Answer all questions on the OMR form provided (40 Marks)

For each question, there are four possible answers, **A**, **B**, **C** and **D**.

Choose the **one** you consider correct.

1 Zn reacts with VO_3^- ions to give V^{n+}.
3.9 g of Zn was required to react completely with 40.0 cm^3 of 1.0 mol dm^{-3} of KVO_3.

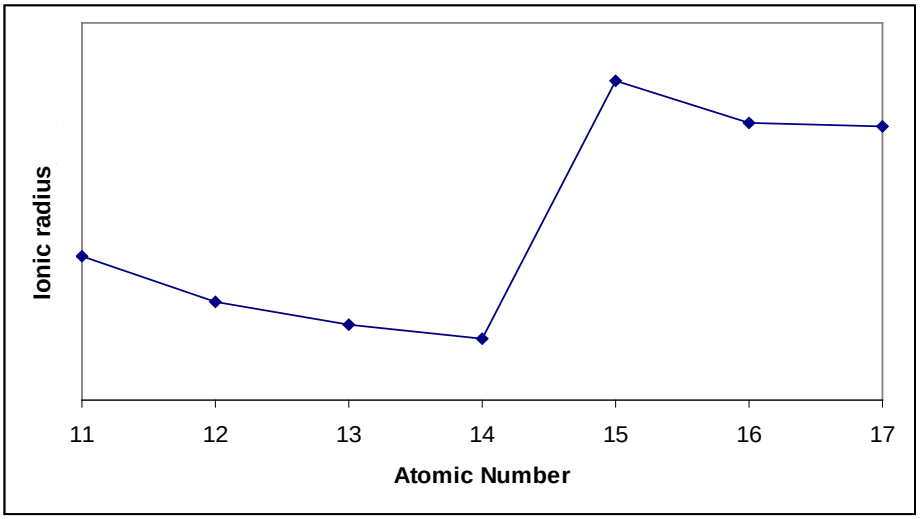
What is the value of n?

	A	1	**C**	3
	B	2	**D**	4

2 In which of the following pairs do the species have **different** shapes?

	A	$AlCl_3$ and CO_3^{2-}
	B	NH_4^+ and CH_4
	C	NH_3 and H_3O^+
	D	SeF_4 and SO_4^{2-}

3 The following graph shows how ionic radius changes across Period 3 for seven elements.



	A	The sharp increase in ionic radius between the 4th and 5th element is due to an increase in the number of principal quantum shells.
	B	There is a decrease in ionic radius for the first 4 elements in Period 3 due to decreasing shielding effect.
	C	There is a decrease in ionic radius for the last 3 elements due to decreasing proton to electron ratio.
	D	The first 4 elements form anions and hence have lower ionic radii than the last 3 elements which form cations.

4 In which of the following reactions is the acid acting as an oxidant?

A $KBr + H_3PO_4 \rightarrow HBr + KH_2PO_4$

B $MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$

C $12HClO_4 + P_4O_{10} \rightarrow 6Cl_2O_7 + 4H_3PO_4$

D $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$

5 A 1dm^3 flask containing helium at 2 kPa pressure is connected (at constant temperature) to a 2 dm^3 flask containing neon at 1 kPa pressure.

What is the final pressure after connection?

A $\frac{4}{3}$ kPa

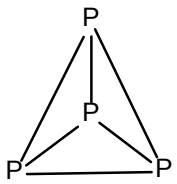
B $\frac{3}{2}$ kPa

C $\frac{5}{3}$ kPa

D 2 kPa

6 *The use of the Data Booklet is relevant to this question.*

Phosphorus, P_4, has the following molecular structure:



Imagine that nitrogen were to form a similar molecule N_4 shown in the reaction below:

$$2N_2(g) \rightarrow N_4(g)$$

What would be the value of ΔH (in kJ mol^{-1}) for the above reaction?

A 1028

B 1348

C 1954

D 2628

7 Which gas shows the greatest deviation from ideal gas behavior?

A HC*l*

B He

C CH_4

D N_2

8 *The use of the data booklet is relevant to this question.*

In many areas, tap water is slightly acidic due to dissolved carbon dioxide. Which metal will not be dissolved by tap water containing carbon dioxide?

