372 | 373<br><b>Uuh</b><br>unheptium<br>373 | 374<br><b>Uuo</b><br>unoctium<br>374 | 375<br><b>Uuh</b><br>unheptium<br>375 | 376<br><b>Uuo</b><br>unoctium<br>376 | 377<br><b>Uuh</b><br>unheptium<br>377 | 378<br><b>Uuo</b><br>unoctium<br>378 | 379<br><b>Uuh</b><br>unheptium<br>379 | 380<br><b>Uuo</b><br>unoctium<br>380 | 381<br><b>Uuh</b><br>unheptium<br>381 | 382<br><b>Uuo</b><br>unoctium<br>382 | 383<br><b>Uuh</b><br>unheptium<br>383 | 384<br><b>Uuo</b><br>unoctium<br>384 | 385<br><b>Uuh</b><br>unheptium<br>385 | 386<br><b>Uuo</b><br>unoctium<br>386 | 387<br><b>Uuh</b><br>unheptium<br>387 | 388<br><b>Uuo</b><br>unoctium<br>388 | 389<br><b>Uuh</b><br>unheptium<br>389 | 390<br><b>Uuo</b><br>unoctium<br>390 | 391<br><b>Uuh</b><br>unheptium<br>391 | 392<br><b>Uuo</b><br>unoctium<br>392 | 393<br><b>Uuh</b><br>unheptium<br>393 | 394<br><b>Uuo</b><br>unoctium<br>394 | 395<br><b>Uuh</b><br>unheptium<br>395 | 396<br><b>Uuo</b><br>unoctium<br>396 | 397<br><b>Uuh</b><br>unheptium<br>397 | 398<br><b>Uuo</b><br>unoctium<br>398 | 399<br><b>Uuh</b><br>unheptium<br>399 | 400<br><b>Uuo</b><br>unoctium<br>400 | 401<br><b>Uuh</b><br>unheptium<br>401 | 402<br><b>Uuo</b><br>unoctium<br>402 | 403<br><b>Uuh</b><br>unheptium<br>403 | 404<br><b>Uuo</b><br>unoctium<br>404 | 405<br><b>Uuh</b><br>unheptium<br>405 | 406<br><b>Uuo</b><br>unoctium<br>406 | 407<br><b>Uuh</b><br>unheptium<br>407 | 408<br><b>Uuo</b><br>unoctium<br>408 | 409<br><b>Uuh</b><br>unheptium<br>409 | 410<br><b>Uuo</b><br>unoctium<br>410 | 411<br><b>Uuh</b><br>unheptium<br>411 | 412<br><b>Uuo</b><br>unoctium<br>412 | 413<br><b>Uuh</b><br>unheptium<br>413 | 414<br><b>Uuo</b><br>unoctium<br>414 | 415<br><b>Uuh</b><br>unheptium<br>415 | 416<br><b>Uuo</b><br>unoctium<br>416 | 417<br><b>Uuh</b><br>unheptium<br>417 | 418<br><b>Uuo</b><br>unoctium<br>418 | 419<br><b>Uuh</b><br>unheptium<br>419 | 420<br><b>Uuo</b><br>unoctium<br>420 | 421<br><b>Uuh</b><br>unheptium<br>421 | 422<br><b>Uuo</b><br>unoctium<br>422 | 423<br><b>Uuh</b><br>unheptium<br>423 | 424<br><b>Uuo</b><br>unoctium<br>424 | 425<br><b>Uuh</b><br>unheptium<br>425 | 426<br><b>Uuo</b><br>unoctium<br>426 | 427<br><b>Uuh</b><br>unheptium<br>427 | 428<br><b>Uuo</b><br>unoctium<br>428 | 429<br><b>Uuh</b><br>unheptium<br>429 | 430<br><b>Uuo</b><br>unoctium<br>430 | 431<br><b>Uuh</b><br>unheptium<br>431 | 432<br><b>Uuo</b><br>unoctium<br>432 | 433<br><b>Uuh</b><br>unheptium<br>433 | 434<br><b>Uuo</b><br>unoctium<br>434 | 435<br><b>Uuh</b><br>unheptium<br>435 | 436<br><b>Uuo</b><br>unoctium<br>436 | 437<br><b>Uuh</b><br>unheptium<br>437 | 438<br><b>Uuo</b><br>unoctium<br>438 | 439<br><b>Uuh</b><br>unheptium<br>439 | 440<br><b>Uuo</b><br>unoctium<br>440 | 441<br><b>Uuh</b><br>unheptium<br>441 | 442<br><b>Uuo</b><br>unoctium<br>442 | 443<br><b>Uuh</b><br>unheptium<br>443 | 444<br><b>Uuo</b><br>unoctium<br>444 | 445<br><b>Uuh</b><br>unheptium<br>445 | 446<br><b>Uuo</b><br>unoctium<br>446 | 447<br><b>Uuh</b><br>unheptium<br>447 | 448<br><b>Uuo</b><br>unoctium<br>448 | 449<br><b>Uuh</b><br>unheptium<br>449 | 450<br><b>Uuo</b><br>unoctium<br>450 | 451<br><b>Uuh</b><br>unheptium<br>451 | 452<br><b>Uuo</b><br>unoctium<br>452 | 453<br><b>Uuh</b><br>unheptium<br>453 | 454<br><b>Uuo</b><br>unoctium<br>454 | 455<br><b>Uuh</b><br>unheptium<br>455 | 456<br><b>Uuo</b><br>unoctium<br>456 | 457<br><b>Uuh</b><br>unheptium<br>457 | 458<br><b>Uuo</b><br>unoctium<br>458 | 459<br><b>Uuh</b><br>unheptium<br>459 | 460<br><b>Uuo</b><br>unoctium<br>460 | 461<br><b>Uuh</b><br>unheptium<br>461 | 462<br><b>Uuo</b><br>unoctium<br>462 | 463<br><b>Uuh</b><br>unheptium<br>463 | 464<br><b>Uuo</b><br>unoctium<br>464 | 465<br><b>Uuh</b><br> |

