

**Advanced Subsidiary GCE (H032)
Advanced GCE (H432)****Data Sheet for Chemistry A**

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General Information

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

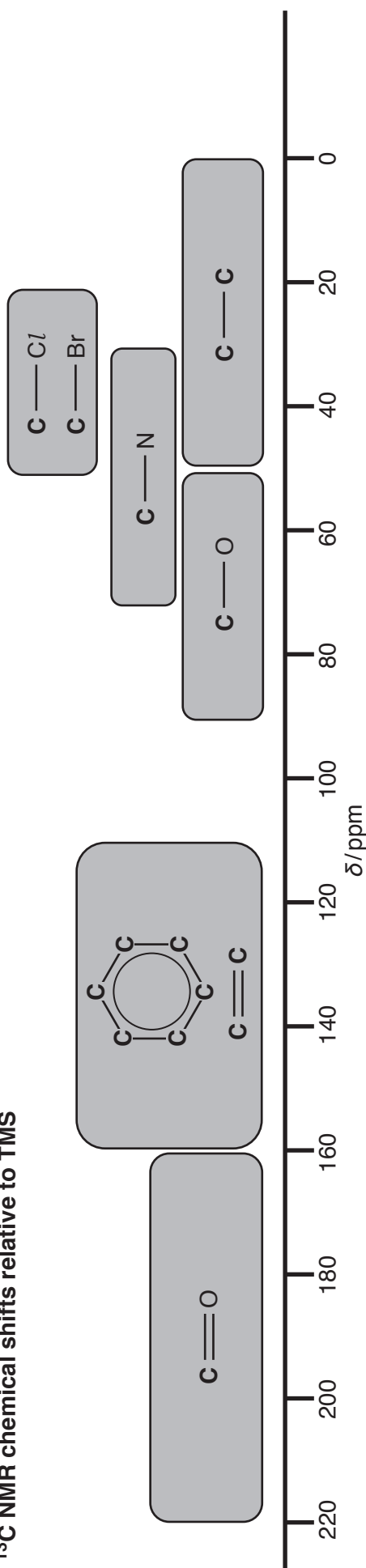
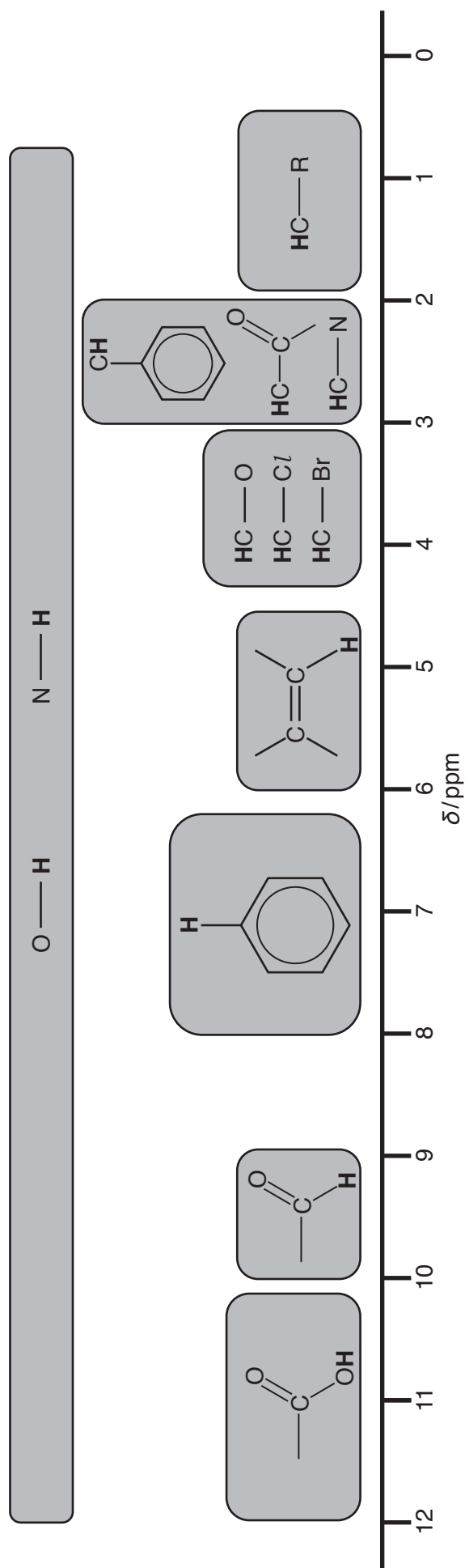
1 tonne = 10^6 g

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/ 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}C NMR chemical shifts relative to TMS **^1H 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.