A Cr **C** Fe

B Cu **D** Pb

9 Which of the following mixtures is **not** an acid/conjugate base pair?

A H_2O/OH^- **C** NaH/Na

B $H_2PO_4^-/HPO_4^{2-}$ **D** NH_3/NH_2^-

10 Which of the following pairs of solutions would form an acidic buffer when mixed?

A HCN and NaCN

B HNO_3 and $NaNO_3$

C NaOH and NaC*l*

D HC*l* and NaOH

11 Bleaching solutions are manufactured by dissolving chlorine gas in sodium hydroxide solution to give the following reaction.

$$Cl_2\,(g) + 2OH^-\,(aq) \rightleftharpoons OCl^-\,(aq) + Cl^-\,(aq) + H_2O\,(l)$$

Users are warned not to mix the bleach with other cleaning solutions to prevent evolution of hazardous chlorine gas. Which of the following actions will lead to liberation of chlorine gas?

A Addition of water to bleach

B Mixing of an alkali with bleach

C Shaking bleach with table salt, NaC*l*

D Subjecting bleach to high pressure

12 Given that,

Equilibrium **I**: $C(s) + O_2(g) \rightleftharpoons CO_2(g)$ $K_{c1} = 3$
Equilibrium **II**: $C(s) + \frac{1}{2} O_2(g) \rightleftharpoons CO(g)$ $K_{c2} = 2$
Equilibrium **III**: $CO(g) + \frac{1}{2} O_2(g) \rightleftharpoons CO_2(g)$ $K_c = ?$

What is the numerical K_c value for the Equilibrium **III**?

	A	$\frac{\sqrt{2}}{3}$	**C**	$\frac{\sqrt{3}}{2}$
	B	$\frac{2}{3}$	**D**	$\frac{3}{2}$

13 The rate of removal of the pain-killing drug paracetamol from the body is a first order reaction with a rate constant, *k*, of 0.26 h^{-1}.

How long will it take for 6.25% of the paracetamol ingested to remain in the body?

	A	2.7 hours	**C**	8.1 hours
	B	10.6 hours	**D**	13.5 hours

14 Sulfates of Group II metals exist as crystalline form as follows:

$MgSO_4.7H_2O$ $CaSO_4.2H_2O$ $SrSO_4$ $BaSO_4$

Which one of the following accounts for this trend in hydration?

	A	The atomic radius of the elements increases down the group.
	B	The ionic character of these sulfates increases down the group.
	C	The ionisation energy of the elements decreases down the group.
	D	The radius of the cation increases down the group.

15 **X** is a mixture of two compounds. When **X** is treated with an excess of dilute hydrochloric acid, a colour gas is evolved and some, but not all of the mixture dissolves.

Which one of the following mixtures could be **X**?

	A	$Ba(NO_3)_2$ and $Ca(OH)_2$
	B	Ag_2SO_4 and $CaCO_3$
	C	$CaCO_3$ and $MgSO_4$
	D	$Ca(OH)_2$ and $MgCO_3$

16 A yellow precipitate of cadmium(II) sulfide is formed when H_2S is passed into an aqueous solution of cadmium(II) ions, Cd^{2+}. This precipitate is also obtained in the presence of dilute hydrochloric acid but not in the presence of concentrated hydrochloric acid nor in excess potassium chloride.

Which explanation accounts for **all** these observations?

A The presence of a high concentration of H^+ (aq) suppresses the ionisation of H_2S (aq).

B The concentration of S^{2-} (aq) is reduced by the formation of SCl_4^{2-} (aq).

C CdS (s) is insoluble in concentrated HCl (aq).

D Cd^{2+} (aq) ions react with Cl^- (aq) to form the complex ion $[CdCl_4]^{2-}$ (aq).

17 A current of 2.0 A is used to plate Ni(s) from 500 cm^3 of a 1.00 mol dm^{-3} Ni^{2+}(aq) solution.

What is the concentration of Ni^{2+}(aq) after 3.0 hours?