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**Answer ALL questions.**

**Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

- 1** This question is about the three states of matter, solid, liquid and gas.
- (a) Solids, liquids and gases can be changed from one state to another.  
The box gives the names of some changes of state.

|            |             |          |
|------------|-------------|----------|
| condensing | evaporation | freezing |
| melting    | sublimation |          |

Use words from the box to answer the questions.

- (i) Give the name of the change from liquid to solid.

(1)

- (ii) Give the name of the change from liquid to gas.

(1)

- (iii) Give the name of the change from solid to gas.

(1)

- (b) Describe the arrangement, movement and energy of the particles in a gas.

(3)

**(Total for Question 1 = 6 marks)**



2 This question is about the rusting of iron.

(a) Oxygen is needed for iron to rust.

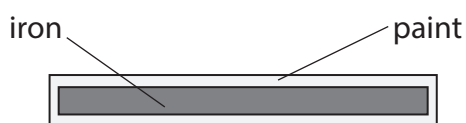
(i) Name one other substance needed for iron to rust.

(1)

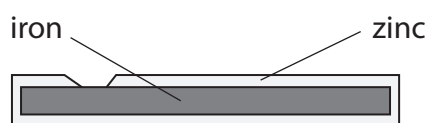
(ii) Give the chemical name for rust.

(1)

(b) The diagram shows method A and method B, which are both used to prevent iron from rusting.



**Method A**



**Method B**

(i) Describe how method A prevents iron from rusting.

(2)

(ii) Name method B.

(1)

(iii) Explain how method B prevents iron from rusting even when the zinc layer is damaged.