OH and **NH** chemical shifts are very variable and are often broad. Signals are not usually seen as split peaks. Note that **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)	(8)		
1 H hydrogen 1.0	2 He helium 4.0	3 Li lithium 6.9	4 Be beryllium 9.0	5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9	19 K potassium 39.1	20 Ca calcium 40.1
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4
55 Cs caesium 132.9	56 Ba barium 137.3	57-71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1
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
119 K potassium 39.1	120 Ca calcium 40.1	121 Sc scandium 45.0	122 Ti titanium 47.9	123 V vanadium 50.9	124 Cr chromium 52.0	125 Mn manganese 54.9	126 Fe iron 55.8	127 Co cobalt 58.9	128 Ni nickel 58.7
137 Rb rubidium 85.5	138 Sr strontium 87.6	139 Y yttrium 88.9	140 Zr zirconium 91.2	141 Nb niobium 92.9	142 Mo molybdenum 95.9	143 Tc technetium	144 Ru ruthenium 101.1	145 Rh rhodium 102.9	146 Pd palladium 106.4
151 K potassium 39.1	152 Ca calcium 40.1	153 Sc scandium 45.0	154 Ti titanium 47.9	155 V vanadium 50.9	156 Cr chromium 52.0	157 Mn manganese 54.9	158 Fe iron 55.8	159 Co cobalt 58.9	160 Ni nickel 58.7
167 Rb rubidium 85.5	168 Sr strontium 87.6	169 Y yttrium 88.9	170 Zr zirconium 91.2	171 Nb niobium 92.9	172 Mo molybdenum 95.9	173 Tc technetium	174 Ru ruthenium 101.1	175 Rh rhodium 102.9	176 Pd palladium 106.4
183 K potassium 39.1	184 Ca calcium 40.1	185 Sc scandium 45.0	186 Ti titanium 47.9	187 V vanadium 50.9	188 Cr chromium 52.0	189 Mn manganese 54.9	190 Fe iron 55.8	191 Co cobalt 58.9	192 Ni nickel 58.7
199 Rb rubidium 85.5	200 Sr strontium 87.6	201 Y yttrium 88.9	202 Zr zirconium 91.2	203 Nb niobium 92.9	204 Mo molybdenum 95.9	205 Tc technetium	206 Ru ruthenium 101.1	207 Rh rhodium 102.9	208 Pd palladium 106.4
215 K potassium 39.1	216 Ca calcium 40.1	217 Sc scandium 45.0	218 Ti titanium 47.9	219 V vanadium 50.9	220 Cr chromium 52.0	221 Mn manganese 54.9	222 Fe iron 55.8	223 Co cobalt 58.9	224 Ni nickel 58.7
231 Rb rubidium 85.5	232 Sr strontium 87.6	233 Y yttrium 88.9	234 Zr zirconium 91.2	235 Nb niobium 92.9	236 Mo molybdenum 95.9	237 Tc technetium	238 Ru ruthenium 101.1	239 Rh rhodium 102.9	240 Pd palladium 106.4
247 K potassium 39.1	248 Ca calcium 40.1	249 Sc scandium 45.0	250 Ti titanium 47.9	251 V vanadium 50.9	252 Cr chromium 52.0	253 Mn manganese 54.9	254 Fe iron 55.8	255 Co cobalt 58.9	256 Ni nickel 58.7
263 Rb rubidium 85.5	264 Sr strontium 87.6	265 Y yttrium 88.9	266 Zr zirconium 91.2	267 Nb niobium 92.9	268 Mo molybdenum 95.9	269 Tc technetium	270 Ru ruthenium 101.1	271 Rh rhodium 102.9	272 Pd palladium 106.4
279 K potassium 39.1	280 Ca calcium 40.1	281 Sc scandium 45.0	282 Ti titanium 47.9	283 V vanadium 50.9	284 Cr chromium 52.0	285 Mn manganese 54.9	286 Fe iron 55.8	287 Co cobalt 58.9	288 Ni nickel 58.7