A 0.39 mol dm^{-3}

B 0.46 mol dm^{-3}

C 0.78 mol dm^{-3}

D 0.89 mol dm^{-3}

18 Which one of the following statements is correct about a reaction for which the equilibrium constant is independent of temperature?

A The enthalpy change of reaction is zero.

B Its rate constants do not vary with temperature.

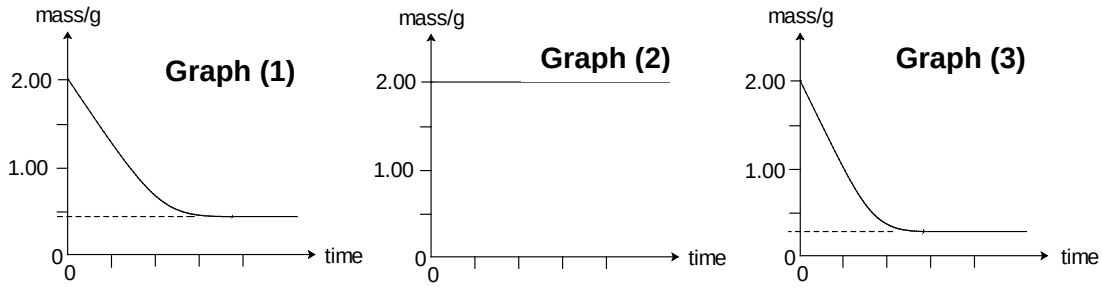
C There are equal numbers of moles of reactants and products.

D The activation energies for both the forward and reverse reactions are zero.

19 Magnesium iodate(V) undergoes thermal decomposition to yield products as shown by the equation below. The other Group II iodates(V) also undergo similar thermal decomposition.

$$2Mg(IO_3)_2(s) \rightarrow 2MgO(s) + 2I_2(g) + 5O_2(g)$$

The three graphs given below show the change in mass when 2.00 g each of three Group II iodates(V) are heated separately at a temperature **T**.



Which three Group II iodates(**V**) give rise to these graphs?

	Graph (1)	Graph (2)	Graph (3)
A	$Ca(IO_3)_2$	$Mg(IO_3)_2$	$Ba(IO_3)_2$
B	$Mg(IO_3)_2$	$Ba(IO_3)_2$	$Sr(IO_3)_2$
C	$Ca(IO_3)_2$	$Mg(IO_3)_2$	$Sr(IO_3)_2$
D	$Sr(IO_3)_2$	$Ba(IO_3)_2$	$Ca(IO_3)_2$

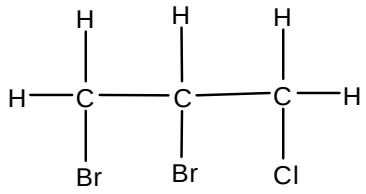
20 A compound **X** exhibits structural isomerism, the isomers being members of different homologous series.
To which pair of isomers could **X** belong?

A	acyl chlorides and carboxylic acids
B	carboxylic acids and esters
C	amino acids and ammonium salts
D	amides and amino acids

21 What is the total number of structural and geometrical isomers for a compound with molecular formula C_3H_5F, excluding cyclic structures?

A	**3**
B	**4**
C	**5**
D	**6**

22 1,2-dibromo-3-chloropropane (**DBCP**) has been used in the control of earthworms in agricultural land. The structure of **DBCP** is shown below.



Which of the following reactions will lead to the highest yield of **DBCP**?

	A	$CH_2=CHCH_2Cl + Br_2 / CCl_4$ ® **DBCP**
	B	$CH_2=CHCHBr_2 + HCl$ (g) ® **DBCP**
	C	$CH_3CH_2CH_2Cl + 2Br_2$ / uv light ® **DBCP** + 2HBr
	D	$CH_3CHBrCH_2Br + BrCl$ / uv light ® **DBCP** + HCl

23 Compound **J**, $C_5H_{11}Cl$ undergoes the following reaction.

$$C_5H_{11}Cl \xrightarrow{\text{Ethanolic KOH}} C_5H_{10}$$

Which of the following **cannot** be Compound **J**?