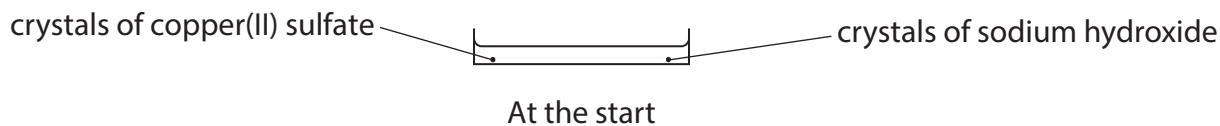
(2)

**(Total for Question 2 = 7 marks)**



- 3** Copper(II) sulfate and sodium hydroxide react to form the insoluble solid copper(II) hydroxide.  
Crystals of copper(II) sulfate and sodium hydroxide are placed at opposite ends of a container of water.  
Solid copper(II) hydroxide forms after several minutes.

The diagram shows the container at the start and after several minutes.



- (a) Name the two processes that must occur before the copper(II) hydroxide forms.

(2)

- 1 .....
- 2 .....

- (b) The experiment is repeated with the water at a higher temperature.

Explain, in terms of particles, why the copper(II) hydroxide takes less time to form.

(2)

- .....
- .....
- .....
- .....

- (c) The formula of copper(II) hydroxide is  $\text{Cu}(\text{OH})_2$

- (i) Give the number of different elements in copper(II) hydroxide.

(1)

- .....

- (ii) Give the charge on the copper ion in  $\text{Cu}(\text{OH})_2$

(1)

- .....

**(Total for Question 3 = 6 marks)**

4 This question is about atoms and ions.

(a) Table 1 shows some information about sub-atomic particles.

Complete Table 1 by giving the missing information.

(3)

|          | Relative mass | Relative charge |
|----------|---------------|-----------------|
| Neutron  |               | 0               |
| Proton   | 1             |                 |
| Electron |               | -1              |

Table 1

(b) Table 2 shows the numbers of protons, neutrons and electrons in species A, B, C, D, E and F.

| Species | Number of protons | Number of neutrons | Number of electrons |
|---------|-------------------|--------------------|---------------------|
| A       | 13                | 14                 | 13                  |
| B       | 1                 | 0                  | 1                   |
| C       | 9                 | 10                 | 10                  |
| D       | 7                 | 7                  | 10                  |
| E       | 20                | 20                 | 18                  |
| F       | 18                | 22                 | 18                  |

Table 2

Use the information in Table 2 to answer these questions.  
Each species may be used once, more than once or not at all.

(i) Give the letter of the species that has 3 electrons in its outer shell.

(1)

(ii) Give the letter of the species that is an ion with a 3- charge.

(1)



(iii) Give the letter of the species with a mass number of 19

(1)

(c) A sample of lithium contains two isotopes,  ${}^6\text{Li}$  and  ${}^7\text{Li}$ .

In terms of sub-atomic particles, give one similarity and one difference between these isotopes.

(2)

similarity

difference

(d) A sample of magnesium contains 79.0% of  ${}^{24}\text{Mg}$ , 10.0% of  ${}^{25}\text{Mg}$  and 11.0% of  ${}^{26}\text{Mg}$ .

Calculate the relative atomic mass,  $A_r$ , of this sample of magnesium.

Give your answer to one decimal place.

(3)

$A_r =$  .....

**(Total for Question 4 = 11 marks)**



5 This question is about elements in Group 7 of the Periodic Table.

(a) Complete the table by giving the missing information.

(3)

| Element  | Colour      | Physical state at room temperature |
|----------|-------------|------------------------------------|
| fluorine | pale yellow | gas                                |
| chlorine | pale green  |                                    |
| bromine  |             | liquid                             |
| iodine   | dark grey   | solid                              |
| astatine | black       |                                    |

(b) The order of reactivity of the Group 7 elements can be shown by using displacement reactions.

(i) When chlorine is added to sodium bromide solution, chlorine displaces bromine.

