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1 (a)	B	1
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Question Number	Correct Answer	Mark
1 (b)	D	1

Question Number	Correct Answer	Mark
2	D	1

3)

Correct Answer	Mark
C	1

4) B (1)

5) D (1)

6) A (1)

7) C (1)

8) C (1)

9)

Question Number	Acceptable Answers	Reject	Mark
(a) 1C	(Strong) covalent bonds between atoms within the layers / good overlap of electron orbitals in layers (1) (Weak) London / dispersion / induced dipole-induced dipole (ALLOW van der Waals) forces between layers (1)	Intermolecular forces alone	2

Question Number	Acceptable Answers	Reject	Mark
(b)	Within a layer, one electron per carbon is (ALLOW electrons are) delocalized (so electrons can move easily along layers) (1) Energy gap (ALLOW distance) between layers is too large for (easy) electron transfer (1)	Electrons between layers not delocalized	2

Question Number	Acceptable Answers	Reject	Mark
(c)	N has one more (outer shell) electron than C(1) Would increase number of (delocalised) electrons ... contributing to the London / dispersion (ALLOW van der Waals) forces (1) OR holding layers together (1)	Just London / dispersion / van der Waals forces stronger	2

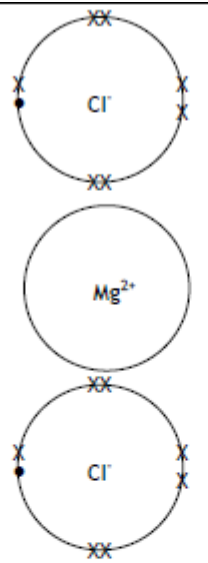
Question number	Acceptable Answers	Reject	Mark
(d)	No heat energy required / low energy requirement / high temperatures not needed / sunlight (which is renewable) could be used Ignore generalisations such as 'greener', 'environmentally friendly' 'smaller carbon footprint' cheaper or fossil fuels not used.		1

Question number	Acceptable Answers	Reject	Mark
(e)	$\text{CO} + 2\text{H}_2 \rightarrow \text{CH}_3\text{OH}$ OR Structural and displayed formulae ALLOW CH_4O for CH_3OH		1

(f) 12 marks	Score 1 mark for each clearly made point <ol style="list-style-type: none"> 1. Need energy to make benzene / catalyst / hydrogen 2. High energy / temperature / pressure needed for the reaction (ALLOW stated T or P) 3. Fossil fuel (oil or coal) used as source of energy, benzene or hydrogen 4. Hydrogen has to be manufactured 5. Hydrogen has to be stored 6. Fossil fuels non-renewable 7. Reduces CO_2 in atmosphere / recycles CO_2 8. CO_2 is a greenhouse gas / causes global warming 9. CO toxic 10. Benzene toxic / carcinogenic 11. 100% atom economy in making methanol 12. Beneficial if phenol useful / not beneficial if phenol a waste product Ignore generalisations such as 'greener', 'smaller carbon footprint' or 'environmentally friendly'.	References to the ozone layer	6
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Question number	Acceptable Answers	Reject	Mark
(g)	Delivering drugs to cells ALLOW Delivering drugs to specific / targeted parts of the body Catalyst with big surface area	Just drug delivery	1

10)			
(a)	$(1s^2 2s^2) 2p^6 3s^2 3p^5$ (ignore repetition of $1s^2 2s^2$) ALLOW subscripts, correct use of p_x , p_y and p_z orbitals or normal font for electrons	2 8 7	1

(b) (i)	 <p>Correct number of outer electrons (ignore whether dots and / or crosses) drawn and also ratio of magnesium : chloride ions is 1:2 (1)</p> <p>Correct formulae and charges of the ions shown somewhere (1)</p> <p>NOTE: Diagram for Mg^{2+} showing the outermost shell with $8e^-$ (dots and/or crosses) and/or Cl^- shown with a 2 in front or 2 as a subscript would also score both marks</p> <p>Mark the two points independently</p>	Covalent bonding (0)	2
(b) (ii)	<p>4 shared pairs of electrons around the carbon labelled C (1)</p> <p>ALL outer electrons, including lone pairs, are correctly shown on each of the four chlorine atoms labelled Cl (1)</p> <p>ALLOW versions without circles</p> <p>IGNORE lines between the shared electrons</p> <p>Mark two points independently</p>	Ionic bonding (0)	2

11)