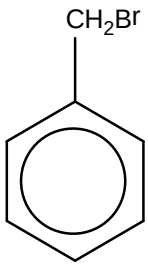
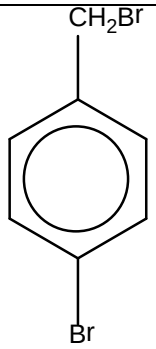
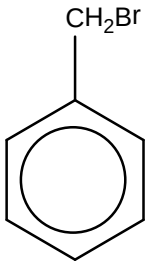
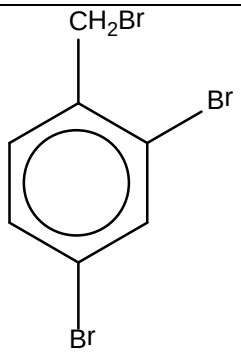
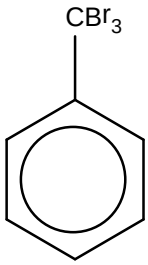
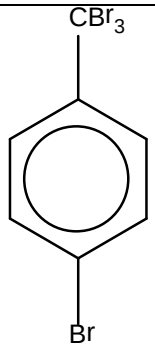
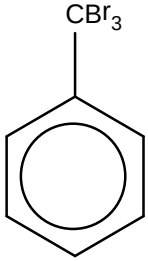
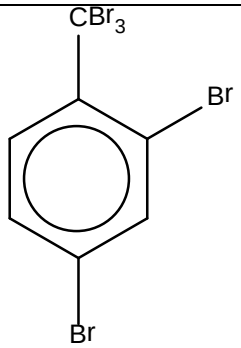
	A	1-chloropentane
	B	2-chloropentane
	C	2 –chloro-3-methylbutane
	D	1-chloro-2,2-dimethlypropane

24	A polypeptide was digested using two different enzymes. The fragments obtained were separated using electrophoresis. Analysis of the fragments from each digestion gave the following results: Digestion using enzyme **N**: thr-phe-leu cys-glu-val ser-glu-cys asp-cys Digestion using the enzyme **O**: val-asp-cys-thr phe-leu-ser glu-cys cys-glu What is the correct sequence of the polypeptide structure?	
	A	cys-glu-val-ser-glu-cys-asp-cys-thr-phe-leu
	B	cys-glu-val-asp-cys-thr-phe-leu-ser-glu-cys
	C	glu-cys-glu-val-asp-cys-thr-phe-leu-ser-glu
	D	ser-glu-cys-glu-val-asp-cys-thr-phe-leu-ser

25 Methylbenzene and bromine, in the ratio of 1:6 were mixed and left under the sun and compound **Q** was isolated.

After which, iron fillings were added to the mixture at room temperature and Compound **R** was identified to be the final product.

Which of the following is likely to be Compounds **Q** and **R**?

	Compound **Q**	Compound **R**
A		
B		
C		
D		

26 One industrial preparation of ethanoic acid is the direct carbonylation of methanol using a rhodium catalyst.

$$CH_3OH + CO \xrightarrow[\text{catalyst}]{\text{rhodium}} CH_3CO_2H$$

Which compound could be used to produce $HC(CO_2H)(CH_2CO_2H)(CH_2CO_2H)$ by this method?