Give a chemical equation for this reaction.

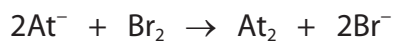
(2)

(ii) Explain whether a reaction takes place when bromine water is added to sodium chloride solution.

(2)



- (iii) The displacement reaction between potassium astatide and bromine can be represented by this ionic equation.



Explain why this is described as a redox reaction.

(2)

(Total for Question 5 = 9 marks)

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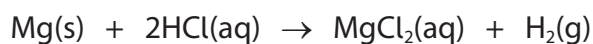
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- 6 A student uses the reaction between magnesium and dilute hydrochloric acid to prepare crystals of hydrated magnesium chloride.

The student adds excess magnesium powder to hydrochloric acid.  
This is the equation for the reaction.



- (a) How does hydrochloric acid behave when acting as an acid?

(1)

- ☐ **A** as an electron acceptor
- ☐ **B** as an electron donor
- ☐ **C** as a proton acceptor
- ☐ **D** as a proton donor

- (b) State one observation made during this reaction.

(1)

.....

.....

- (c) Give a reason why the student adds an excess of magnesium to the dilute hydrochloric acid.

(1)

.....

.....

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(d) Describe what the student should do to the mixture formed in (c) to produce pure, dry crystals of hydrated magnesium chloride.

(5)

(Total for Question 6 = 8 marks)



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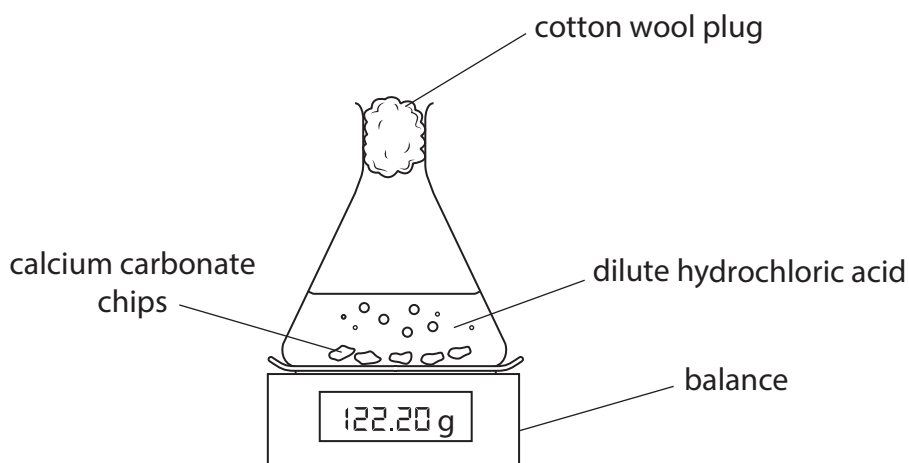
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- 7 A student reacts small chips of calcium carbonate with an excess of dilute hydrochloric acid.

This is the student's method.

- add 5.00 g of small calcium carbonate chips to a conical flask
- add 30 cm<sup>3</sup> of dilute hydrochloric acid which is in excess
- quickly add a cotton wool plug and place the conical flask on a balance



This is the equation for the reaction.



The reading on the balance decreases as carbon dioxide gas is lost through the cotton wool plug.

- (a) Calculate the mass reading on the balance when all of the calcium carbonate has reacted.  
 Assume that all of the carbon dioxide gas is lost through the cotton wool plug.  
 [for  $\text{CaCO}_3$ ,  $M_r = 100$  for  $\text{CO}_2$ ,  $M_r = 44$ ]

(3)

mass = ..... g

- (b) The student repeats the experiment with a different mass of calcium carbonate and a different volume of dilute hydrochloric acid.  
The hydrochloric acid is in excess.  
The student records the total mass of carbon dioxide produced at 1-minute intervals for 8 minutes.

