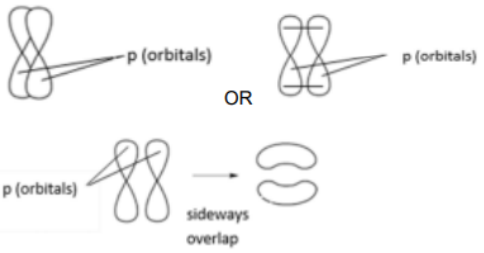
3. Chemical bonding

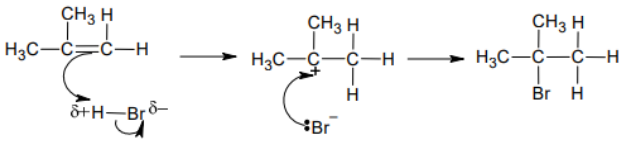
3.4 Covalent bonding and coordinate bonding

Paper 3

Marking Scheme

Q1.

(a)	(electrostatic) attraction between nuclei of two atoms and shared pair of electrons	1
(b)(i)	sp^2	1
(b)(ii)	**M1** σ bond – diagram showing how σ bond is made from direct overlap of orbitals i.e.  OR **M2** π bond - diagram showing how π bond is made from sideways overlap of 2× p– orbitals i.e. 	2
(c)(i)	**EITHER** (pair of) electrons in π bond are further away from the nuclei so weaker attraction **OR** (pair of) electrons in σ bond are closer to the two nuclei so stronger attraction	1

(c)(ii)	 **M1** arrow from = of C=C to H of H-Br **M2** correct dipole on H-Br **AND** arrow from H-Br bond to Br **M3** correct intermediate **AND** 2-bromopropane **M4** arrow from lone pair on Br^- to C^+ of their intermediate (with +ve or δ+ charge)	4

Q2.

(f)(i)	**M1** one sigma / σ bond **AND** head-on (overlap of) p / sp (orbitals)	1
	M2 two pi / π bond(s) **AND** side-on (overlap of / involving) p (orbitals)	1
(f)(ii)	P≡P is much weaker so P_2 is more reactive (than N_2)	1

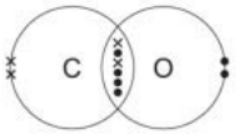
Q3.

(a)	**M1** one sigma / σ bond and two pi / π bonds **M2** sp hybridisation (in each N atom) **M3** sigma / σ forms from direct / head-on / end-on overlap of orbitals **AND** pi / π forms sideways / lateral overlap of (p) orbitals	3

Q4.

(a)(i)	**M1** both make triple (covalent) bond / 3 shared pairs of electrons	1
	M2 one bond in CO is coordinate / dative covalent / formed by donating a pair of electrons from O (to C)	1

Q5.

(b)(i)	(covalent) bond with both electrons are provided from the same / one species OR shared pair (of electrons) are provided from the same species / one atom *owtte*	1
(b)(ii)	3 bonding pairs between C and O, 4 •'s AND 2×'s 1 lone pair on C, ××, AND 1 lone pair on O, ••. 	2

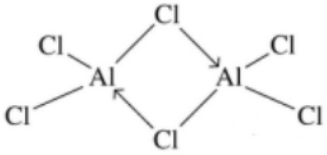
Q6.

(c)(i)	Mixing / overlap / combination of one / an s and one / a p orbital	1
(c)(ii)	*Sketch a diagram to show HOW two sp hybrid orbitals can form a SIGMA bond* **M1**  **M2** 	2

Q7.

(c)(i)		1
(c)(ii)	sp^2	1

Q8.

(a)(i)	**M1:** *correct representation of Al_2Cl_6, dot and cross or line diagram*  **M2: TWO** correct co-ordinate bonds identified	**2**