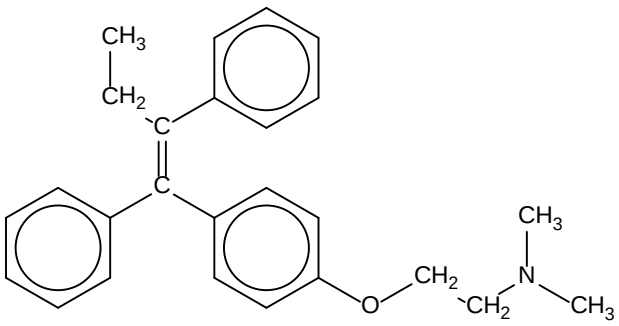
A $HC(OH)(CO_2H)(CH_2CO_2H)$

B $HC(CO_2H)(CO_2H)(CH_2OH)$

C $HC(OH)(CH_2OH)(CH_2OH)$

D $HC(CH_2OH)(CH_2OH)(CH_2OH)$

27 Tamoxifen is widely used in the treatment of breast cancer.



Tamoxifen

What is the number of sp^2 and sp^3 carbon atoms respectively after subjecting Tamoxifen to hydrogen gas under heat and in the presence of nickel?

	sp^2	sp^3
A	6	20
B	8	18
C	18	8
D	20	6

28	The reduction of a nitrile produces a compound of formula $C_3H_7NH_2$. Which of the following would be produced if the same nitrile is heated with hydrochloric acid?	
	A	CH_3CONH_2
	B	CH_3CH_2COOH
	C	$(CH_3)_2CHCOOH$
	D	CH_3CH_2OH
29	**GABA** has the structural formula, $H_2NCH_2CH_2CH_2CO_2H$. It is a neuro-transmitter released by red algae to encourage shellfish larvae to settle on the ocean bed. How does **GABA** differ from amino acids obtained by the hydrolysis of proteins?	
	A	It does not form zwitterions.
	B	It is not a 2-aminocarboxylic acid.
	C	It is insoluble in water.
	D	It cannot form a polyamide linkage.
30	Which property enables proteins to function as a pH buffer?	
	A	Proteins contain the carboxyl and amino groups.
	B	Proteins are soluble.
	D	Proteins have high molecular mass.
	D	Proteins possess secondary and tertiary structures.

For questions 31 – 40, the responses **A** to **D** should be selected on the basis of

A	*B*	*C*	*D*
1,**2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is to be used as a correct response.

31 Which of the following is/are correct statement(s) about a 12.0 g sample of ^{12}C?

A The number of atoms is 6.02×10^{23}.

B The number of atoms is the same as the number of atoms in 4.0 g of ^{4}He.

C The number of atoms is the same as the number of atoms in 2.0 g of $^{1}H_2$.

32 The enthalpy change of reaction, $D\mathit{H}_r$, between sodium and water (in excess) to produce sodium hydroxide and hydrogen gas can be measured in the laboratory.

$$2Na(s) + 2H_2O(\mathit{l}) \xrightarrow{D\mathit{H}_r} 2NaOH(aq) + H_2(g)$$

Other than temperature change of the solution, what information is/are needed to calculate a value for the enthalpy change of this reaction?

1 Mass of water

2 Mass of sodium

3 Pressure

33 0.1 mol of each of the following is separately added to 100 cm^3 of water.

Which of the following resulting solution(s) show an increasing order of pH values?

1 PCl_3, $AlCl_3$, $NaCl$

2 NH_3, $NaOH$, $Ba(OH)_2$

3 HCl, CH_3CO_2H, CH_3CH_2OH

34 Which of the following reaction(s) is/are always endothermic?

1 Hydration of a gaseous ion

2 The dissociation of a diatomic molecule into atoms

3 The sublimation of a solid

35 The table below shows the solubility product, in mol dm^{-3} for three metal sulfides. In an acidic solution, $[S^{2-}]_{saturated} = 10^{-18}$ mol dm^{-3}.

Metal ion	Mn^{2+}	Ni^{2+}	Ag^{+}
K_{sp} of sulfide	10^{-16}	10^{-21}	10^{-36}

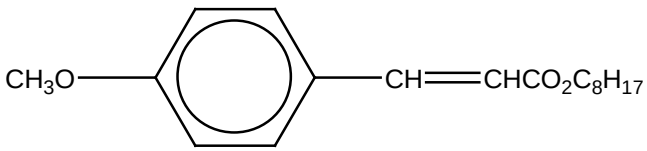
Which of the metal sulfide(s) would be precipitated from the acidic solution containing 0.010 mol dm^{-3} of the metal ion when the solution is saturated with hydrogen sulfide?