295 Rb rubidium 85.5	296 Sr strontium 87.6	297 Y yttrium 88.9	298 Zr zirconium 91.2	299 Nb niobium 92.9	300 Mo molybdenum 95.9	301 Tc technetium	302 Ru ruthenium 101.1	303 Rh rhodium 102.9	304 Pd palladium 106.4
311 K potassium 39.1	312 Ca calcium 40.1	313 Sc scandium 45.0	314 Ti titanium 47.9	315 V vanadium 50.9	316 Cr chromium 52.0	317 Mn manganese 54.9	318 Fe iron 55.8	319 Co cobalt 58.9	320 Ni nickel 58.7
327 Rb rubidium 85.5	328 Sr strontium 87.6	329 Y yttrium 88.9	330 Zr zirconium 91.2	331 Nb niobium 92.9	332 Mo molybdenum 95.9	333 Tc technetium	334 Ru ruthenium 101.1	335 Rh rhodium 102.9	336 Pd palladium 106.4
343 K potassium 39.1	344 Ca calcium 40.1	345 Sc scandium 45.0	346 Ti titanium 47.9	347 V vanadium 50.9	348 Cr chromium 52.0	349 Mn manganese 54.9	350 Fe iron 55.8	351 Co cobalt 58.9	352 Ni nickel 58.7
359 Rb rubidium 85.5	360 Sr strontium 87.6	361 Y yttrium 88.9	362 Zr zirconium 91.2	363 Nb niobium 92.9	364 Mo molybdenum 95.9	365 Tc technetium	366 Ru ruthenium 101.1	367 Rh rhodium 102.9	368 Pd palladium 106.4
375 K potassium 39.1	376 Ca calcium 40.1	377 Sc scandium 45.0	378 Ti titanium 47.9	379 V vanadium 50.9	380 Cr chromium 52.0	381 Mn manganese 54.9	382 Fe iron 55.8	383 Co cobalt 58.9	384 Ni nickel 58.7
391 Rb rubidium 85.5	392 Sr strontium 87.6	393 Y yttrium 88.9	394 Zr zirconium 91.2	395 Nb niobium 92.9	396 Mo molybdenum 95.9	397 Tc technetium	398 Ru ruthenium 101.1	399 Rh rhodium 102.9	400 Pd palladium 106.4
407 K potassium 39.1	408 Ca calcium 40.1	409 Sc scandium 45.0	410 Ti titanium 47.9	411 V vanadium 50.9	412 Cr chromium 52.0	413 Mn manganese 54.9	414 Fe iron 55.8	415 Co cobalt 58.9	416 Ni nickel 58.7
423 Rb rubidium 85.5	424 Sr strontium 87.6	425 Y yttrium 88.9	426 Zr zirconium 91.2	427 Nb niobium 92.9	428 Mo molybdenum 95.9	429 Tc technetium	430 Ru ruthenium 101.1	431 Rh rhodium 102.9	432 Pd palladium 106.4
439 K potassium 39.1	440 Ca calcium 40.1	441 Sc scandium 45.0	442 Ti titanium 47.9	443 V vanadium 50.9	444 Cr chromium 52.0	445 Mn manganese 54.9	446 Fe iron 55.8	447 Co cobalt 58.9	448 Ni nickel 58.7
455 Rb rubidium 85.5	456 Sr strontium 87.6	457 Y yttrium 88.9	458 Zr zirconium 91.2	459 Nb niobium 92.9	460 Mo molybdenum 95.9	461 Tc technetium	462 Ru ruthenium 101.1	463 Rh rhodium 102.9	464 Pd palladium 106.4
471 K potassium 39.1	472 Ca calcium 40.1	473 Sc scandium 45.0	474 Ti titanium 47.9	475 V vanadium 50.9	476 Cr chromium 52.0	477 Mn manganese 54.9	478 Fe iron 55.8	479 Co cobalt 58.9	480 Ni nickel 58.7
487 Rb rubidium 85.5	488 Sr strontium 87.6	489 Y yttrium 88.9	490 Zr zirconium 91.2	491 Nb niobium 92.9	492 Mo molybdenum 95.9	493 Tc technetium	494 Ru ruthenium 101.1	495 Rh rhodium 102.9	496 Pd palladium 106.4
503 K potassium 39.1	504 Ca calcium 40.1	505 Sc scandium 45.0	506 Ti titanium 47.9	507 V vanadium 50.9	508 Cr chromium 52.0	509 Mn manganese 54.9	510 Fe iron 55.8	511 Co cobalt 58.9	512 Ni nickel 58.7