The table shows the student's results.

| Time in minutes | Total mass of CO <sub>2</sub> produced in grams |
|-----------------|-------------------------------------------------|
| 0               | 0.00                                            |
| 1               | 0.80                                            |
| 2               | 1.40                                            |
| 3               | 1.64                                            |
| 4               | 1.72                                            |
| 5               | 1.76                                            |
| 6               | 1.80                                            |
| 7               | 1.80                                            |
| 8               | 1.80                                            |



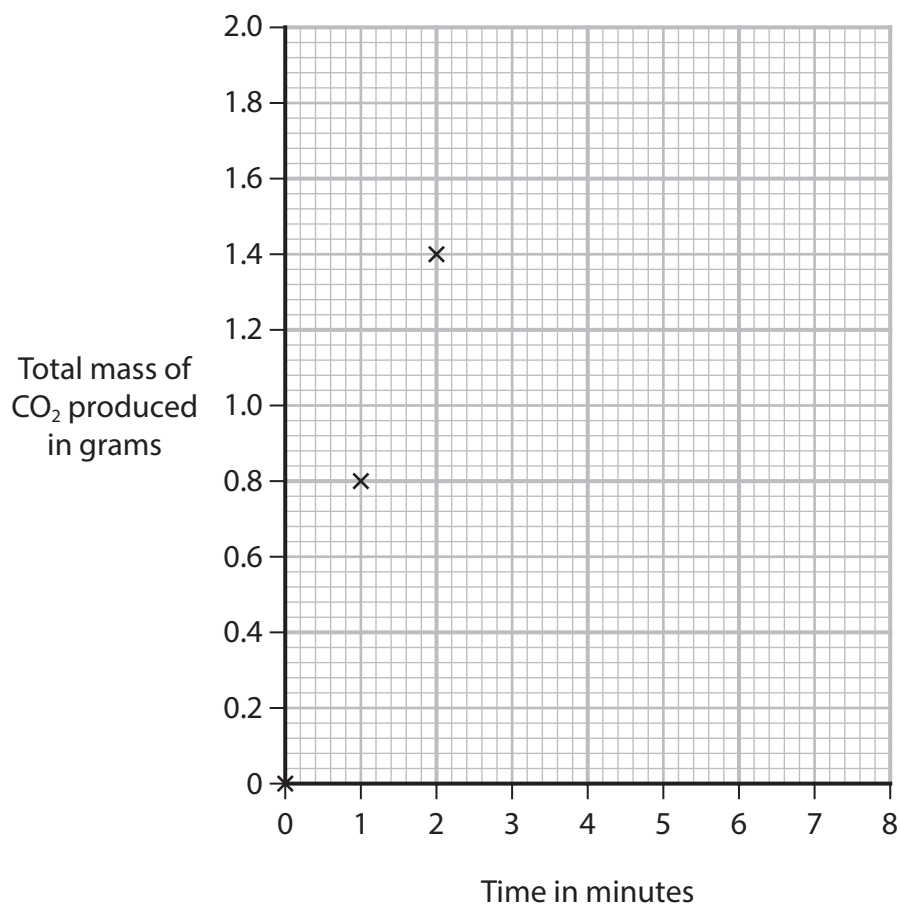
- (i) Plot the student's results.

The first three have been plotted for you.

(1)

- (ii) Draw a curve of best fit through the points.

(1)



- (iii) Calculate the rate of reaction at 2 minutes by drawing a tangent to the curve and calculating the gradient of the tangent.

Give the units for the rate of reaction.

(3)

rate of reaction = .....

units = .....

(iv) Explain why the shape of the graph changes during the 8 minutes.

(4)

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(c) The student repeats the experiment using the same mass of calcium carbonate but as powder rather than chips, keeping all other conditions the same.

Explain the effect of this change on the rate of reaction.

(3)

(Total for Question 7 = 15 marks)



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8 This question is about the covalent compounds hydrogen chloride and silicon dioxide.

