M1.(a) (i) giant lattice

allow each carbon atom is joined to three others

1

atoms in graphene are covalently bonded

*max. **2** marks if any reference to wrong type of bonding*

1

and covalent bonds are strong **or** need a lot of energy to be broken

allow difficult to break

1

(ii) because graphene has delocalised electrons

allow each carbon atom has one free electron

1

which can move <u>throughout the structure</u>

*do **not** accept just electrons can move.*

1

(b) because there are weak forces between molecules

allow no <u>bonds</u> between the layers

1

so layers / molecules can slip / slide.

1

[7]

M2.(a) because atoms / ions / particles in alloy are different (sizes)

*do **not** allow reference to molecules*

ignore reference to compounds

1

so layers distorted

(and layers / atoms / ions / particles) don't slide **or** slide less easily

accept all marking points in a suitably labelled or annotated diagram

1

*if no other mark awarded accept an alloy is a mixture **or** contains different metals / elements for **1** mark*

1

(b) giant structure **or** lattice **or** macromolecule

*max **3** marks if incorrect bonding*

1

strong bonds (between carbon / atoms)

1

covalent (bonds)

1

each carbon / atom forms 4 bonds

accept tetrahedral

*if no other marks awarded, allow carbon (atoms) for **1** mark*

1

(c) *reference to incorrect bonding = max **3** reference to 'weak covalent bonds' = max **2** allow correctly drawn diagram for first two*

marking points eg. *(tangled) lines with no cross-links*

chains **or** large molecules

ignore layers

1

with intermolecular forces **or** forces between chains

allow bonds for forces accept no cross-links

1

that are weak

must relate to 2 nd marking point

1

and are easily overcome/ broken (when heated)

accept molecules / chains can flow / move

1

[11]

M3. (a) (i) *ionic / molecules / metallic / (inter)molecular = max **2***

because graphene / it has a giant structure / lattice / macromolecular

accept <u>all</u> / <u>every</u> / <u>each</u> atom is <u>bonded to</u> 3 other atoms

1

because graphene / it has covalent bonds / is covalent

1

because in graphene / the bonds are strong **or**
a lot of energy needed / hard to break the bonds

1

(ii) there are delocalised / free electrons

1

because one (delocalised / free) electron <u>per atom</u> linked to first marking point

accept because three <u>electrons per atom</u> used (in bonding)

accept because one electron <u>per atom</u> not used (in bonding)

1

(b) opaque (owtte)

eg could not see through them

or layers slide
or layers not aligned

ignore thick

1

[6]

M4. (a) **Graphite:**

because the layers (of carbon atoms) in graphite can move / slide

it = graphite

1

this is because there are only weak intermolecular forces **or** weak forces between layers

accept Van der Waals' forces allow no <u>covalent</u> bonds between layers

1

Diamond:

however, in diamond, each carbon atom is (strongly / covalently) bonded to 4 others

allow diamond has three dimensional / tetrahedral structure

1

so no carbon / atoms able to move / slide

*allow so no layers to slide **or** so diamond is rigid*

1

(b) because graphite has delocalised electrons / sea of electrons

allow free / mobile / roaming electrons

1

which can carry charge / current **or** move <u>through the structure</u>

1

however, diamond has no delocalised electrons

accept however, diamond has all (outer) electrons used in bonding

1

[7]

M5. any **three** from:

any reference to incorrect bonding = max 2

- giant structure / lattice / macromolecule
- covalent (bonds)
- bonds are (very) strong

  allow bonds difficult to break

  ***or** takes a lot of energy to break bonds*
- each atom / carbon joined to <u>four</u> others

  accept each atom / carbon forms <u>four</u> bonds

3

[3]

M6. (a) any **four** from:

*max **3** marks if any reference made to covalent / ionic bonding / molecules or intermolecular forces **or** graphite / diamond **or** forces of attraction between electrons and then ignore throughout*

- giant structure / lattice
  ignore layers
- positive ions
- sea of electrons **or** delocalised / free electrons
  ignore electrons can move
- awareness of outer shell / highest energy level electrons are involved
- (electrostatic) attractions / bonds between electrons and positive ions
- bonds / attractions (between atoms/ ions) are strong
  allow hard to break for strong
  ignore forces unqualified
- a lot of energy / heat is needed to break these bonds / attractions
  ignore high temperature

4

(b) (i) that they are very small

accept tiny / really small / a lot smaller / any indication of very small

eg microscopic, smaller than the eye can see

or

1–100 nanometres **or** a few (hundred) atoms

ignore incorrect numerical values if very small is given

1

(ii) any **2** from:

- one (non-bonded) electron from each atom
- delocalised / free electrons
  allow sea of electrons
  ignore electrons can move

- electron carry / form / pass current / charge
  ignore carry electricity

2

[7]

M7. **five** ideas from the following for one mark each

- each carbon / atom joined / bonded to three other carbon / atoms
  or each carbon forms 3 bonds
- in layers
- only weak forces (of attraction) / bonds between layers
  allow weak electrostatic / intermolecular forces /bonds between layers
- layers / atoms can slide over each other
- one electron on each carbon is not used for bonding
- electrons delocalised **or** electrons free
  allow 'sea' of electrons
- electrons carry the charge / current
- giant structure / lattice
- covalent (bonds)
- strong bonds **or** a lot of energy needed to break bonds
  *reference to ionic bonding = **max 4***
  diagrams could be used:
  - *to show layered structure*
  - *to show that each carbon is bonded to three other carbon atoms*
  - *to show giant structure (at least 3 rings required)*

[5]