1 Mn^{2+}

2 Ni^{2+}

3 Ag^{+}

36 The compound 2-ethylhexyl-p-methoxycinnamate (MOC) is used as a sunscreen.



Which of the following statement(s) is/are correct?

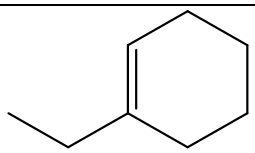
1 A brown precipitate is formed with cold alkaline $KMnO_4$.

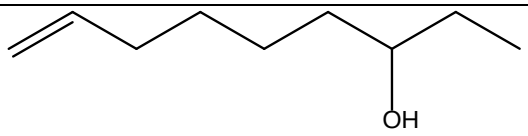
2 A racemic mixture is produced when it is boiled with HC*l* (g).

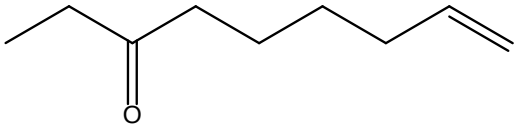
3 It is insoluble in organic solvents.

37 A hydrocarbon, on heating with acidified $KMnO_4$ gives $CH_3CH_2COCH_2CH_2CH_2CH_2COOH$.

Which of the following is/are possible structure(s) of the hydrocarbon?

1 

2 

3 

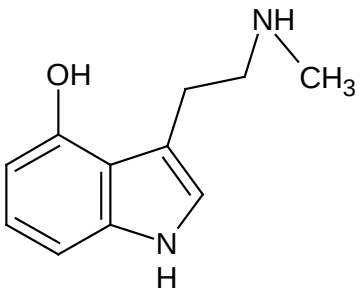
38 Which of the following reaction(s) *c*ould have the same intermediate?

1 $CH_3CH{=}CH_2$ ® intermediate ® $CH_3CH(NH_2)CH_3$

2 $CH_3CH{=}CH_2$ ® intermediate ® CH_3COCH_3

3 $CH_3CO_2CH(CH_3)_2$ ® intermediate ® $CH_3CHBrCH_3$

39 *Psilocin* is a psychedelic mushroom alkaloid. It is the active compound that produces hallucinations from ingesting "magic mushrooms" and amplifies sensory experience. Compound **Y** is a derivative of *Psilocin*.



Y

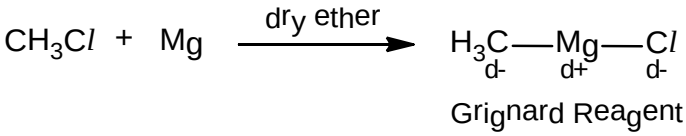
Which of the following statement(s) is/are true about **Y**?

1 It gives white fumes with CH_3COCl.

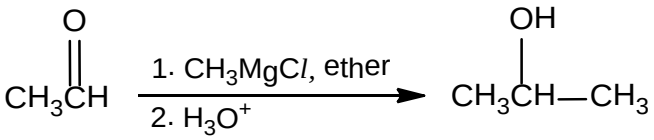
2 It dissolves in both aqueous acids and alkalis.

3 The nitrogen-containing group in the ring has a lower pK_b than the nitrogen-containing group in the side chain.

<table>
<tr><td>40</td><td colspan="2">The Grignard reaction is a very important tool in organic reactions involving the formation of carbon-carbon bond. Grignard reagents are formed by reacting halogenoalkane, R-X, with magnesium in dry ether.

For example, reaction of CH_3Cl with Mg,
 

Grignard Reagent
Grignard reagents allow the carbon chain of carbonyl compounds to be lengthened.

For example,
 

Which compounds could be made from a ketone and a Grignard reagent?</td></tr>
<tr><td></td><td>1</td><td>$CH_3C(CH_2CH_3)_2OH$</td></tr>
<tr><td></td><td>2</td><td>$CH_3CH_2CH_2CH_2OH$</td></tr>
<tr><td></td><td>3</td><td>$(CH_3CH_2)_2CHOH$</td></tr>
</table>

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