SECTION A (1 mark for each correct response)

1.	A	2.	A	3.	D	4.	A	5.	B
6.	D	7.	C	8.	B	9.	D	10.	B
11.	B	12.	A	13.	D	14.	D	15.	C
16.	B	17.	C	18.	A	19.	D	20.	C

Brief comments/explanations on answers.

1. electron (Thomson); proton (Moseley); neutron (Chadwick); nucleus (Rutherford); **Correct answer: A.**

2. electronegativity increases across the table from left to right and increases up groups. **Correct answer: A**

3. atomic radius increases across the table from right to left and increases down groups as the number of occupied shells increases. (F is the smallest and K is the largest) **Correct answer: D**

4. Using the atomic numbers on the PT, Fe has 32 neutrons, Co 30, Mn 31, Ni 28. **Correct answer: A**

5. K^+ has 18 electrons and only three occupied shells. **Correct answer: B**

6. The molar mass of $C_{12}H_{22}O_{11}$ = 342 g mol^{-1} of which 144 g is C. This is 42%. **Correct answer: D**

7. 1 mole (or 6.0 x 10^{23} molecules) of CH_4 has a molar mass of 16.0 g mol^{-1}
1 molecule has a mass of $16.0 / (6.0 \times 10^{23}) = 2.7 \times 10^{-23}$ g. **Correct answer: C**

8. n(Cu) = 31.8/63.5 = 0.500 mol n(O) = 16.0 /16.0 = 1.0
n(Cu) : n(O) = 1.0 : 2.0 **Correct answer: B**

9. Element U has 4 valence electron $2s^2 2p^2$. **Correct answer: D**

10. S is a metal with 2 electrons. T is a non-metal with 6 electrons. S^{2+} and T^{2-} will form the ionic compound with formula ST. **Correct answer: B**

11. Nitrogen has 3 single bonds and one lone pair to form its octet. **Correct answer: B**

12. Ionic compounds have directional forces and are brittle. **Correct answer: A**

13. Aluminium conducts electricity, oxygen and methane are gases at RT, so SiO_2 , a giant covalent network lattice is the answer. **Correct answer: D**

14. CH_3Cl is the only non-symmetrical molecule. **Correct answer: D**

15. butan-2-ol has the formula $CH_3CH_2CH(OH)CH_3$ and has 10 hydrogen atoms. **Correct answer: C**

16. $n(Na_2CO_3) = m/M = 212 \times 10^{-3} / 106 = 2.00 \times 10^{-3}$ **Correct answer: B**

17. Ions present are Na^+, Na^+ and CO_3^{2-}. 3 ions are present per 'cluster'. $3 \times 0.5 = 1.5$ mol of ions. **Correct answer: C**

18. The carboxyl group is —COOH. So the compound must have at least two oxygens: However III is not a possible formula. **Correct answer: A**

19. D does not have any C=C bonds which are needed to from an addition polymer. **Correct answer: D**

20. Nanochemistry is based around 1.0×10^{-9} m = 1.0 nanometre = 1.0×10^{-6} mm **Correct answer: C**

SECTION B

Question 1 (5 marks)

a) i) The early part of the modern table is based on recurring properties every ninth element. **(1 mark)**

ii) The noble gases had not been discovered when Newlands put his table together. **(1 mark)**

b) i) any two of: chemical formulae, valencies, atomic masses, physical properties **(2 marks)**

ii) Mendeleev left gaps for as yet undiscovered elements. On the basis of the position of these gaps and in relation to these undiscovered elements, Mendeleev was able to predict the properties of these unknown elements. He also suggested there were errors in some masses. **(1 mark)**

Question 2 (11 marks)

a) i) Y ii) D iii) E iv) G v) A
vi) T (as TCl_3) vii) X (as XQ_4) **(7 × 1 = 7 marks)**

b) i) AL (accept LiCl) **(1 mark)**
ii) T_2Z_3 (accept Al_2O_3) **(1 mark)**

c) i) $1s^2 2s^2 2p^2$ **(1 mark)**
ii) $1s^2 2s^2 2p^6$ **(1 mark)**

Question 3 (6 marks)

a) i) First ionisation energy is the energy required to remove the most loosely bound electron (allow outermost electron) in the atom where the process occurs in the gaseous state. **(1 mark)**

ii) $Na(g) \rightarrow Na^+(g) + e^-$ **(1 mark)**

b) i) first ionisation energy decreases from right to left as the electrons in the outer shell are held by a smaller core charge. **(1 mark)**

ii) atomic radius increases as there is a weaker core charge pulling on the outer shell electrons. **(1 mark)**

c) i) first ionisation energy decreases – the electron to be removed is further away from the nucleus and therefore less tightly held. **(1 mark)**

ii) atomic radius increases – there are more occupied shells containing electrons. **(1 mark)**

Question 4 (6 marks)

a) mass spectrometer **(1 mark)**

b) the reference isotope $^{12}C = 12$ exactly **(1 mark)**

c) let **x** = fraction of Lithium-6 therefore $(1 - x)$ = fraction of Lithium-7 **(1 mark)**

$6.015x + 7.016(1 - x) = 6.90$ **(1 mark)**

$0.116 = 1.001x \Rightarrow x = 0.116 = 11.6\ \%$ **(1 mark)**

d) ^6_3Li **(1 mark)**

Question 5 (10 marks)

a) $CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(g)$
(1 mark for balanced equation & 1 mark for states)