3(a)	<p>ALLOW reverse arguments in each case</p> <p>Any three from:-</p> <ul style="list-style-type: none"> • sodium atoms/sodium ions are larger (than magnesium atoms/ions) <p>NOTE: Allow symbols (eg Na or Na⁺) (1)</p> <ul style="list-style-type: none"> • sodium ions are Na⁺ whereas magnesium ions are Mg²⁺ OR Na⁺/sodium ions have smaller charge (density) than Mg²⁺/magnesium ions (1) <p>[NOTE: It follows that the statement that "Na⁺ ions are larger than Mg²⁺ ions" would score the first two scoring points above)]</p> <ul style="list-style-type: none"> • sodium has fewer delocalized electrons (than magnesium) (1) • attraction between the positive ions and (delocalized) electrons is weaker in sodium (than magnesium) (1) • sodium is not close-packed (but magnesium is close-packed) (1) • less energy needed (to break bonds) (1) 	<p>Attraction between nucleus and (delocalized) electrons</p> <p>Mention of intermolecular forces/molecules negates the energy mark</p> <p>NOTE: Arguments based on ionization energies OR suggestion of removal of outer shell electrons as part of the melting process scores (0)</p> <p>overall</p>	3
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3(b)	<p>First mark: Idea of (breaking) covalent bonds in silicon (1)</p> <p>Second and third marks: ANY TWO FROM</p> <ul style="list-style-type: none"> • Silicon is giant covalent / giant atomic/giant molecular/macromolecular/giant structure/giant lattice IGNORE just "giant" (1) • Phosphorus made up of simple molecules /small molecules/ P₄ molecules /phosphorus is molecular covalent /molecular/simple covalent IGNORE just "simple"/"simple structure" (1) • Between phosphorus molecules: weak forces/weak intermolecular forces/weak London forces/weak van der Waals' forces/weak dispersion forces/weak induced-dipole forces (1) <p>[ALLOW "weak bonds" if implies between phosphorus molecules]</p> <ul style="list-style-type: none"> • More energy needed (to break bonds in silicon) (1) 	<p>Intermolecular forces broken in silicon/ covalent bonds broken in phosphorus</p> <p>"silicon giant ionic"/"silicon giant metallic"</p> <p>Weak bonds between phosphorus atoms</p>	3
(c)	<p>IGNORE any references to "energy" in this part of the question</p> <p>Argon monatomic/argon (composed of) single atoms NOTE: This must be stated in words, not just by use of its symbol Ar</p> <p>IGNORE any comments about argon atoms having a full outer shell or argon being a noble gas</p> <p>IGNORE any comment about forces/bonds between argon particles</p>	<p>Any suggestion that argon is molecular</p> <p>Argon having a giant structure (of atoms)</p>	1

(d)	<p>First mark:</p> <p>Mg has mobile electrons/delocalized electrons/free electrons/sea of electrons (to carry the charge)</p> <p>ALLOW Mg^{2+} instead of Mg or magnesium (1)</p> <p>Second mark:</p> <p>Sulfur's electrons are fixed (in covalent bonds)/sulfur's electrons are involved in bonding/sulfur's electrons are not free (to move)/no delocalized electrons in sulfur/no mobile electrons in sulfur (1)</p>	<p>Mg has free ions/Mg has mobile ions</p> <p>Sulfur has 'no free ions'/sulfur has delocalized electrons/just "sulfur has covalent bonds"/just "sulfur is not a metal"</p>	2
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12)

(a)(i)	<p>$Ba(s) + 2H_2O(l) \rightarrow Ba(OH)_2(aq) + H_2(g)$</p> <p>OR</p> <p>$Ba(s) + 2H_2O(l) \rightarrow Ba^{2+}(aq) + 2OH^-(aq) + H_2(g)$</p> <p>Correct products (1)</p> <p>State symbols and balancing (1)</p>	<p>Ba_2 $H_2O(aq)$ BaO_2</p>	2
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Question number	Acceptable Answers	Reject	Mark
(a)(ii)	<p>Ba(increases in ON) from 0 to +2 (1)</p> <p>H (decreases in ON) from +1 to 0 (1)</p> <p>TE from (a)(i)</p> <p>Stand-alone marks</p>	<p>Inclusion of oxygen changes will lose 1 mark</p>	2

Question number	Acceptable Answers	Reject	Mark
(b)	<p>$Ba(OH)_2 + 2HCl \rightarrow BaCl_2 + 2H_2O$</p> <p>IGNORE state symbols even if incorrect</p> <p>ALLOW</p> <p>$H^+ + OH^- \rightarrow H_2O$</p> <p>TE from (a)(i):</p> <p>$BaO + 2HCl \rightarrow BaCl_2 + H_2O$</p>		1

Question number	Acceptable Answers	Reject	Mark
(c)	<p>White precipitate / white solid / white crystals (rather than colourless solution) (1)</p> <p>Barium sulfate is insoluble (whereas barium chloride is soluble) (1)</p> <p>Stand-alone marks</p>	'Cloudy' alone	2

Question number	Acceptable Answers	Reject	Mark
(d)(i)	<p>If flame test is described in (d)(i) then award appropriate marks for (d)(ii). A correct decomposition equation given in (d)(i) would score 1 mark.</p> <p>Allow valid discussion of thermal stability appearing in (d)(ii) for mark in (d)(i)</p> <p>Barium carbonate is more thermally stable (than magnesium carbonate) / requires more heating / needs a higher temperature / decomposes more slowly / produces carbon dioxide more slowly</p> <p>OR</p> <p>Reverse argument (MgCO_3 decomposes faster)</p> <p>ALLOW BaCO_3 doesn't decompose on heating but MgCO_3 does (1)</p> <p>$\text{MCO}_3 \rightarrow \text{MO} + \text{CO}_2$ Where M stands for Mg or Ba (1)</p> <p>IGNORE state symbols even if incorrect</p>	<p>Just 'barium'</p> <p>Just 'produces more carbon dioxide'</p> <p>Just 'magnesium'</p>	2
(d)(ii)	<p>Flame test or description of: Mg does not colour flame (1)</p> <p>ALLOW colourless / clear</p> <p>Ba: (pale / apple) green flame (1)</p> <p>Stand-alone marks</p>	<p>Magnesium gives white / bright flame</p> <p>'blue-green'</p> <p>Instrument analysis</p>	2