519 Rb rubidium 85.5	520 Sr strontium 87.6	521 Y yttrium 88.9	522 Zr zirconium 91.2	523 Nb niobium 92.9	524 Mo molybdenum 95.9	525 Tc technetium	526 Ru ruthenium 101.1	527 Rh rhodium 102.9	528 Pd palladium 106.4
535 K potassium 39.1	536 Ca calcium 40.1	537 Sc scandium 45.0	538 Ti titanium 47.9	539 V vanadium 50.9	540 Cr chromium 52.0	541 Mn manganese 54.9	542 Fe iron 55.8	543 Co cobalt 58.9	544 Ni nickel 58.7
551 Rb rubidium 85.5	552 Sr strontium 87.6	553 Y yttrium 88.9	554 Zr zirconium 91.2	555 Nb niobium 92.9	556 Mo molybdenum 95.9	557 Tc technetium	558 Ru ruthenium 101.1	559 Rh rhodium 102.9	560 Pd palladium 106.4
567 K potassium 39.1	568 Ca calcium 40.1	569 Sc scandium 45.0	570 Ti titanium 47.9	571 V vanadium 50.9	572 Cr chromium 52.0	573 Mn manganese 54.9	574 Fe iron 55.8	575 Co cobalt 58.9	576 Ni nickel 58.7
583 Rb rubidium 85.5	584 Sr strontium 87.6	585 Y yttrium 88.9	586 Zr zirconium 91.2	587 Nb niobium 92.9	588 Mo molybdenum 95.9	589 Tc technetium	590 Ru ruthenium 101.1	591 Rh rhodium 102.9	592 Pd palladium 106.4
599 K potassium 39.1	600 Ca calcium 40.1	601 Sc scandium 45.0	602 Ti titanium 47.9	603 V vanadium 50.9	604 Cr chromium 52.0	605 Mn manganese 54.9	606 Fe iron 55.8	607 Co cobalt 58.9	608 Ni nickel 58.7
615 Rb rubidium 85.5	616 Sr strontium 87.6	617 Y yttrium 88.9	618 Zr zirconium 91.2	619 Nb niobium 92.9	620 Mo molybdenum 95.9	621 Tc technetium	622 Ru ruthenium 101.1	623 Rh rhodium 102.9	624 Pd palladium 106.4
631 K potassium 39.1	632 Ca calcium 40.1	633 Sc scandium 45.0	634 Ti titanium 47.9	635 V vanadium 50.9	636 Cr chromium 52.0	637 Mn manganese 54.9	638 Fe iron 55.8	639 Co cobalt 58.9	640 Ni nickel 58.7
647 Rb rubidium 85.5	648 Sr strontium 87.6	649 Y yttrium 88.9	650 Zr zirconium 91.2	651 Nb niobium 92.9	652 Mo molybdenum 95.9	653 Tc technetium	654 Ru ruthenium 101.1	655 Rh rhodium 102.9	656 Pd palladium 106.4
663 K potassium 39.1	664 Ca calcium 40.1	665 Sc scandium 45.0	666 Ti titanium 47.9	667 V vanadium 50.9	668 Cr chromium 52.0	669 Mn manganese 54.9	670 Fe iron 55.8	671 Co cobalt 58.9	672 Ni nickel 58.7
679 Rb rubidium 85.5	680 Sr strontium 87.6	681 Y yttrium 88.9	682 Zr zirconium 91.2	683 Nb niobium 92.9	684 Mo molybdenum 95.9	685 Tc technetium	686 Ru ruthenium 101.1	687 Rh rhodium 102.9	688 Pd palladium 106.4
695 K potassium 39.1	696 Ca calcium 40.1	697 Sc scandium 45.0	698 Ti titanium 47.9	699 V vanadium 50.9	700 Cr chromium 52.0	701 Mn manganese 54.9	702 Fe iron 55.8	703 Co cobalt 58.9	704 Ni nickel 58.7
711 Rb rubidium 85.5	712 Sr strontium 87.6	713 Y yttrium 88.9	714 Zr zirconium 91.2	715 Nb niobium 92.9	716 Mo molybdenum 95.9	717 Tc technetium	718 Ru ruthenium 101.1	719 Rh rhodium 102.9	720 Pd palladium 106.4
727 K potassium 39.1	728 Ca calcium 40.1	729 Sc scandium 45.0	730 Ti titanium 47.9	731 V vanadium 50.9	732 Cr chromium 52.0	733 Mn manganese 54.9	734 Fe iron 55.8	735 Co cobalt 58.9	736 Ni nickel 58.7
743 Rb</									