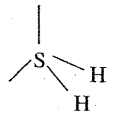
b) $n(CH_4) = m / M = 80 / 16 = 5.0$ mol **(1 mark)**

c) $n(H) = 4 \times n(CH_4) = 20.0$ mol **(1 mark)**

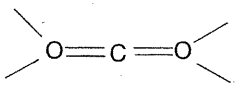
$N(H) = n \times N_A = 20.0 \times 6.0 \times 10^{23} = 1.2 \times 10^{25}$ atoms **(1 mark)**

d) In 16 g, 12 g of C therefore $12 / 16 = 0.75$ i.e. 75 % **(1 mark)**

e)



V- shaped or angular



linear **(2 + 2 = 4 marks)**

Question 6 (4 marks)

1-butene or but-1-ene **(1 mark)**

methanol **(1 mark)**

$CH_3CH_2CH_2COOH$ **(1 mark)**

2-chlorobutane **(1 mark)**

Question 7 (9 marks)

a) Iodine and hexane are composed of non-polar molecules **(1 mark)** while water is made up of polar molecules **(1 mark)**. Non-polar molecular substances such as iodine dissolve better in non-polar solvents such as hexane because of similar strengths of the dispersion forces between molecules **(1 mark)**.

b) i) For Na_2S any two of the following:
solid at room temperature, dissolves in water, high melting point, conducts in molten and aqueous states. **(max. of 1 mark)**

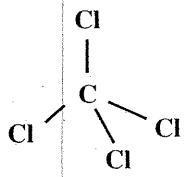
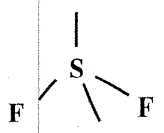
For H_2S any two of the following:
gas at room temperature, low mp/bp, has a foul smell, does not conduct electricity. **(max. of 1 mark)**

ii) Na_2S consists of a network lattice of Na^+ cations and S^{2-} anions in a 2:1 ratio. **(1 mark)**
The ionic bonding involves strong electrostatic attractions between ions and therefore accounting for the high mp. Heat and water can disrupt the ionic lattice to allow ions freedom to move. **(1 mark)**

H_2S is a molecular substance. **(1 mark)**
It has very weak dipole-dipole attractions between molecules together with dispersion forces. **(1 mark)**

Question 8 (9 marks)

a) **(1 mark for each structural formula, 1 mark for each shape, total of 6 marks)**

Molecule	Structural Formula	Shape
N_2	— N≡N —	linear
CCl_4		tetrahedral
SF_2		angular or v-shaped

b) N_2 non-polar; there is no electronegativity difference between the bonded atoms. **(1 mark)**

CCl_4 non-polar; although dipoles exist between the C and Cl atoms, the molecule is symmetrical and the bond dipoles sum to zero. **(1 mark)**

SF_2 highly polar; dipoles exist due to the significant electronegativity difference between the S and F atoms and the molecule is not symmetrical. **(1 mark)**

Question 9 (8 marks)

a) $2K(s) + Cl_2(g) \rightarrow 2KCl(s)$ **(1 mark for balanced equation & 1 mark for correct states)**

b) Each K atom (2,8,8,1) loses one electron to form K^+ (2,8,8) **(1 mark)**
Each Cl atom (2,8,7) gains one electrons to form Cl^- (2,8,8) **(1 mark)**

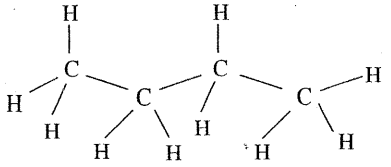
c) Potassium chloride is ionic **(1 mark)** whereas Cl_2 is molecular **(1 mark).**
The electrostatic attraction (ionic bonding) between cations and anions is very strong **(1 mark)** making it a solid with a relatively high melting temperature.
The dispersion forces **(1 mark)** between Cl_2 molecules are not strong enough to hold the Cl_2 molecules together at room temperature.

Question 10 (11 marks)

a) i) Alkanes: A, D , G, J **(2 marks)** ii) C_nH_{2n+2} **(1 mark)**

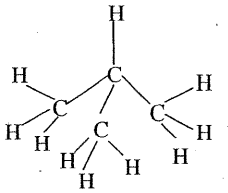
iii) J or I or H **(1 mark)**

iv) J (C_4H_{10}) has two structural isomers possible.



butane

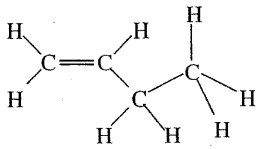
(1 + 1 = 2 marks)



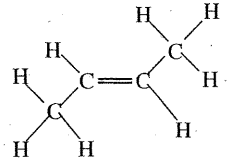
Methylpropane

(1 + 1 = 2 marks)

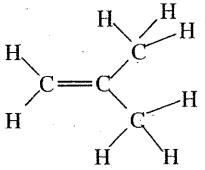
OR letter I (C_4H_8) has three structural isomers possible



but-1-ene or 1-butene



but-2-ene or 2-butene



methylpropene

b) i) F **(1 mark)**

ii) n $C_3H_6 \rightarrow$ —$(C_3H_6)_n$— **(1 mark)**

iii) polypropene **(1 mark)**

END OF SUGGESTED SOLUTIONS