(a) Describe the forces of attraction in a covalent bond.

(2)

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(b) Hydrogen chloride has the formula HCl

(i) Draw a dot-and-cross diagram to show the bonding in a hydrogen chloride molecule.

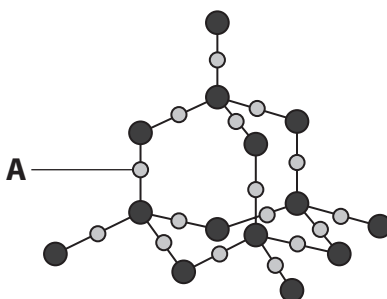
Show only the outer shell electrons in each atom.

(2)

(ii) Explain why the boiling point of hydrogen chloride is low.

(2)

(c) The diagram shows part of the structure of silicon dioxide.



(i) Give a reason why particle A represents an oxygen atom.

(1)

- (ii) This is the equation for the reaction between silicon dioxide and calcium oxide.



Give a reason why silicon dioxide reacts with calcium oxide.

(1)

- (iii) Silicon dioxide has the same structure as diamond.  
Silicon dioxide is very hard and has a very high melting point.

Explain these properties.

Refer to the structure and bonding of silicon dioxide in your answer.

(5)

(Total for Question 8 = 13 marks)



9 This question is about products from crude oil.

(a) Most of the compounds in crude oil are from the same homologous series.

Give the name of this homologous series.

(1)

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(b) Many fuels are obtained from the fractional distillation of crude oil.

Explain how the combustion of a common impurity in fuels causes acid rain.

(3)

(c) The equation shows the cracking of a hydrocarbon produced from the fractional distillation of crude oil.



(i) Give the temperature and the catalyst used in catalytic cracking.

(2)

temperature

catalyst

(ii) Explain why cracking is a useful process in the oil industry.

(3)



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(d) The formula  $C_5H_{12}$  represents three isomers.

(i) Explain what is meant by the term **isomers**.

(2)

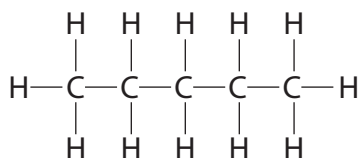
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(ii) This is the displayed formula of one of the isomers.



Draw the displayed formula of each of the other two isomers.

(2)

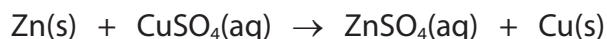
|  |  |
|--|--|
|  |  |
|--|--|

(Total for Question 9 = 13 marks)



**10** A student investigates the reaction between zinc and copper(II) sulfate solution.

This is the equation for the reaction.



This is the student's method.

Step 1 add 25.0 cm<sup>3</sup> of copper(II) sulfate solution to a glass beaker

Step 2 record the temperature of the solution

Step 3 add between 5 g and 6 g of zinc powder (an excess) and stir the mixture

Step 4 record the highest temperature reached

- (a) (i) Explain an improvement to step 1 to produce a more accurate temperature rise.

(2)

- (ii) Give a reason why the student does not need to know the exact mass of zinc powder added in step 3.

(1)

- (iii) State the colour change in the solution.

(1)

from ..... to .....

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(b) (i) The table shows the student's results.

|                                                                              |      |
|------------------------------------------------------------------------------|------|
| volume of copper(II) sulfate solution in $\text{cm}^3$                       | 25.0 |
| initial temperature of the copper(II) sulfate solution in $^{\circ}\text{C}$ | 18.5 |
| final temperature of the copper(II) sulfate solution in $^{\circ}\text{C}$   | 48.6 |

Calculate the heat energy change ( $Q$ ) in joules (J).

[for the solution,  $c = 4.2 \text{ J/g}^{\circ}\text{C}$ ]

[mass of  $1.0 \text{ cm}^3$  of solution =  $1.0 \text{ g}$ ]

(3)

$Q = \dots\dots\dots \text{ J}$

(ii) The student repeats the experiment and calculates  $Q$  as  $3800 \text{ J}$ .  
The solution used contains  $6.38 \text{ g}$  of copper(II) sulfate.

Calculate the molar enthalpy change,  $\Delta H$ , in  $\text{kJ/mol}$ .

Include a sign in your answer.

[for  $\text{CuSO}_4$ ,  $M_r = 159.5$ ]

(4)

$\Delta H = \dots\dots\dots \text{ kJ/mol}$

**(Total for Question 10 = 11 marks)**



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**11** This question is about sodium sulfate,  $\text{Na}_2\text{SO}_4$

(a) A teacher finds an unlabelled bottle containing a white solid.

Describe tests to show that the white solid is sodium sulfate.

(5)

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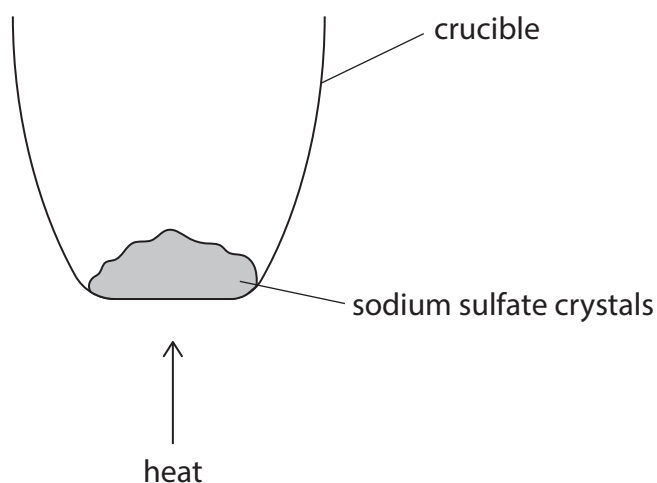
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(b) A student has a sample of crystals of hydrated sodium sulfate,  $\text{Na}_2\text{SO}_4 \cdot x\text{H}_2\text{O}$

The student uses this apparatus to find the value of  $x$  in  $\text{Na}_2\text{SO}_4 \cdot x\text{H}_2\text{O}$



This is the student's method.

- find the mass of the empty crucible
- add some hydrated sodium sulfate crystals to the crucible
- find the total mass of the crucible and hydrated sodium sulfate crystals
- heat the crucible to remove water from the crystals
- find the mass of the crucible and its contents every 2 minutes for 10 minutes

The table shows the student's results.

|                                                                               | Mass in grams |
|-------------------------------------------------------------------------------|---------------|
| mass of empty crucible                                                        | 23.57         |
| mass of empty crucible and $\text{Na}_2\text{SO}_4 \cdot x\text{H}_2\text{O}$ | 26.79         |
| mass after 2 minutes                                                          | 26.34         |
| mass after 4 minutes                                                          | 25.73         |
| mass after 6 minutes                                                          | 25.23         |
| mass after 8 minutes                                                          | 24.99         |
| mass after 10 minutes                                                         | 24.99         |



- (i) State how the results show that all the water has been removed from the crystals.

(1)

- (ii) Calculate the mass of anhydrous sodium sulfate remaining after heating.

(1)

mass of anhydrous sodium sulfate = ..... g

- (iii) Calculate the mass of water lost from the sodium sulfate crystals during heating.

(1)

mass of water = ..... g

- (iv) Use the student's results to calculate x in the formula  $\text{Na}_2\text{SO}_4 \cdot x\text{H}_2\text{O}$

[for  $\text{Na}_2\text{SO}_4$ ,  $M_r = 142$       for  $\text{H}_2\text{O}$ ,  $M_r = 18$ ]

(3)

x = ..... J

**(Total for Question 11 = 11 marks)**

**TOTAL FOR PAPER = 110 MARKS**



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